BergerABAM

REVISED Final Sampling and Analysis Plan

Mukilteo Multimodal Project
Dredge Material Characterization

Prepared for
Washington State Department of Transportation
Ferries Division
Seattle, Washington

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Revised Sampling and Analysis Plan (SAP)

Mukilteo Multimodal Project
Dredged Material Characterization

Prepared for

Washington State Department of Transportation
Ferries Division
Seattle, Washington

Attention: Dredged Material Management Office (DMMO)

3 April 2013

Prepared by

BergerABAM
1111 Main Street, Suite 300
Vancouver, Washington 98660

Job No. A07.0859.00

Sally L. Fisher
Senior Project Manager

Victoria R. England, LG
Environmental Scientist

REVISED SAMPLING AND ANALYSIS PLAN

Washington State Department of Transportation Ferries Division
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Acronyms and Abbreviations

ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act/Superfund
COCs	contaminants of concern
CFR	Code of Federal Regulations
CSL	cleanup screening level
CUL	cleanup level
CSCSL	Confirmed or Suspected Contaminated Sites List
DMMO	Dredge Material Management Office
DMMP	Dredge Material Management Program
DMMU	Dredge Material Management Unit
DNR	Department of Natural Resources
Ecology	Department of Ecology
EDR	Environmental Data Resources, Inc.
EIM	Environmental Information Management
EPA	Environmental Protection Agency
EPTA	Evaluation Procedures Technical Appendix
G	grams
GPS	Global Positioning System
xxH:xxV	Horizontal to Vertical
KG	kilograms
LUST	leaking underground storage tank
MG	milligrams
ML	maximum level
MLLW	mean lower low water
mls	milliliters
NAD	North American Datum
NPL	National Priorities List
PCS	petroleum contaminated soil

PSDDA	Puget Sound Dredged Disposal Analysis program
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RHA	River and Harbors Act
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SD	Suitability Determination
SL	screening level
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SVOCs	semi-volatile organic compounds
UST	underground storage tank
VOCs	volatile organic compounds
WAC	Washington State Administrative Code
µg	micrograms

1.0 INTRODUCTION

The Washington State Department of Transportation (WSDOT) Ferries Division proposes the Mukilteo Multimodal Project (project) to improve the operations and facilities serving the mainland terminus of the Mukilteo-Clinton ferry route in Washington State. The project will include a new ferry berth, loading area, waiting area, and associated infrastructure to be located approximately 1,800 feet to the northeast of the existing Mukilteo ferry terminal. The project location is shown on the Vicinity Map and Site Plan (Figures 1 and 2).

The project is located at the site of the Mukilteo Tank Farm (tank farm) and associated Tank Farm Pier (pier). The project includes removing the pier and dredging through a sediment mound located beneath the pier to create a channel to accommodate the passage of ferry boats to and from the new terminal.

The tank farm, currently owned by the United States Air Force (USAF), is in the process of being transferred to the Port of Everett in accordance with congressional action. WSDOT will acquire a portion of the property from the Port of Everett for the project. The existing conditions within the project area are shown on Figure 2.

This draft Sampling and Analysis Plan (SAP) describes the site history, potential sources of contaminants, existing data, the proposed project, and associated sampling and analysis of the proposed dredge material. The analytical results will be used to characterize the sediment to evaluate the potential suitability of dredge material for open-water disposal in accordance with Dredged Material Management Program (DMMP) protocols. This draft SAP is provided to the Dredge Material Management Office (DMMO) for the DMMP's approval of the sampling program and procedures prior to completing sediment sampling.

2.0 PROPOSED PROJECT

2.1 Potential Dredging Configuration

WSDOT proposes to dredge the berth/channel through the existing sediment beneath the pier starting approximately 210 feet from the shoreline and extending to 690 feet from the shoreline along the axis of the pier. The pier extends northeast into Possession Sound from the shoreline between former Tanks 2 and 3, as shown on Figure 2 and Figure 3. The pier is 1,360 feet long by 102 feet wide and is supported by approximately 3,900 pressure-treated creosote piles. The pier decking and piles will be removed prior to dredging. The decking will be recycled if possible, and the piles will be transported off site for disposal at an appropriate upland site in accordance with applicable regulations. Complete pile removal will be attempted

and best management practices will be in place during pier and pile removal activities to prevent debris from being left in the sediment.

Sediment has mounded beneath the pier to elevations ranging from -14 feet mean lower low water (MLLW) to approximately -25 feet MLLW. Existing depths in the area to be dredged currently range from approximately -14 to -25 MLLW. The dredge prism is expected to be approximately 120 feet wide and will extend to -30 MLLW (including 2 feet of overdredge), as shown on Figures 4 and 5. The dredging volume will be approximately 23,500 cubic yards (see Table 1).

2.2 Project Area Dredging History

The area on the east side of the pier appears to have been dredged when the pier was constructed in 1941, based on the bathymetry shown on historic construction drawings. Dredging beneath the pier footprint has likely not occurred since the pier's construction. The mound beneath the pier consists of sediment that was trapped by the pier piles and accumulated over time on top of native material. The depth to native material cannot be determined based upon recent sampling events.

3.0 EXISTING SITE CONDITIONS

3.1 General

The upland portion of the project site occupies parcels of property currently owned by the USAF (former tank farm and pier, Parcel 13), WSDOT (existing ferry holding area, Parcel 5), A&J Enterprises (ferry holding lanes leased to WSDOT, Parcel 6), and James Mongrain (pressed or blown glass and glassware, Parcel 8). Approximately 80 percent of the tank farm property is paved with asphalt or concrete, as shown on Figure 2.

Stormwater on the tank farm was historically collected in oil/water separators and discharged from three outfalls within the Mukilteo Multimodal Project footprint. Currently, stormwater on the west portion of the site is collected in catch basins and routed through oil/water separators (one associated with the historical tank farm and one with the existing National Oceanographic and Atmospheric Administration facility) and discharged into Possession Sound. Figure 2 shows existing outfall and oil/water separator locations.

Proposed Dredge Area

A portion of the pier occupies the proposed dredge prism. Tank farm infrastructure still exists on the pier, including fuel piping from historic fueling operations and railroad spurs. The railroad spurs extend approximately 400 feet onto the pier from the shoreline. The pier is in disrepair and currently cannot be accessed.

4.0 SITE HISTORY

The history of the project area, as described below, was compiled from various sources provided by WSDOT, including USAF reports, site investigation reports,

and regulatory agency files. The following information relates only to the historical use of the tank farm pier and activities along the waterfront (tank farm) in the proposed ferry berth area.

4.1 Upland

The tank farm property was occupied by a lumber and shingle mill from approximately 1909 through 1930. The mill buildings were destroyed in a fire in 1938.

The tank farm property was acquired by the U.S. Army during World War II and the site was used for loading ammunition on to ships bound for the Pacific theater during the war. The property facilities included administration buildings, maintenance buildings, an ammunition repair shop, railroad spurs, coal-fired equipment, and a pile retaining wall.

The tank farm property was transferred to the USAF in 1951. The property operated as a fuel storage and transfer facility under the USAF and, later, the Defense Logistics Agency (DLA). Fuel storage and transfer operations ceased at the property in 1989.

Environmental site investigations and remediation were conducted at the site after the operations shut down. A remedial treatment system was operated on a portion of the site from 1997 through 2002. Subsequent compliance monitoring led to the Washington State Department of Ecology (Ecology) issuing a Satisfaction of Enforcement Order No. DE 93TC-N268 for the project site in 2006 and the removal of the site from Ecology's Hazardous Sites List in 2008. No further monitoring was required at the site by Ecology after 2006. The site investigations and remediation are described in Section 5.2.

4.2 Tank Farm Pier

The tank farm pier was built in 1941 and was used to load ammunition onto ships during World War II. Munitions were reportedly lost over the side of the pier during this time.

The tank farm pier deck was reinforced with concrete to allow four railroad spurs to be constructed on the pier in 1951. One of the spurs was later removed to accommodate fuel pipelines that extend the entire length of the pier. Approximately 520 of the original tank farm pier piles were removed and replaced in 1959. The remaining 3,380 (approximate) appear to be the original piles placed at the time of pier construction.

The pier was used to receive deliveries of jet fuel (JP-4) and aviation gasoline from 1953 through at least 1973 and possibly until 1989 when fuel storage and transfer operations ceased on the tank farm. The tank farm pier had fallen into disrepair and was no longer used for loading fuel onto railcar tankers by the late 1970s. The fuels

delivered to the pier were distributed by a network of pipes and associated equipment, including the 10 tank farm tanks, to barges, railcars, and tanker trucks. The pier's fuel pipelines remain on the pier and were reportedly flushed after 1989.

5.0 POTENTIAL SOURCES OF CONTAMINATION

Potential sources of contamination were identified based on a comprehensive review of various available sources, including databases, reports, investigations, and data provided by WSDOT and information from Ecology's Environmental Information Management (EIM) database.

5.1 Database Review

5.1.1 Regulatory Database Search

We reviewed a regulatory database search completed by Environmental Data Resources Inc. (EDR) to identify potential sites of concern within and adjacent to the dredge area. The EDR report was obtained by WSDOT in March 2011 for the draft Hazardous Material Discipline Report associated with the project. The results of the review are summarized in the following sections.

5.1.1.1 Project Area. The former tank farm (listed as the fuel laboratory and U.S. Defense Fuel Support Point) is listed as a conditionally exempt small-quantity generator (CE-SQG), leaking underground storage tank (LUST)/underground storage tank (UST) site and on the Confirmed or Suspected Contaminated Sites List (CSCSL), with a No Further Action (NFA) determination dated 2006. Six USTs are listed as either removed or closed in place and 10 USTs are listed as exempt. The contents of the USTs are not listed in the EDR report.

5.1.1.2 Adjacent to Project Area. Other properties in the vicinity of the dredge area listed in the EDR report are either cross-gradient or too far from the study area to be considered potential sources of concern.

5.1.2 Available Site Data Review

We reviewed reports and documents for the project area provided by WSDOT in August and September of 2012 to identify potential sources of contamination that may have impacted sediment quality within the proposed dredge prism. The following sections discuss the findings of that review.

5.1.2.1 Project Area.

Former Tank Farm Pier

Sediment has built up under the pier around the pier piles, with the top of the sediment mound being as much as 25 feet higher than the surrounding sediment. The presence of treated piles within the dredge area is a potential environmental concern during pile pulling and dredging activities. The impact may be limited

because of the age of the pilings and based on the findings of a limited pile study conducted in 1982.[1]

A 1982 physical and core-sample investigation by the USAF of the pier's piles indicates that the piles may not have been fully treated prior to pier construction, and there is little creosote remaining in the exposed portion of the piles. However, only 10 percent of the piles were examined for the study, and the results did not address the condition of the portion of the pile below the mudline. Previous studies of creosote impacts from treated piles/poles indicate that the area of impact around the treated piles will likely be limited to a 1-foot halo around each of the treated piles (Environmental Literacy Council, 2002 and North American Wood Pole Coalition, undated report).

Crates of ammunition were reportedly lost over the side of the pier during ship-loading operations in World War II. U.S. Navy divers recovered several World War II vintage ammunition shells from beneath the pier in 1986 and 1987.

An underwater marine sediment ordnance survey was conducted in 1993. The survey was completed to a depth of 12 inches from 20 feet under the pier to 50 feet away from the pier to locate potentially buried ordnance remaining from World War II ammunition loading operations. No ordnance was found.[2] It is unlikely, though possible, that ammunition exists in the sediment mound beneath the pier or in the vicinity of the pier in sediment deeper than 12 inches below the mudline.

Some of the JP-4 and aviation gasoline fuels delivered to the pier may have spilled into Possession Sound due to equipment and pipe leaks, malfunctions, and failures, though it is not noted in any of the documentation reviewed for this report. If spills did occur, the fuel may have contaminated sediments that make up the sediment mound.

Light standards, an elevated walkway, pier operations building/guard shack, smaller sheds, and piping are located on the pier. The walkway and piping could be coated with paint containing lead and possibly other heavy metals such as chromium. Light fixture ballasts and other oil-filled electrical equipment in the building and sheds and on the pier could contain PCBs. Mercury switches, such as thermostats, as well as asbestos-containing material (ACM), could exist in any structures on the pier.

[1] "Structural Survey Mukilteo Fuel Pier," by KPFF Consulting Engineers for the Defense Logistics Agency, dated 28 October 1982.
[2] "After Action Report on DFSP Pier Mukilteo, WA 6-10" by U.S. Department of the Navy, dated 22 July 1993.

5.1.2.2 Upland Project Area.

Former Tank Farm – Upland Area

The tank farm was operated by the USAF and DLA from 1951 until 1989. Each bulk fuel tank was cleaned every two to five years, and the tank sludge was disposed of in the truck turnaround area east of Tank 10 prior to 1965.

Several spills and releases of petroleum hydrocarbons (including gasoline-, diesel-, lube oil-, and jet fuel-range) were reported at the tank farm between 1979 and 1987, including a release of approximately 6,700 gallons of JP-4 to the ground from a section of damaged underground pipeline in 1986. Petroleum hydrocarbons were observed in beach seeps and a sheen was observed on Possession Sound that resulted from the 1986 release.

Five of the bulk storage tanks (Tanks 1 through 3, 7, and 8) were sandblasted and repainted in 1986. Approximately 30 cubic yards of spent sandblasting grit from this operation was transported off site. Site files do not indicate whether or not the soils around these tanks were assessed for the presence of residual sandblast grit or associated contaminants of concern (chromium and lead) that were identified in the sandblast grit transported off of the property. Water samples were collected by Ecology from stormwater around Tanks 3, 7, and 8 and tested for metals in 1996. The water from Tanks 7 and 8 was found to be clean enough to discharge to sanitary sewers. Water samples collected around Tank 3 were found to be contaminated with metals at concentrations greater than state surface water cleanup standards.

Nineteen tanks were removed from the site on or after 1991. Four aboveground storage tanks (ASTs) for diesel, FS11, and non-potable water still remain on the upland portion of the property. Three of these ASTs are empty and inactive and the non-potable water AST is still active. (U. S. Air Mobility Command, August 2012)

Contaminants of concern (COCs) were encountered at concentrations greater than site-specific cleanup levels (CULs) and/or Washington State Model Toxics Control Act (MTCA) Method A CULs for unrestricted land use (where site-specific cleanup levels were not promulgated for a particular contaminant) in upland site soil during 2006/2007 archaeological and geotechnical investigations completed in Area 1 and the west side of Area 3. The exceedances were encountered at depths that roughly correlate with the groundwater smear zone, between 8 feet and 12 feet below ground surface (bgs), where tidal influence causes the groundwater level to fluctuate. The condition of groundwater at these locations is not known. The following COCs were encountered at concentrations greater than site-specific cleanup levels for soil.

- Benzene
- Benzo(a)anthracene
- Chrysene
- Benzo(b) and (k) anthracenes
- Lead

- Silver

Diesel-, lube oil-, and gasoline-range petroleum hydrocarbons were also encountered at concentrations greater than the MTCA Method A CULs for those analytes. The sampling locations and areas where COCs exceedances were encountered are shown on Figure 3.

COCs at concentrations greater than site-specific cleanup levels and/or MTCA Method A CULs were also encountered in the surface granular asphalt bedding material beneath the bottom pad of Tank 3. It is possible that this contamination exists in bedding material beneath all large AST pads.

Remaining tank farm features that may represent COC sources include the welded steel bottoms of the 10 bulk fuel storage tanks; the concrete containment walls and their access stairways; the reinforced concrete floors; the network of underground piping, valves, fuel filters, and pumping systems; the oil/water separators and their associated drain lines; and underground piping and structures, as well as monitoring, extraction, and air sparging wells that may still remain on site from remediation activities. Residual petroleum may be encountered during decommissioning of underground pipelines and structures.

5.2 Previous Investigations

5.2.1 Upland Investigations and Site Remediation

Various site investigations and remedial actions have been completed on the tank farm portion of the site. Hazardous materials were encountered in the tank farm soil, groundwater, surface water, and sediment in the late 1970s through 1980s. COCs detected in soil and groundwater at the site during investigations conducted between the late 1970s and 1980s include total petroleum hydrocarbons, volatile organic compounds (VOCs) [3], and lead. Floating product was observed on groundwater on the west and east portions of the site throughout the 1980s. COCs detected in soil and/or groundwater at the site between the 1980s and 2007 include jet fuel, other petroleum hydrocarbons (including liquid and dissolved phase petroleum hydrocarbons), polychlorinated biphenyls (PCBs), VOCs, metals, polycyclic aromatic hydrocarbons (PAHs), and semi-volatile organic compounds (SVOCs).

Environmental impacts at the site are generally related to the petroleum transfer and storage operations, including a spill of 6,700 gallons of jet fuel (JP-4) after a distribution pipe was damaged in 1986/1987. The spill led to petroleum hydrocarbons discharging in seeps on the beach and a sheen on Possession Sound. The spill was the result of a damaged section of underground distribution pipeline

[3] VOCs detected at the site in the 1970s and 1980s include benzene, ethylbenzene, toluene, chloroform, methylene chloride, and tetrahydrofuran.

located north of Tank 9. The conditions at the site and the 1986/1987 spill prompted the Washington State Office of the Attorney General to issue Remedial Action Order DE90-N209 requiring DLA to complete a remedial investigation and feasibility study (RI/FS) for cleanup of the Mukilteo Tank Farm pursuant to MTCA and its associated cleanup regulations (1990 Remedial Action Order).

Completed cleanup actions generally consisted of tank removals and groundwater cleanup. A fuel recovery well was installed between the fuels laboratory and an oil-water separator in 1982. The DLA completed an RI/FS for the tank farm (including in-water areas) in 1996 that established site-specific soil and groundwater cleanup levels for certain VOCs, SVOCs/PAHs, and metals.[4] No site-specific soil or groundwater standards were developed for petroleum hydrocarbons.

The Mukilteo Tank Farm was divided into three operable units or areas (Area 1, Area 2, and Area 3, as shown on Figure 2) for corrective action purposes after investigative work was performed in the early 1990s. Area 1 focused mainly on contamination in the vicinity of the USAF Fuels Laboratory. Area 2 was found to have soil and groundwater contamination, with a dissolved groundwater contaminant plume centered between Tanks 9 and 10, extending parallel to the shoreline from the west end of the Tank 9 containment to the east end of the Tank 10 containment. Corrective action was not required in Area 3 because significant contaminant levels were not identified in that area.

Soil vapor extraction and air sparge remediation systems were installed in Area 1 and Area 2. The remedial systems were operational from May 1997 to November 2000. Approximately 338,000 pounds of hydrocarbons (or approximately 49,400-56,100 gallons of hydrocarbons, using conversion factors of 6.02 pounds per gallon for aviation gasoline fuels and 6.84 pounds per gallon for JP-4) was removed from the site during remediation system operation.

Ecology issued a Partial Satisfaction of Enforcement Order No. DE 93TC-N268 indicating that no further monitoring was required for most of the site on April 21, 2005. Soil, groundwater, surface water and marine sediment compliance monitoring was conducted following the shutdown of the remediation system (through 2006) when Ecology determined that the Enforcement Order had been satisfied and no further monitoring was required.

[4] Site specific CULs were promulgated for VOCs- acetone (soil only), benzene, toluene, ethylbenzene, and xylenes (BTEX; soil and groundwater); SVOCs - anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, di-n-butylphthalate, fluoranthene, fluorene, and pyrene (soil only) and 2-methylnapthalene and naphthalene (soil and groundwater); and metals - arsenic (As), chromium (Cr)-VI, copper (Cu), lead (Pb), mercury (Hg), silver (Ag), zinc (Zn) –(soil and groundwater), and Cr-III (groundwater only)

Contaminants of concern (including petroleum hydrocarbons, metals, VOCs, and PAHs)[5] were encountered in site soil at concentrations greater than site-specific CULs and/or MTCA Method A CULs for unrestricted land use during geotechnical and archaeological investigations completed in 2006 and 2007 for WSDOT. The impacted soil was encountered at depths that roughly correlate with the groundwater smear zone (8-12 feet bgs) where tidal fluctuations influence groundwater level fluctuations at the site. The extent of impacted soil on this portion of the project area is not known. Figure 3 shows areas of concern identified during the 2006/2007 investigation and suspected areas of concern based on the 2006/2007 investigation findings and site use history. The soil conditions on the upland portion of the site have not been evaluated since 2007 and the groundwater conditions have not been evaluated since compliance monitoring ended at the site in 2006.

The upland environmental conditions are discussed in detail in the project Draft Hazardous Materials Discipline Report (WSDOT 2012) and other documents.

5.2.2 Sediment Investigations

Various investigations of surface sediment quality conditions were conducted by the USAF and U.S. Environmental Protection Agency (EPA) offshore of the tank farm property between 1983 and 2003 and by WSDOT in 2012 as described below. The sediment sampling locations are shown on Figure 3. Investigation results are summarized below.

- The USAF subcontracted a survey of pollutant levels in clams, beach sediments, and seawater in an area located to the east of the dredge prism and project area in 1983 and found no evidence of hydrocarbon contamination in the marine environment. Fluoranthene was detected at a concentration greater than the DMMP Maximum Level (ML) for that analyte in one sediment sample (MUKA) located offshore of the west end of the Tank Farm.

- COCs were encountered at concentrations greater than the associated DMMP Screening Levels (SL) and ML in four surface sediment samples collected during a 1986 investigation conducted by the EPA. The COC exceedances include acenaphthene, benzoic acid, phenol, and fluorene.[6]

- A 1994 sediment investigation was completed by GSI on behalf of the USAF as part of ongoing RI/FS activities. There were no exceedances of SMS SQS encountered in any of the sediment samples analyzed for the 1994 sediment investigation. However, some biological tests of those samples failed. Continued sediment monitoring was included in the Compliance Monitoring Plan (CMP,

[5] See "Mukilteo Multimodal Project Draft l Environmental Impact Statement: Hazardous Materials Discipline Report," prepared for the U.S. Department of Transportation Federal Transit Administration and WSDOT, January 2012.

[6] This data was reviewed in Ecology's EIM database https://fortress.wa.gov/ecy/eimreporting/

1998) associated with RI/FS activities for the site. The CMP identified area-specific monitoring requirements for site sediments associated with the site upland remedial actions.

- Marine sediment samples collected for the USAF RI/FS in 2003 from the top 10 cm (4 inches) at 10 intertidal and 13 subtidal locations were found to comply with regulatory cleanup criteria for all organic and inorganic COCs. The samples had been analyzed for VOCs and SVOCs, pesticides, PCBs, metals, and nitroaromatic compounds (for the presence of ammunition constituents). No further assessment or remedial cleanup action for marine sediment along the shoreline at the Mukilteo Tank Farm was required by Ecology based on these results. Ecology issued a "No Further Action" determination for the Mukilteo Tank Farm in 2006 and project site was given a site cleanup status of "Removal from Hazardous Sites List Completed" in Ecology's 2008 Sediment Cleanup Site Status Report. (Shaw Environmental, Inc., 2004)

- WSDOT conducted preliminary sediment sampling in 2012 (Parametrix) to support the NEPA/SEPA process for the Mukilteo Multimodal Project. The sampling was conducted based upon February 2012 Sediment Sampling and Analysis Plan (Parametrix/Leon Environmental 2012 for WSDOT). Sediment samples were collected from locations around the perimeter of the pier and beneath the pier, as shown on Figure 3.

  The sediment observed in the cores collected in 2012 consists primarily of loosely consolidated shell hash, silty fines, medium to coarse sand or clay, and some cobbles and pebbles. Masses of woody debris, shells, and other debris were observed at all sampling locations though there were no clear layers observed from location to location. Small pockets of black material resembling asphalt were observed around a rock or cobble in all depth intervals in the samples collected from three of the perimeter cores (V4 through V6). Leon Environmental attributed this black material to debris originating from the aging paved pier deck surface.

  Composited samples from the upper interval (surface to 4 feet) at three perimeter locations, one on each side of the pier along three transects, were analyzed for standard list of DMMP/SMS COCs plus dioxins/furans (analyzed only in the surface composite samples), tributyltin and petroleum hydrocarbons (diesel-, gasoline-, and motor oil-range). Two composite samples and one discrete sample were analyzed from the 4- to 8-foot interval and three discrete samples were analyzed from the 8- to 12-foot interval from sample locations around the pier. One or more COCs were encountered at concentrations greater than DMMP Screening Levels SLs and/or SMS SQS in sediment samples collected from six locations around the perimeter of the former fuel pier. The COCs encountered at

concentrations greater than DMMP SL and/or SMS SQS in the pier perimeter samples include:

- Chlordane (surface to 4-foot interval – V1/V6, V2/V5, V3/V4 composite samples).
- Chlordane (4- to 8-foot interval - V3/V4 composite sample).
- PAHs (8- to 12-foot interval - V4 discrete sample).
- Dioxins/Furans (0- to 4-foot interval – V2/V5 composite sample).

The sediment samples were analyzed for petroleum hydrocarbons due to the historical use of the pier as a former fueling and loading pier. The petroleum hydrocarbon results are presented in the 2012 Parametrix report for informational purposes and were not compared to any screening levels as there are no DMMP or SMS SLs for petroleum hydrocarbons. The petroleum hydrocarbon results indicated:

- Gasoline-range hydrocarbons were not detected in any of the sediment samples analyzed.
- Diesel-range petroleum hydrocarbons were either not detected or were detected at concentrations ranging from 17 to 120 mg/kg (discrete sample V4 collected from the 8 to 12 feet interval).
- Motor oil-range petroleum hydrocarbons were either not detected or were detected at concentrations ranging from 28 to 200 mg/kg (discrete sample V4 collected from the 8 to 12 feet interval).

Exceedances were not detected in the samples that were collected from the surface interval (surface to 4 feet) beneath the pier. Deeper sediment samples (from the 4- to 8-foot interval) collected from two of the three sample locations beneath the pier were not analyzed.

Composited samples from the full sample length (0 to 12 feet interval) at each pier perimeter location (V1/V6, V2/V5 and V3/V4) and from the full sample length (0 to 4 feet interval) at each under pier location (D1 through D3) were submitted to a specialized laboratory (Engineering/Remediation Resource Group, Inc.) for an independent technical evaluation of likely munitions and explosives contamination of concern based on analysis of nitroaromatics and nitramines concentrations. Munitions-related analytes were not detected in any of the samples analyzed for those constituents.

The results of the study are summarized below and in Appendix A.

5.2.3 Polychlorinated Dibenzo-p-dioxins and Furans (PCDD/F)

Data regarding the potential presence of polychlorinated dibenzo-p-dioxins and furans (PCDD/F) in the vicinity of the project area were not found during our review of available documents and the Ecology EIM database. Historical activities in and around the project area and existing site use do not appear to be potential sources of PCDD/F in the proposed dredge prism.

The DMMP SL for dioxins/furans was exceeded in one surface composite (V2/V5) collected from the pier perimeter during the 2012 sampling event. Exceedances were not encountered in any of the other samples analyzed for those constituents during the 2012 sampling event.

6.0 PROGRAM OBJECTIVES AND APPROACH

6.1 Objectives

The objective of this SAP is to characterize potential dredge materials within the project area to evaluate the following:

- Suitability of the material for disposal at a DMMP unconfined open-water disposal site.
- Suitability for beneficial use as in-water or upland fills.
- Upland disposal options (if the dredged material is not suitable for DMMP disposal or beneficial use).

6.2 Approach Considerations

6.2.1 General Assumptions

The approach is based on the following:

- This draft SAP is based on the assumption that the Dredge Material Management Office (DMMO) will determine that the surface dredge material (upper 4-feet interval) is moderate ranked and the subsurface dredge material (below 4 feet below the mudline) is high ranked with the associated sampling frequency and recency guidelines based on existing site conditions and historical site use.[7]
- Samples for DMMP characterization will be collected from a vessel outfitted for sediment sampling and sample collection will be attempted both from perimeter and under pier sample vibracore locations.
- Z-sample collection will be attempted, but it may not be possible to collect a sample from the depth representing the newly exposed dredge surface prior to dredging due to sediment conditions or access to the under-pier sample

[7] Recency guidelines allow characterization data to be valid for low-moderate to moderate ranked sites for 5 to 7 years and for high ranked sites for 2 years .

locations. If a pre-dredging sample is not collected, the newly exposed surface will be sampled after dredging to characterize that material.

6.2.2 Eligibility for Potential Open-Water Disposal

It is assumed for the purposes of this SAP that the material within the project area will be defined as "dredged material" and may be considered potentially eligible for unconfined open-water disposal at the Port Gardner DMMP disposal site and/or beneficial use.

6.2.3 Site Ranking

The DMMP (DMMO, 2009, revised 2013) defines site ranking as follows:

- "Low" ranking where there are "Few or no sources of chemicals of concern. Data are available to verify low chemical concentrations (below DMMP screening levels) and no significant response in biological tests."
- "Low-moderate" ranking is used where "Available data indicate a low rank may be warranted, but there are insufficient data to confirm the ranking."
- "Moderate" ranking is used at those sites where "Sources exist in the vicinity of the project, or there are present or historical uses of the project site, with the potential for producing chemical concentrations within a range associated historically with some potential for causing adverse biological impacts."
- "High" ranking is used at those sites where "Many known chemical sources, high concentrations of chemicals of concern, and/or biological testing failures in one or both of the two most recent cycles of testing."

6.2.3.1 Surface Sediment

The portion of Possession Sound around the city of Mukilteo generally has a high ranking with respect to chemicals of concern based on the historical and existing use of upland facilities in the area according to the DMMP User's Manual, "Current general and project-specific rankings for Puget Sound."[8] However, research of historic and existing activities in the vicinity of the dredge area, historic sediment sampling results and the results of the 2012 sediment sampling indicate a moderate ranking for the surface (upper 4 feet), which is supported by the following:

- Potential sources of contamination at the site include the presence of creosote-treated piles within the dredge prism, the historical storage and transfer of petroleum products on the pier and adjacent upland and stormwater outfalls in the site area.

[8] "Dredged Material Evaluation and Disposal Procedures (Users' Manual), Table 4-2" by DMMO, US Army Corps of Engineers Seattle District, dated July 2008 (revised November 2009).

- Existing data indicate that COCs were detected in a limited number of sediment samples at concentrations greater than SMS/DMMP screening level criteria:

  - SMS/DMMP exceedances were not detected in the surface samples collected around the project site in 2003 (Shaw Environmental) or the samples collected in 2012 from the upper 4 feet of material under the pier (Parametrix/Leon Environmental). The sample locations are shown on Figure 4.

  - Exceedances of chlordanes were detected in the samples collected from the upper 4 feet of material around the perimeter of the pier during the 2012 sampling event. Exceedance of dioxins/furans was detected in one of the pier perimeter composite samples (V2/V5) collected from the surface 0- to 4- foot interval during the 2012 sampling event.

- The site was removed from Ecology's Hazardous Sites list in the 2008 Sediment Cleanup Status Report.

6.2.3.2 Subsurface Sediment

Research of historic and existing activities in the vicinity of the dredge area, historic sediment sampling results and the results of the 2012 sediment sampling indicate a high rank for subsurface material (greater than 4 feet below the mudline), which is supported by the following:

- Potential sources of contamination at the site include the presence of creosote-treated piles within the dredge prism, the historical storage and transfer of petroleum products on the pier and adjacent upland and stormwater outfalls in the site area.

- Historical bioassays conducted during the 1994 sampling event (USAF) indicated toxicity in some sediment samples collected in the area.

- Existing data indicate exceedances in samples collected from greater than 4 feet below the mudline including

  - DMMP SL Exceedances of chlordanes detected in the samples collected from one composite sample collected from the 4- to 8-foot interval around the north end of the pier.

  - DMMP SL and SMS SQS exceedances of PAHs in a discrete sample collected from the 8- to 12-foot interval near the northeast corner of the pier.

7.0 SAMPLE COLLECTION AND HANDLING PROCEDURES

7.1 General

Dredge volume, dredge prism configuration and sampling frequency are based on typical cross sections and conditions within the project area. The dredge prism for the option considered for this SAP is based on the following assumptions:

- The existing top of slope ranges from approximately elevation -14 to -25 feet MLLW.
- The design dredging depth will be elevation –30 feet MLLW, including 2 feet of allowable overdredge depth.
- The new slope face will have a 2H:1V slope from the top of bank to -30 feet MLLW.
- The surface material (mudline to 4 feet interval) in the dredge prism will be ranked moderate.
- The subsurface material (below 4 feet) in the dredge prism will be ranked high.

7.2 General Sampling Scheme

The sampling and analyses frequency for DMMP characterization for this project has been determined in accordance with the proposed site rankings as discussed above. We expect that this frequency will also be sufficient for evaluating suitability for beneficial use, compliance with the Sediment Management Standards (SMS, WAC 173-204) and/or other disposal options. It is recognized that material considered for upland beneficial use or disposal may require additional testing appropriate to the proposed scenario based on other regulatory programs and/or requirements that are outside the scope of the DMMP review and approval authority.

We have assumed for planning purposes that the dredge prism consists entirely of material that was deposited beneath the tank farm pier via longshore drift. The material characteristics will be documented in the boring logs. The dredge depths range from approximately 13 feet at the northeast end of the prism to approximately 20 feet at the southwest end of the prism. Sample collection will be attempted at least 2 foot deeper than the proposed dredge depth (including 2 feet of overdredge) at each boring location in order to collect Z-samples representing the newly exposed, post-dredge surface conditions.

Post-dredge surface samples will be collected where pre-dredge Z-samples cannot be achieved during the dredge material characterization sampling. The post dredge samples will be collected from the newly exposed dredge surface in the approximate locations of the boring locations identified for the sampling event described in this

SAP. The three proposed vibracore borings and three alternate locations will be located approximately as shown on Figures 4 and 5.

Sampling and analysis for this project will be performed in accordance with DMMP/Puget Sound Estuary Program (PSEP) protocols. Samples will be collected using a diver guided winch mounted vibracore sampler similar to what was used during the 2012 sampling event. Cores will be processed and samples collected either as soon as the core is extruded on the boat or onshore at the end of each sampling day. Material will be continually sampled from the surface to a depth of approximately 13 feet (along the majority of the prism) and, if possible, to a depth of approximately 20 feet at the southwest end of the prism.

The project area has been delineated into dredge material management units (DMMUs) as follows.

- The potential dredge area has been delineated into three DMMUs ranging from approximately 3 to 12 feet thick, as shown on Figure 5.
- Each DMMU will be further divided into 3- to 12-foot-thick subunits that will be composited for analysis in accordance with the compositing scheme shown in Figure 5. Nine samples will be collected and composited for analysis of the three DMMUs as shown in Table 1.

One additional sample will be collected and archived from each vibracore location as Z-samples (up to three discrete samples archived for potential Z-layer analysis) representative of the post-dredge surface conditions. These samples will be collected from material at depths greater than the bottom of the dredge prism (-30 to -32 feet MLLW), as shown on Figure 5. Up to three additional cores (MMP-4 through MMP-6 on Figure 5) will be completed to collect Z-samples if the proposed vibracores (MMP-1 through MMP-3) cannot reach the post-dredge surface elevation because of sediment conditions or access challenges.

Surface samples from the newly exposed post-dredge surface will be collected after dredging is completed from locations coinciding with vibracores MMP-1 through MMP-3 if pre-dredging Z-sample collection is unsuccessful. The post-dredge surface samples will be collected from the upper two feet of the sediment surface using vibracore sampling equipment operated from a vessel outfitted for that purpose.

Post-dredge surface samples are typically collected from the top 10 cm of the newly exposed dredge surface. However, the post-dredge surface at the project site will be subject to some prop wash scour when the new ferry terminal is operational. The "Mukilteo Hydrodynamics & Sediment Transport Technical Memorandum " (Coast and Harbor, 2013) indicates limited scour (up to 1.4 feet deep) may be caused by prop wash at elevations of approximately -20 to -25 feet MLLW. The scour may impact a portion of the newly dredged surface in the proposed dredge prism, which

is why we propose to collect Z-samples from the upper two feet of the post-dredge surface after dredging is completed if none of the pre-dredge Z-samples can be collected.

Each DMMU sample will be analyzed for DMMP/SMS conventional parameters, the full suite of DMMP/SMS COCs, non-chlorinated volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) PCBs, PCDD/F, pesticides, and tributyltin (TBT) as shown on Table 2. Sediment reference material will also be submitted for analysis of PCBs and PCDD/F in accordance with DMMP guidance.

7.3 Compositing Scheme

7.3.1 General

Samples will be collected from the subunits in each boring and composited to represent DMMUs as described above. Details of the compositing scheme, including depth, subunits and DMMU volumes are shown on Table 1. The anticipated compositing schemes are shown schematically on Figure 5. DMMU samples will be collected and archived for bioassays. Subunit samples will be collected and archived for potential future chemical analysis, if needed.

7.3.2 Surface Unit

DMMP requirements for sampling and analysis of surface sediment for a moderate-ranked site consist of one sample per 4,000 cubic yards and one analysis per 16,000 cubic yards.

The volume of the surface unit (DMMU 1) is estimated to be approximately 8,300 cubic yards. Subunit samples representing approximately 2,700 to 2,800 cubic yards (see Table 1) of material each will be collected. Three subunit samples will be composited to represent DMMU 1, as shown on Figure 5.

7.3.3 Subsurface Units

DMMP requirements for sampling and analysis of subsurface sediment for a high-ranked site consist of one sample per 4,000 cubic yards and one analysis per 12,000 cubic yards.

DMMU 2 and DMMU 3 represents the subsurface units of the dredge prism, as shown on Figure 5. The volume of DMMU 2 is estimated to be approximately 6,100 cubic yards and the volume of DMMU 3 is estimated to be approximately 9,100 cubic yards. Subunit samples representing approximately 1,600 to 4,200 cubic yards (see Table 1) of material will be collected and composited for chemical analysis of DMMU 2 and DMMU 3 as shown on Table 1. Subunit samples will also be archived for potential future analysis.

7.3.4 Post-dredge Surface Z-Samples

Three discrete samples representing the post-dredge sediment surface will be collected from each of the three vibracore locations, if possible. The post-dredge

surface is considered to be at -30 feet MLLW for the purposes of this project. The Z-layer samples will be archived pending results from the overlying DMMU sample. The Z-samples collected will be submitted for analysis if the analytical results from DMMU-3 show concentrations of COCs exceeding the associated DMMP SLs and/or SMS SQS.

Up to three additional vibracores (MMP-4 through MMP-6 on Figures 4 and 5) will be attempted if it is not possible to reach the Z-sample elevation in any of the planned vibracore locations (MMP-1 through MMP-3). Up to three samples will be collected from the newly exposed sediment surface after dredging is completed if Z-samples cannot be collected in the locations shown on Figure 5.

The Z-samples and post-dredge samples, if necessary, will be submitted for analysis of conventionals and the COCs (if any) detected at concentrations exceeding SMS SQS or DMMP SLs in the overlying DMMU 3. Portions of these samples will be archived and frozen pending the need for additional analyses.

7.4 Sample Collection and Handling Procedures

DMMP-approved sample requirements, analytical methods and QA/QC criteria are included in Appendix B. Sample volumes, holding times, containers, preservatives, and chemical analytical methods are summarized in Table B-1 in Appendix B. QA/QC criteria are summarized in Table B-2 and B-3 .

7.4.1 Sample Collection

7.4.1.1 Pre-Dredge Characterization

Samples will be collected using a diver-directed vibracore operated from a vessel outfitted for that purpose. Floats will be secured to the coring assembly and a diver will tow the vibracore to a viable sampling location under the pier. The diver will attach the vibracore assembly to an overhead or side-positioned line and pulley and remove the floats when a viable sampling location has been identified. The assembly will be lowered to the mudline and the vibracore will be triggered and vibrated into the sediment until the sample depth is reached or it hits refusal. The diver will guide the assembly back to the boat once the core has been extracted and the floats are attached.

Depth of core penetration into the subsurface will be compared to the length of the core recovered during sampling. The amount of recovery will be recorded and the cores will be capped with aluminum foil and core barrel caps on each end of the core pending sample extrusion.

The vibratory action during sampling tends to consolidate the sample material, so the core length frequently does not match the penetration depth. The sample recovery will be evaluated against the acceptable threshold of 80 percent recovery as recommended by the DMMP. Resampling and/or moving the sampling location, as

appropriate, will be conducted if the initial core recovery is less than 80 percent. The sampling team will make at least 3 sampling attempts in the target area before moving the sampling station to another location within the DMMU. The sampling team will contact the DMMO representative, Kelsey Vanderelst, to discuss options if 80 percent recovery cannot be obtained within three attempts.

The proposed method is based upon primarily successful methodology that Parametrix and Leon Environmental used for the 2012 sediment sampling (Parametrix 2012). BergerABAM (on behalf of WSDOT) will consult with Parametrix regarding these procedures prior to sampling.

7.4.1.2 Post-Dredge Characterization

Up to three post-dredge surface sediment samples will be collected from the newly exposed sediment surface from any of the three areas (delineated by red-dashed lines on Figure 5) where pre-dredge Z-sample collection could not be achieved. The post-dredge surface samples will be collected from the upper 2 feet of the sediment surface using vibracore sampling equipment operated from a vessel outfitted for that purpose.

7.4.2 Sampling Equipment Decontamination

Samples will be collected using a vibracore sampler operated from a vessel outfitted for that purpose. All samplers and miscellaneous sampling tools will be thoroughly cleaned prior to use according to the following procedure:

- Hot water rinse
- Wash with brush and Alconox soap
- Triple rinse with distilled water

All sampling equipment not used immediately after cleaning will be wrapped in aluminum foil and/or stored in plastic bags. The rule of "potential for contaminants" will be used such that any sampling equipment suspected of contamination will be rejected and decontaminated prior to use.

7.4.3 Sample Handling and Compositing

Material at each boring location will be continuously sampled from the existing surface to the dredge design depth for the pre-dredge characterization sampling. Post-dredge surface samples collected after the dredging is completed, if needed, will be collected from borings continuously sampled from the newly exposed dredge surface to 2 feet below the mudline (-30 to -32 MLLW).

Samples from each boring will be separated into 3.0-foot to 12.0-foot fractions representing the subunits as shown on Figure 5, (identified as subunit layers A through C), and Table 1. The fractions will be stored separately for compositing with subunits collected from the other borings, as appropriate. An equal and

representative portion of material will be taken from each core sample to be composited for each sample that will be submitted for analysis.

Logs and field notes of all samples will be maintained during sampling activities. At a minimum, the following will be included in the log:

- Elevation of each station sampled as measured from MLLW
- Station location determined in latitude and longitude using GPS
- Date and time of collection of each sample
- Names of field person(s) collecting and logging in the sample
- Sample characteristics, including grain size, density, and moisture
- Weather conditions
- Tidal conditions and tidal stage
- The sample station number as derived from this sampling plan
- Length and depth intervals of each sample and percent recovery for each sample
- Apparent resistance of the material to sampling based on the depth of penetration of the sampler
- Percent of apparent compression of core samples (significant compaction is not anticipated based on the sandy composition of recently collected samples)
- Picture of each core
- Any deviation from the approved sampling plan

The sample material will be composited and thoroughly mixed in stainless steel bowls. One to 2 liters of homogenized sample will be jarred to provide adequate volume for physical and chemical analyses. Approximately 4 liters of the homogenized sample will be jarred (with zero headspace) to provide adequate volume for bioassay testing. The composited samples will be stored in iced coolers for transport to the laboratory.

All handwork (extruding, mixing, and compositing) will be performed using stainless steel spoons. All sampling, mixing, and compositing equipment will be decontaminated prior to collection at each sampling station. Disposable latex/nitrile gloves will be used and will be rinsed with distilled water before and after handling each individual sample, as appropriate, to prevent sample contamination. Gloves will be disposed of between composites to prevent cross contamination.

7.4.4 Volatiles and Sulfides Subsampling

Volatile (ethylbenzene and total xylenes) and sulfides subsamples will be collected immediately upon sample extrusion and prior to compositing (volatiles and sulfides could be lost while compositing) from one randomly chosen sample representing each DMMU. Subsamples will be collected along the entire length of the representative sample section, from material that has not had contact with the sampler.

Two separate 4-ounce containers will be completely filled with sample sediment for volatiles. No headspace will be allowed to remain in either container. Two samples will be collected to ensure that an acceptable sample is submitted to the laboratory for analysis.

Sulfides samples will be preserved using 5 milliliters (mls) of 2 Normal zinc acetate per 30-g of sediment (DMMP, updated November 2009). The acetate will be placed in a 4-ounce sampling jar and the sample material will be placed in the jar, covered, and shaken vigorously to completely expose the material to the zinc acetate.

7.5 Sample Archiving

A portion of the material collected from each subunit at each DMMU will be archived for potential future individual analysis and/or bioassay analysis.

7.6 Field Sampling Schedule

The sampling will be performed using vibracore equipment owned and operated by a subcontractor licensed to work in the state of Washington. Sampling is expected in mid-2013, but is not scheduled.

7.7 Positioning

Station positions will be determined in latitude and longitude using a hand-held GPS unit (North American Datum [NAD] 83/07) to the nearest 0.1 second. The accuracy of measured and recorded horizontal coordinates will be within 3 meters.

Vertical elevations within each boring location will be measured directly based on depth sampled compared to mudline. Depths below mudline can typically be determined within approximately 0.1 foot. Vertical elevations will be referenced to MLLW based tidal stage and mudline elevations at the time of sampling.

7.8 Sample Transport and Chain-of-Custody Procedures

The samples will be transported to an accredited chemical analytical laboratory when the sampling and compositing is completed. Chain-of-custody procedures will be used to track sample handling from field collection through delivery of the samples to the laboratory. Specific procedures will be as follows:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations, as specified in 49 CFR 173.6 and 49 CFR 173.24.

- The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler, and BergerABAM's office name and address) to enable positive identification.
- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.
- Sample coolers will be transported by vehicle to an accredited chemical analytical laboratory.

The chain-of-custody form will be signed by the persons transferring custody of the coolers upon transfer of sample possession to the laboratory. The shipping container seal will be broken and the condition of the samples will be recorded by the receiver upon receipt of samples at the laboratory.

8.0 LABORATORY PHYSICAL AND CHEMICAL SEDIMENT ANALYSIS

8.1 Analysis Program

The analysis program for this project has been developed primarily to evaluate suitability for open-water disposal in accordance with DMMP. Chemical analysis of the composite samples will consist of sediment conventionals, tributyltin, dioxins/furans, non-chlorinated VOCs (ethylbenzene and total xylenes) and DMMP and SMS COCs, as shown in Table 2. Analysis for TCLP will be performed if needed for upland disposal evaluation.

DMMP screening levels and SMS sediment quality standards (SQS) are shown in Table 2. Chemical analysis of material archived from the individual sampling stations may be performed if DMMP screening levels are exceeded. The decision to test individual subunits will be made in conjunction with the WSDOT and the Dredged Material Management Office (DMMO).

The Puget Sound Sediment Reference Material (SRM) will be requested from the DMMO and will be submitted for PCB and dioxins/furans analysis for data evaluation and validation purposes. Certified reference material, as identified in documentation provided by Analytical Resources, Inc. and included as Appendix C, will be used for data evaluation and validation purposes for the metals, SVOCs and pesticides analyses. The material will be handled and analyzed in accordance with DMMP guidance (DMMP, 2009 and 2012).

The chemical analytical data generated from the chemical analysis will also be used to evaluate general sediment quality in accordance with the SMS (also shown in Table 2). Information regarding the chemical characteristics of sediments that will be

potentially suspended and/or dispersed during construction may be required for obtaining Ecology's Short-term Water Quality Modification and Water Quality Certification permits for the project. Suitability for various beneficial uses may also be indicated using the SMS evaluation.

The SMS evaluation will be used by WSDOT as appropriate in making project decisions regarding beneficial uses under consideration, but the results of the SMS evaluation will not affect DMMP suitability for open water disposal. Results of the SMS evaluation will be used to determine the antidegradation status of the surface material exposed by dredging and to evaluate potential water quality effects during in-water activities such as pile removal. Additional testing for dredge material characterizationwill not be triggered based on the results of the SMS evaluation.

The need to submit samples for bioassay testing will be evaluated after the dredge material characterization data results are reviewed. Bioassay testing will be triggered by the exceedance of one or more screening levels for DMMP COCs in the DMMU samples. Samples selected for bioassay testing will be submitted for both acute and chronic tests to characterize toxicity. Bioassay testing will include the following tests.

- 10-day amphipod (Eohaustorieus estuaries) mortality testing (acute toxicity)
- 20-day juvenile infaunal (Neanthes arenaceodentata) growth test (chronic toxicity)
- Sediment larval (Mytilus galloprovincialis or Dendraster exentricus) test (acute toxicity).

8.2 Laboratory Analyses Protocols

Analytic protocols, including sample holding times and method detection limits, will be in accordance with EPA and Puget Sound Estuary Program (PSEP) protocols and requirements. Laboratory testing procedures will be conducted in accordance with the Puget Sound Dredged Disposal Analysis (PSDDA) Evaluation Procedures Technical Appendix (EPTA), June 1988; the PSDDA Phase II Management Plan Report, September 1989; and with the PSEP Recommended Protocols. Several details of these procedures are discussed below.

8.3 Chain-of-Custody

A chain-of-custody record for the samples will be maintained throughout all sampling activities and will accompany samples during shipment to the laboratory, as previously described. Information tracked by the chain-of-custody records in the laboratory include sample identification number, date and time of sample receipt, analytical parameters required, location and conditions of storage, date and time of removal from and return to storage, signature of person removing and returning the sample, reason for removing from storage, and final disposition of the sample.

8.4 Limits of Detection

The samples will be analyzed for all the parameters listed in Table 2. Detection limits of all chemicals of concern must be below DMMP screening levels (SLs). Failure to achieve this may result in a requirement to reanalyze or to conduct bioassays. All reasonable means, including additional cleanup steps and method modifications, will be used to bring all limits-of-detection below DMMP SLs.

All conventional parameters, including grain size, total organic carbon, total solids, total volatile solids, ammonia, and sulfides, will be analyzed. Particle grain-size distribution for each composite sample will be determined in accordance with American Society for Testing and Materials (ASTM) D 422 (modified). Wet sieve analysis will be used for the sieve sizes U.S. No. 4, 10, 20, 40, 60, 140, 200 and 230. Hydrogen peroxide will not be used in preparations for grain-size analysis. Hydrometer analysis will be used for particle sizes finer than the 230 sieve. Water content will be determined using ASTM D 2216. Sediment classification designation will be made in accordance with U.S. Soil Classification System, ASTM D 2487.

8.5 Quality Assurance/Quality Control

The chemistry QA/QC procedures will follow PSEP and the QA/QC criteria established for the PSDDA/DMMP programs. The bioassay procedures will follow PSEP protocols and Puget Sound Water Quality Authority "Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments" and the QA/QC criteria established for the SMS/DMMP programs. Bioassay performance standards and evaluation guidelines are included in Appendix B (Table B-3).

8.6 Laboratory Written Report

A written report will be prepared by the analytical laboratory documenting all the activities associated with sample analyses. At a minimum, the following will be included in the report:

- Results of the laboratory analyses and QA/QC results, including case narrative
- All protocols used during analyses
- Chain-of-custody procedures, including explanation of any deviation from those identified herein
- Any protocol deviations from the approved sampling plan
- Location and availability of data
- QA2 data required by Ecology for the EDD in EIM format

As appropriate, this sampling plan may be referenced in describing protocols.

9.0 REPORTING

9.1 QA Report

The project quality assurance representative will prepare a quality assurance report based upon activities involved with the field sampling and review of the laboratory analytical data. The laboratory QA/QC reports will be incorporated by reference. This report will identify any field and laboratory activities that deviated from the approved sampling plan and the referenced protocols and will make a statement regarding the overall validity of the data collected. The QA/QC report will be incorporated into the Final Report.

9.2 Final Report

A written report shall be prepared by BergerABAM documenting all activities associated with collection, compositing, transportation of samples and chemical analysis. The chemical analytical report will be included as an appendix. The following will be included in the Dredge Material Characterization Report:

- Type of sampling equipment used.
- Protocols used during sampling and testing and an explanation of any deviations from the sampling plan protocols.
- Logs of the borings showing descriptions of each sample and indicating the native horizon.
- Methods used to locate the sampling positions within an accuracy of 3 meters.
- Locations of the borings where the samples were collected. Locations will be reported in latitude and longitude to the nearest tenth of a second.
- A plan view of the project showing the actual sampling locations and DMMU boundaries.
- Chain-of-custody procedures used and explanation of any deviations from the sampling plan procedures.
- Description of sampling and compositing procedures.
- Final QA report and validation report.
- Data results relative to DMMP and SMS criteria in a table.
- Percent recovery for each core.
- Measured water depth and tide info for each core.

- A table with compositing scheme and length of each core in feet and relative to MLLW.
- Bioassay results, including bioassay laboratory report, if applicable.
- Sampling field logs, as appendix.
- Data in EIM format submitted to DMMO.
- QA2 data required by Ecology for data validation prior to entering data in their Sediment Quality database. In addition, all field and laboratory analyses results and associated QA data will be submitted to the Corps of Engineers in electronic format.
- Project cost data will be forwarded to the DMMO separately.

10.0 STUDY TEAM AND RESPONSIBILITIES

10.1 General

The SAP includes: (1) project planning and coordination; (2) field sample collection; (3) laboratory preparation and analyses; (4) QA/QC management; and (5) final data report. The program will use the following team members and responsibilities.

10.1.1 Project Planning and Coordination

Ms. Sally Fisher of BergerABAM is the primary contact for characterization activities and project permitting coordination. Ms. Victoria England of BergerABAM is the primary technical representative for characterization activities.

10.1.2 Field Sample Collection

Ms. England will provide overall direction to the field and laboratory programs and will coordinate field activities. She will be responsible for assuring that all the required logistics elements and protocols are followed, including accurate sample positioning, sample handling and field decontamination procedures, physical evaluation and logging of samples, and chain of custody of the samples until delivered to the analytical laboratory. Samples will be collected using equipment owned and operated by a subcontractor licensed to work in the State of Washington. The driller will be provided with this SAP and will be required to follow the procedures described herein. The driller will record any deviations from the SAP in their daily logs.

10.1.3 Laboratory Analysis

Analytical Resources, Inc. (ARI) will perform chemical analysis for this project. ARI will be provided with this SAP and will be required to follow the procedures described herein. The laboratory staff will record any deviations from the SAP in their analytical data package for the project. Quality Assurance/Quality Control Management

Ms. Fisher will provide QA/QC oversight and senior review for the field-sampling and laboratory programs. Ms. Amber Roesler, BergerABAM, will review laboratory QA/QC data to assure validity of data and conformance to QA/QC requirements, and will provide a written QA/QC report.

10.1.4 Final Data Report

Ms. England will be responsible for preparation of the final sampling data report identifying sample locations, field and laboratory methods, QA/QC, lessons learned, and data results.

11.0 REFERENCES

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Table 1 - Compositing Scheme and DMMU Volumes

DMMU/ Sample	Total DMMU Volume (cy)	Vibracore	Depth (feet below mudline)	Sample	Sample Volume	Material[1]
DMMU-1	8,300	**MMP-1**	0-4	**MMP-1A**	2,800	Surface
DMMU-2	6,100		4-8	**MMP-1B**	2,000	Subsurface
DMMU-3	9,100		8-19	**MMP-1C**	4,200	Subsurface
Z	-NA-		19-21	**Z1**	-NA-	Post-dredge surface[2]
DMMU -1	8,300	**MMP-2**	0-4	**MMP-2A**	2,800	Surface
DMMU-2	6,100		4-8	**MMP-2B**	2,000	Subsurface
DMMU-3	9,100		8-13	**MMP-2C**	3,300	Subsurface
Z	-NA-		13-15	**Z2**	-NA-	Post-dredge surface[2]
DMMU -1	8,300	**MMP-3**	0-4	**MMP-3A**	2,700	Surface
DMMU-2	6,100		4-8	**MMP-3B**	2,100	Subsurface
DMMU-3	9,100		8-12	**MMP-3C**	1,600	Subsurface
Z	-NA-		12-14	**Z3**	-NA-	Post-dredge Surface[2]
P1	-NA-	**MMP-4**	12-14	**P1[3]**	-NA-	Post-dredge Surface
P2	-NA-	**MMP-5**	12-14	**P2[3]**	-NA-	Post-dredge Surface
P3	-NA-	**MMP-6**	14-16	**P3[3]**	-NA-	Post-dredge Surface
23,500		**Maximum Total Dredge Volume (cy)**				

Notes:

1. Assumes surface material will be ranked "moderate" and subsurface material will be ranked "high."
2. Post-dredge surface samples will be collected from the upper 2-feet at the post-dredge surface depth.
3. Post-dredge surface samples will be collected from MMP-4, MMP-5 and MMP-6 only if samples representing that material cannot be collected from vibracores MMP-1 through MMP-3. Samples will be collected from the newly exposed dredge surface at locations MMP-1 through MMP-3 after dredging is completed if pre-dredge Z-samples cannot be collected.

Table 2 - DMMP and SMS Chemical Evaluation Criteria[1]

Chemical	DMMP Criteria			SMS Criteria	
	SL	BT	ML	SQS	CSL
Conventionals					
Total Solids (%)	--	--	--	--	--
Total Volatile Solids (%)	--	--	--	--	--
Total Organic Carbon (%)	--	--	--	--	--
Ammonia (mg/kg)	--	--	--	--	--
Total Sulfides (mg/kg)	--	--	--	--	--
Metals[2] mg/kg dry wt.					
Antimony	150	---	200	--	--
Arsenic	57	507.1	700	57	93
Cadmium	5.1	11.3	14	5.1	6.7
Chromium	260	260	--	260	270
Copper	390	1,027	1,300	390	390
Lead	450	975	1,200	450	530
Mercury	0.41	1.5	2.3	0.41	0.59
Nickel	--	--	--	--	--
Selenium	--	3	--	--	--
Silver	6.1	6.1	8.4	6.1	6.1
Zinc	410	2,783	3,800	410	960
Organometallic Compounds					
Tributyltin – bulk (µg/kg dry wt.)	73	73	--	--	--
Organics					
Non-chlorinated VOCs	--	--	--	--	--
Ethylbenzene	--	--	--	--	--
Total Xylenes	--	--	--	--	--
LPAH[3] µg/kg dry wt.					
Total LPAH[4]	5,200	--	29,000	370	780
Acenaphthylene	560	--	1,300	66	66
Acenaphthene	500	--	2,000	16	57
Anthracene	960	--	13,000	220	1,200
Fluorene	540	--	3,600	23	79
Naphthalene	2,100	--	2,400	99	170
Phenanthrene	1,500	--	21,000	100	480
2-Methylnaphthalene	670	--	1,900	38	64

Table 2 - DMMP and SMS Chemical Evaluation Criteria[1] (continued)

Chemical	DMMP Criteria			SMS Criteria	
	SL	BT	ML	SQS	CSL
HPAH[3] µg/kg dry wt,					
Total HPAH[5]	12,000	--	69,000	960	5,300
Benzo(a)anthracene	1,300	--	5,100	110	270
Benzo(a)pyrene	1,600	--	3,600	99	210
Total Benzofluoranthenes[6]	3,200	--	9,900	230	450
Benzo(g,h,i)perylene	670	--	3,200	31	78
Chrysene	1,400	--	21,000	110	460
Dibenzo(a,h)anthracene	230	--	1,900	12	33
Fluoranthene	1,700	4,600	30,000	160	1,200
Indeno(1,2,3-c,d)pyrene	600	--	4,400	34	88
Pyrene	2,600	11,980	16,000	1,000	1,400
Miscellaneous Extractables[3] µg/kg dry wt.					
Dibenzofuran	540	--	1,700	15	58
Hexachlorobutadiene	11	--	270	3.9	6.2
N-Nitrosodiphenylamine	28	--	130	11	11
Benzoic Acid	650	--	760	650	650
Benzyl Alcohol	57	--	870	57	73
Chlorinated Hydrocarbons[3] µg/kg dry wt.					
Hexachlorobenzene	22	168	230	0.38	2.3
1,2-Dichlorobenzene	35	--	110	2.3	2.3
1,4-Dichlorobenzene	110	--	120	3.1	9
1,2,4-Trichlorobenzene	31	--	64	0.81	1.8
Phthalates[3] µg/kg dry wt.					
Bis(2-ethylhexyl)phthalate	1,300	--	8,300	47	78
Butyl benzyl phthalate	63	--	970	4.9	64
Diethyl phthalate	200	--	1,200	61	110
Dimethyl phthalate	71	--	1,400	53	53
Di-n-butyl phthalate	1,400	--	5,100	220	1,700
Di-n-octyl phthalate	6,200	--	6,200	58	4,500
PCBs[3] µg/kg dry wt.					
Total PCBs	130	38[7]	3,100	12	65
Pesticides[3] µg/kg dry wt.					
4,4 DDD	16	--	--	--	--
4,4 DDE	9	--	--	--	--
4,4 DDT	12	--	--	--	--
Total DDT	--	50	69	--	--
Aldrin	9.5	--	--	--	--
Dieldrin	1.9	--	1700	--	--
Chlordane	2.8	37	--	--	--
Heptachlor	1.5	--	270	--	--

Table 2 - DMMP and SMS Chemical Evaluation Criteria[1] (continued)

Chemical	DMMP Criteria			SMS Criteria	
	SL	BT	ML	SQS	CSL
Phenols[3] µg/kg dry wt.					
Pentachlorophenol	400	504	690	360	690
Phenol	420	--	1,200	420	1,200
2 Methylphenol	63	--	77	63	63
4 Methylphenol	670	--	3,600	670	670
2,4-Dimethylphenol	29	--	210	29	29
PCDD/PCDF (total TEQ; ppt dry wt.)	4	10	--	--	--

Notes:

1. DMMP = Dredged Material Management Program (February 2013), SMS = Sediment Management Standards (February 2011).
2. Dry weight results are reported as milligrams per kilogram (mg/kg).
3. Dry weight results are micrograms per kilogram (µg/kg).
4. Total LPAH = The sum of acenaphthylene, acenaphthene, anthracene, fluorene, naphthalene and phenanthrene.
5. Total HPAH = The sum of benzo(a)anthracene, benzo(a)pyrene, total benzofluoanthenes, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3,-c,d)pyrene and pyrene.
6. Total benzofluoranthenes = the sum of the "b," "j" and "k" isomers. The "j" isomer co-elutes with the "k" isomer, thus the concentration of the "j" isomer is included in the "k" isomer concentration.
7. This value is normalized to total organic carbon and is expressed in mg/kg carbon.

SL = Screening Level
SQS = Sediment Quality Standards
CSL = Cleanup Screening Levels
BT = Bioaccumulation Trigger
ML = Maximum Level
LPAH = low molecular weight polynuclear aromatic hydrocarbon compounds
HPAH = high molecular weight polynuclear aromatic hydrocarbon compounds
TOC = Total organic carbon

Shading indicates that the criteria and results are TOC normalized. To normalize to total organic carbon, the dry weight concentration for each parameter is divided by the decimal fraction representing the percent total organic carbon content of the sediment.

Figures

Figure 1 - Vicinity Map

Mukilteo Multimodal Project
DMMP Sampling and Analysis Plan

N

0 250 500 1,000 1,500 Feet

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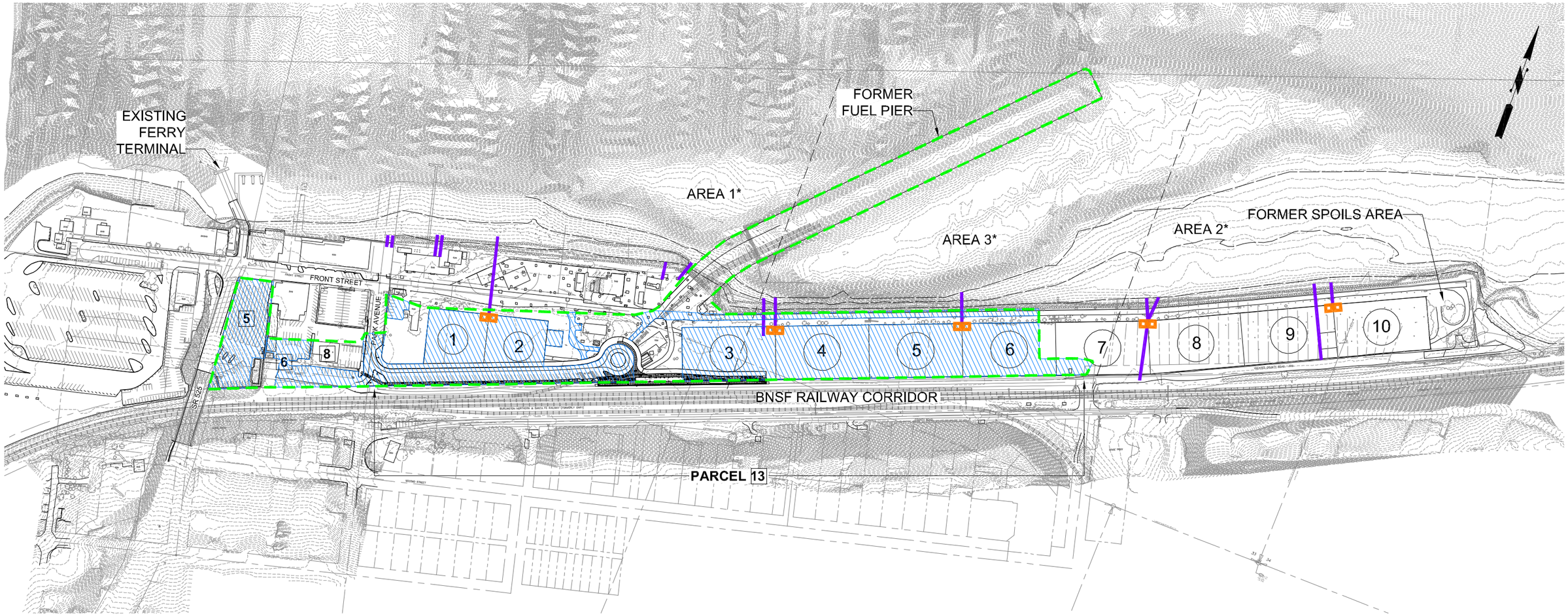

EXISTING CONDITIONS

SCALE: 1"=300'

LEGEND

1 = Tank pad number

Mukilteo Multimodal Project boundary

Pavement/Concrete Surface

Oil-water Separators

Outfall

5 Parcel Number for Reference

*Areas as identified in the "Mukilteo Multimodal Project Draft Environmental Impact Statement Hazardous Materials Discipline Report" January 2012

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MUKILTEO MULTIMODAL PROJECT:
DMMP SAMPLING AND ANALYSIS PLAN

FIGURE 2: EXISTING CONDITIONS

DRAWING NO. 2
PROJECT NO. FAWAT-07-859
DATE: 11/1/2012
SHEET NO. 2

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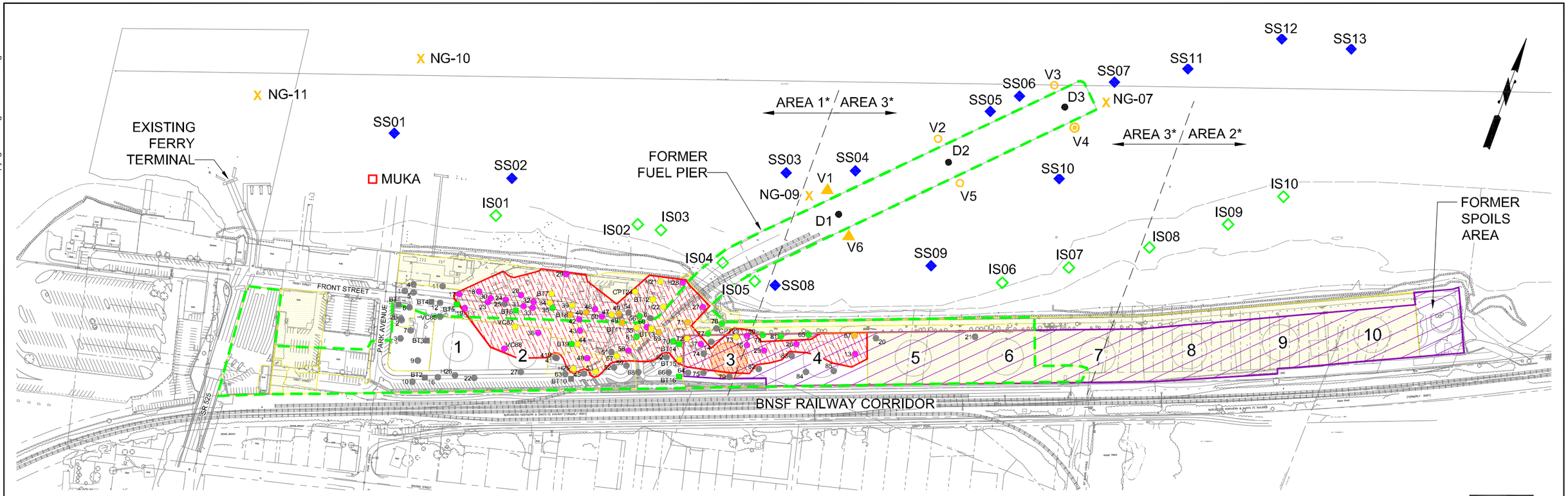

Perimeter Sediment Samples

YEAR	SAMPLE ID	DEPTH	COCs[1]
1983	MUKA	SURFACE	fluoranthene
1986	NG-07	SURFACE	acenaphthene
	NG-09		benzoic acid
	NG-10		phenol
	NG-11		acenaphthene, phenol, fluorene
2003	SS01 - SS13	SURFACE	No Exceedences
	IS01 - IS10		
2012	V1/V6	0-4' (composite)	chlordanes
	V2/V5		chlordanes, dioxins/furans
	V3/V4		chlordanes
	V1/V6	4-8' (composite)	No Exceedances
	V3/V4		chlordanes
	V4	8-12' (discrete)	++

++PAHs (indeno(1,2,3-c,d)pyrene, benzo(g,h,i)perylene, dibenz(a,h)anthracene), pyrene, total HPAHs

Under Pier Sediment Samples

YEAR	SAMPLE ID	DEPTH	COCs[1]
2012	D1	0-4' (discrete)	No Exceedences
	D2		
	D3		
	D2	4-8' (discrete)	Archived; not analyzed
	D3		

Soil Samples

Surface impacted soil: COCs = petroleum hydrocarbons, PAHs; confirmed 2007 [2]

8-12' bgs impacted soil: COCs = petroleum hydrocarbons, BTEX, PAHs; confirmed 2007 [2]

Suspected, impacted surface soil (petroleum hydrocarbons, pesticides, metals, PAHs)

Suspected, impacted soil 8-12' bgs (petroleum hydrocarbons, BTEX and/or PAHs)

Mukilteo multimodal project boundary

2006/2007ARCHAEOLOGICAL/GEOTECHNICAL INVESTIGATION LOCATIONS

- 72 > MTCA (boring)
- BT15 > MTCA (trench)
- 67 >200 ppm PID (boring)
- BT11 >200 ppm PID (trench)
- 13 Observation of impacted soils
- 65 <200 ppm PID (boring)
- BT14 <200 ppm PID (trench)
- 25 Boring locations (8/06; 9/06; 4/07), no impacts observed
- BT3 Approximate NWAA trench locations (7/06) no impacts observed

COCs = contaminants of concern
PAHs = polycyclic aromatic hydrocarbons
BTEX = benzene, toluene, ethylbenzene and xylene
bgs = below ground surface
NFA = no further action
SMS = sediment management standards
SQS = sediment quality standards
DMMP = dredge material management program
SL/ML = screening level/maximum level
MTCA = Model Toxics Control Act

Notes:
1. Sediment COCs encountered at concentrations greater than DMMP SL/ML and/or SMS SQS.
2. Soil COCs encountered at concentrations greater than MTCA A cleanup levels and/or site specific cleanup levels.
3. Ecology granted the site an NFA in 2006. Under the agreed order no cleanup levels were promulgated for petroleum hydrocarbons. There is the potential that shallow soil (0-8' bgs) and groundwater in the upland portion of the site are impacted by petroleum hydrocarbons, PAHs and BTEX based on the historical site use.
4. The sediment sample locations shown are approximate.

*Areas as identified in the "Mukilteo Multimodal Project Draft Environmental Impact Statement Hazardous Materials Discipline Report" January 2012

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MUKILTEO MULTIMODAL PROJECT SITE: DMMP SAMPLING AND ANALYSIS PLAN

FIGURE 3: CONFIRMED AND SUSPECTED CONTAMINANTS OF CONCERN: UPLAND SOIL & IN-WATER SEDIMENT

DRAWING NO. 3
PROJECT NO. FAWAT-07-859
DATE: 2/28/2013
SHEET NO. 3

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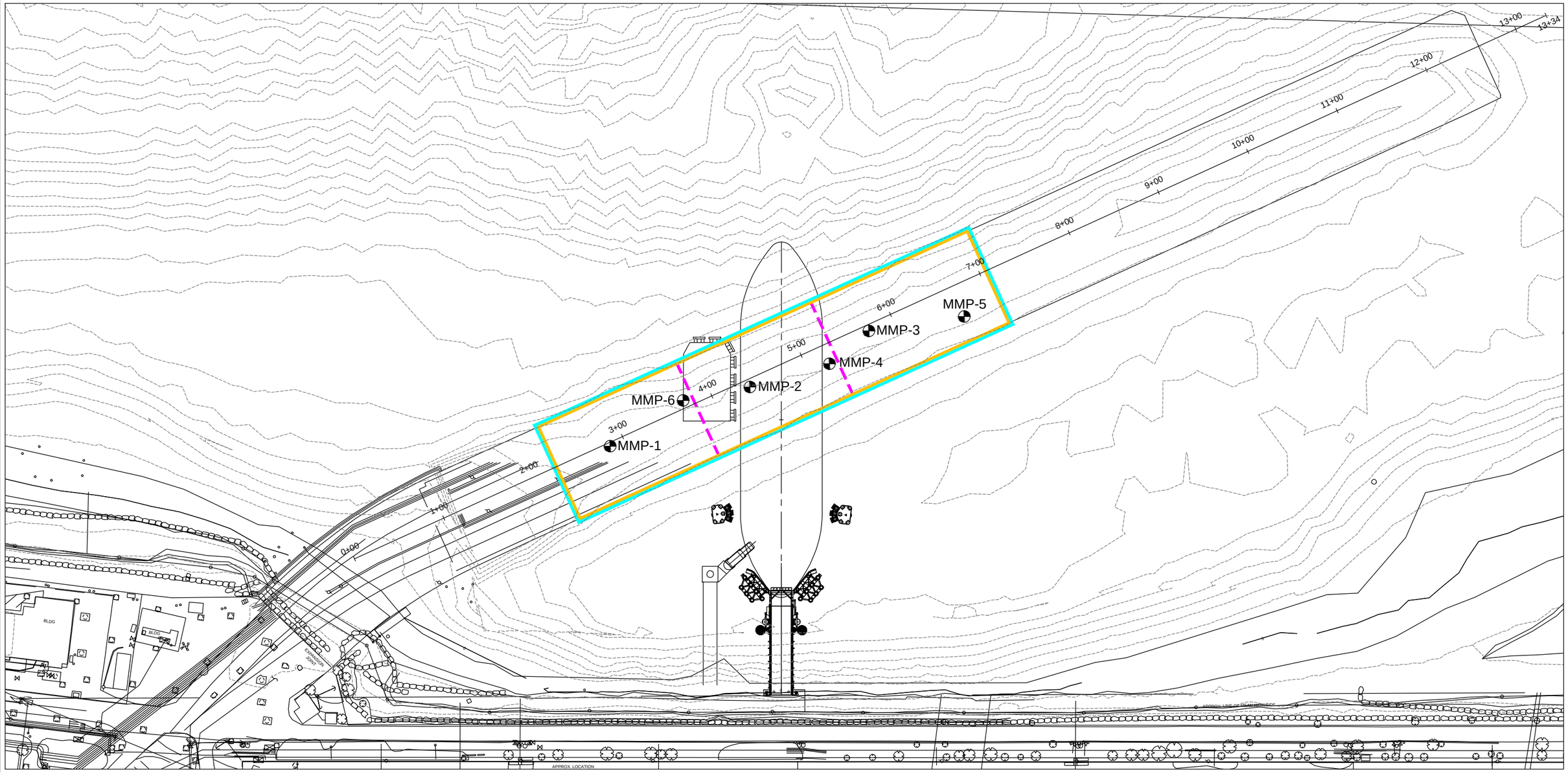

NOTES:

1. THE LOCATION OF FEATURES SHOWN ARE APPROXIMATE
2. THIS FIGURE IS FOR INFORMATION PURPOSES AND IS INTENDED TO ASSIST IN SHOWING FEATURES DISCUSSED IN THE ATTACHED DOCUMENT

SURFACE DMMU BOUNDARY

DMMU SUBUNIT BOUNDARY

BOUNDARY OF DREDGE PRISM

MMP-1 APPROXIMATE LOCATION OF VIBRACORE

MMP-4 THROUGH MMP-6 APPROXIMATE LOCATION OF ADDITIONAL VIBRACORES

50 0 50 100
scale feet

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MUKILTEO MULTIMODAL PROJECT SITE: DMMP SAMPLING AND ANALYSIS PLAN

FIGURE 4: SITE PLAN - DREDGE PRISM AND VIBRACORE LOCATIONS

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DATE: 3/12/2013
SHEET NO. 4

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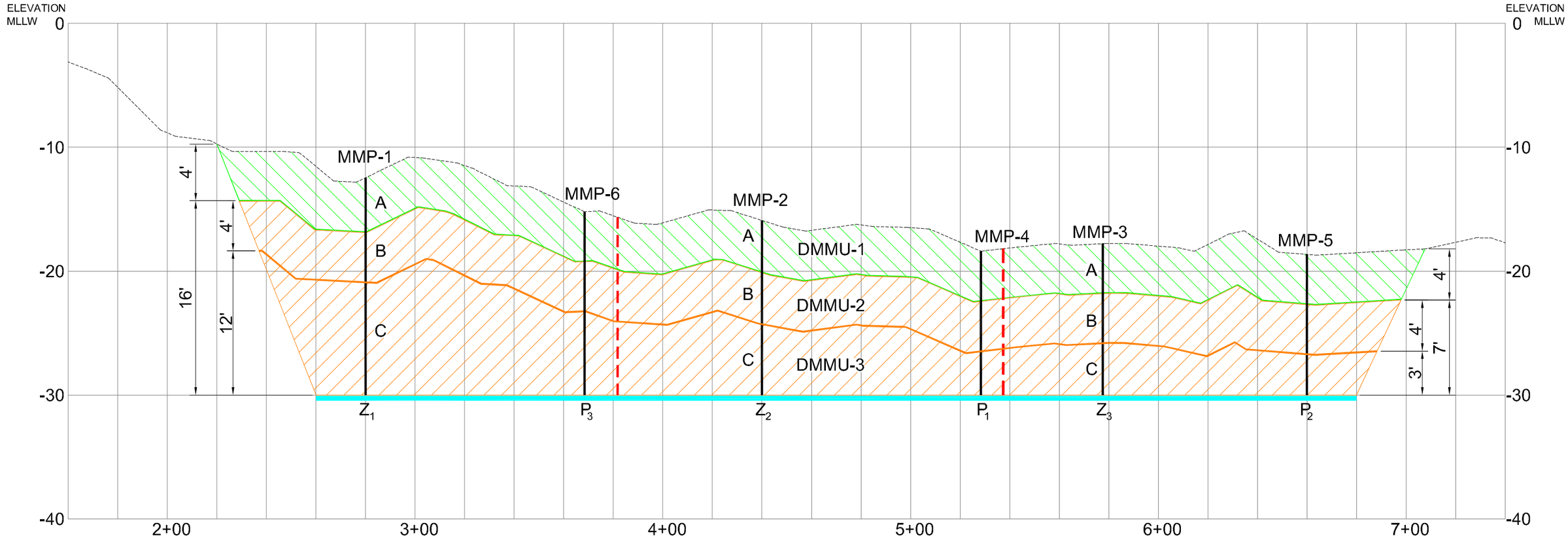

NOTES:

1. IF Z-SAMPLE COLLECTION IS NOT ACHIEVED FROM THE MMP-1 THROUGH MMP-3 VIBRACORES, UP TO 2 ADDITIONAL VIBRACORES, MMP-4 AND MMP-5, WILL BE COMPLETED TO COLLECT Z-SAMPLES IN ALTERNATE LOCATIONS OR POST-DREDGE SAMPLES WILL BE COLLECTED FROM Z_1 THROUGH Z_3 LOCATIONS.
2. THE LOCATION OF FEATURES SHOWN ARE APPROXIMATE.
3. THIS FIGURE IS FOR INFORMATION PURPOSES AND IS INTENDED TO ASSIST IN SHOWING FEATURES DISCUSSED IN THE ATTACHED DOCUMENT.
4. THE DREDGE PRISM IS ~480 FEET LONG BY ~120 FEET WIDE WITH A DESIGN DEPTH OF -30 FEET MLLW, INCLUDING 2 FEET OF OVERDREDGE.
5. SAMPLE COLLECTION WILL BE ATTEMPTED FROM THE UPPER 10 CENTIMETERS OF POST-DREDGE SURFACE.

	SURFACE MATERIAL (MODERATE RANKING)
	SUBSURFACE MATERIAL (HIGH RANKING)
	POST-DREDGE SURFACE MATERIAL
MLLW	MEAN LOWER LOW WATER
DMMU-1	DREDGE MATERIAL MANAGEMENT UNIT
MMP-1	APPROXIMATE VIBRACORE LOCATION
A	SUBUNIT IDENTIFICATION
Z_1	APPROXIMATE POST-DREDGE SURFACE SAMPLE LOCATION
P_1	POTENTIAL ALTERNATE Z-SAMPLE LOCATIONS
MMP-4 THROUGH MMP-6	APPROXIMATE LOCATION OF POTENTIAL ADDITIONAL VIBRACORE LOCATIONS

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MUKILTEO MULTIMODAL PROJECT SITE: DMMP SAMPLING AND ANALYSIS PLAN

FIGURE 5: SCHEMATIC DMMU PLAN

DRAWING NO.	5
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SHEET NO.	5

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Appendix A
2012 Sediment Sampling Analytical Data Results

Table 3-1 - Conventional Parameters

		0' - 4' intervals												4' - 8' intervals						8' - 12' intervals					
ANALYTE	**UNITS**	**V1/V6**	**Q[1]**	**D1**	**Q[1]**	**V2/V5**	**Q[1]**	**D2**	**Q[1]**	**V3/V4**	**Q[1]**	**D3**	**Q[1]**	**V1/V6**	**Q[1]**	**V5**	**Q[1]**	**V3/V4**	**Q[1]**	**V1**	**Q[1]**	**V5**	**Q[1]**	**V4**	**Q[1]**
CONVENTIONALS																									
Total Solids	%	68.7		69.8		55.8		59.6		65.4		85.2		76.1		68.3		66.9		92.9		87.6		64.7	
Preserved Total Solids	%	67.7		75.7		55.0		69.3		67.6		80.7		77.9		68.5		75.6		86.2		84.1		71.1	
Total Volatile Solids	%	2.94		2.6		5.31		5.5		2.72		1.45		1.88		2.72		2.68		0.68		0.67		3.71	
N-Ammonia	mg-N/kg dw	12.2		2.92		6.5		3.36		8.2		2.30		16.7		2.5		13.9		0.7		0.6		28.5	
Sulfide	mg/kg dw	218		153		376		159		409		6.99		32		402		246		6.8		1.19	U	530	
Acid Volatile Sulfide	mg/kg dw	231		173		15.6		18.8		12		56		126		707		136		6.2		1.14	U	474	
Total Organic Carbon	%	1.32		1.75		2.40		1.77		1.12		1.72		1.05		1.26		1.35		0.339		0.104		1.34	
GRAIN SIZE																									
Gravel	**%**	**16.5**		**25.1**		**25.6**		**26.5**		**30.5**		**30.7**		**6.7**		**16.6**		**34.2**		**4.2**		**26.2**		**34.5**	
Very Coarse Sand	%	14.2		16.5		20.9		16.7		22.0		14.9		11.0		15.3		22.3		14.5		19.0		14.3	
Coarse Sand	%	24.6		21.2		13.0		14.8		14.9		21.3		25.8		18.8		16.1		37.2		25.0		10.3	
Medium Sand	%	22.2		18.1		10.0		17.4		9.9		20.3		22.9		17.3		9.5		34.2		22.9		9.1	
Fine Sand	%	7.2		6.4		7.7		7.0		5.7		6.0		7.0		7.8		3.6		6.8		4.8		6.8	
Very Fine Sand	%	3.6		2.9		5.4		2.2		3.5		1.5		6.9		5.3		2.3		1.4		0.5		4.1	
Total Sand	**%**	**71.8**		**65.1**		**57.0**		**58.1**		**56.0**		**64.0**		**73.6**		**64.5**		**53.8**		**94.1**		**72.2**		**44.6**	
Coarse Silt	%	1.4		1.1		2.4		2.3		0.7		0.2		6.0		3.9		0.9		1.6	U	1.6	U	4.9	
Medium Silt	%	1.2		0.9		1.7		1.5		1.2		0.4		3.8		2.2		1.1		1.6	U	1.6	U	1.9	
Fine Silt	%	1.5		1.6		5.0		3.5		4.0		0.5		2.3		2.6		2.0		1.6	U	1.6	U	3.3	
Very Fine Silt	%	2.7		2.0		3.5		3.1		3.3		1.0		1.8		3.0		2.9		1.6	U	1.6	U	3.9	
8-9 Phi Clay	%	1.7		1.3		1.5		1.8		1.5		0.8		1.5		2.2		1.7		1.6	U	1.6	U	2.5	
9-10 Phi Clay	%	1.5		1.3		1.0		1.1		0.9		0.8		1.5		2.2		1.5		1.6	U	1.6	U	2.0	
> 10 Phi Clay	%	1.8		1.7		2.3		2.1		1.8		1.4		2.9		2.9		1.9		1.6	U	1.6	U	2.3	
Total Fines	**%**	**11.8**		**9.9**		**17.4**		**15.4**		**13.4**		**5.3**		**19.8**		**19.0**		**12.0**		**1.6**	**U**	**1.6**	**U**	**20.9**	

1) Qualifier (Q)

U - The target analyte w as not detected at the reported concentration.

Table 3.1 source"Mukilteo Multimodal Project Y-10936 TAA; Sediment Sampling Data Report," by Parametrix for WSDOT, November 2012

Table 3-2 - Comparison to DMMP Criteria

	DMMP Screening Criteria			0' - 4' intervals												4' - 8' intervals						8' - 12' intervals					
ANALYTE	SL	ML	UNITS	V1/V6	Q[11]	D1	Q[11]	V2/V5	Q[11]	D2	Q[11]	V3/V4	Q[11]	D3	Q[11]	V1/V6	Q[11]	V5	Q[11]	V3/V4	Q[11]	V1	Q[11]	V5	Q[11]	V4	Q[11]
METALS (mg/kg)																											
Antimony	150	200	mg/kg dw	20	U	20	U	40	U	20	U	40	U	6	U	6	U	20	U	30	U	5	U	5	U	20	U
Arsenic	57	700	mg/kg dw	20	U	20	U	40	U	20	U	40	U	6	U	6	U	20	U	30	U	5	U	5	U	20	U
Cadmium	5.1	14	mg/kg dw	0.7	U	0.6	U	2	U	0.8	U	2	U	0.3		0.2	U	0.7	U	1	U	0.2	U	0.2	U	0.7	U
Chromium	260	- - -	mg/kg dw	31		23		15		51		22		24		35.2		33		23		21.3		22.9		25	
Copper	390	1300	mg/kg dw	12.8		11.9		12		13.3		10		10.2		17		17.9		20		6.1		7.7		22	
Lead	450	1200	mg/kg dw	7	U	6	U	20	U	8	U	20	U	14		4		10		20		2	U	2	U	25	
Mercury	0.41	2.3	mg/kg dw	0.03	U	0.04		0.03	U	0.05		0.03		0.03		0.08		0.07		0.03		0.02	U	0.03	U	0.25	
Nickel	- - -	- - -	mg/kg dw	29		27		16		36		21		27		34		35		24		26		38		26	
Selenium[1]	- - -	- - -	mg/kg dw	20	U	20	U	40	U	20	U	40	U	6	U	6	U	20	U	30	U	5	U	5	U	20	U
Silver	6.1	8.4	mg/kg dw	1.0	U	1.0	U	3	U	1.0	U	2	U	0.4	U	0.4	U	1	U	2	U	0.3	U	0.3	U	1.0	U
Zinc	410	3800	mg/kg dw	52		32		40		33		32		28		32		50		96		23		29		100	
ORGANOMETALLIC COMPOUNDS																											
Tributyltin ion (bulk)[2]	73	- - -	ug/kg dw	3.8	U	- - -		3.6	U	- - -		3.5	U	- - -		3.5	U	3.5	U	22.0		3.4	U	3.6	U	3.4	U
PAHs																											
Naphthalene	2100	2400	ug/kg dw	41		170		100		160		120		45		98		99		36		20	U	18	U	240	
Acenaphthylene	560	1300	ug/kg dw	20		43		45		65		35		24		22		41		25		20	U	18	U	53	
Acenaphthene	500	2000	ug/kg dw	26		110		23		41		37		36		46		30		16	J	20	U	18	U	160	
Fluorene	540	3600	ug/kg dw	28		100		42		55		64		47		54		50		29		20	U	18	U	150	
Phenanthrene	1500	21000	ug/kg dw	210		260		260		170		340		150		170		160		160		20	U	18	U	430	
Anthracene	960	13000	ug/kg dw	50		140		93		120		120		110		70		94		82		20	U	18	U	250	
Total LPAHs	**5200**	**29000**	**ug/kg dw**	**375**		**823**		**563**		**611**		**716**		**412**		**460**		**474**		**348**		**20**	**U**	**18**	**U**	**1283**	
2-Methylnaphthalene[3]	670	1900	ug/kg dw	20	U	32		15	J	42		25		11	J	25		22		10	J	20	U	18	U	50	
Fluoranthene	1,700	30000	ug/kg dw	550		340		980		360		1600		200		260		220		690		20	U	18	U	1200	
Pyrene	2,600	16000	ug/kg dw	760		1900		1000		1900		1900		1800		630		1200		1300		20	U	27		4700	
Benzo(a)anthracene	1300	5100	ug/kg dw	99		260		300		290		350		240		120		150		200		20	U	18	U	550	
Chrysene	1,400	21000	ug/kg dw	220		480		600		560		780		540		180		300		420		20	U	18	U	1000	
Total Benzofluoranthenes[4,5]	3200	9900	ug/kg dw	320		1600		870		1400		1400		1800		400		900		900		20	U	11	J	2700	
Benzo(a)pyrene	1,600	3600	ug/kg dw	140		690		330		590		570		820		200		420		370		20	U	18	U	1300	
Indeno(1,2,3-cd)pyrene	600	4400	ug/kg dw	60		310		160		310		290		340		87		170		180		20	U	18	U	530	
Dibenz(a,h)anthracene	230	1900	ug/kg dw	23		120		58		120		97		140		33		67		63		4.9	U	4.6	U	180	
Benzo(g,h,i)perylene	670	3200	ug/kg dw	61		300		150		320		280		340		94		170		180		20	U	18	U	570	
Total HPAHs	**12000**	**69000**	**ug/kg dw**	**2233**		**6000**		**4448**		**5850**		**7267**		**6220**		**2004**		**3597**		**4303**		**20**	**U**	**38**		**12730**	
CHLORINATED HYDROCARBONS																											
1,3-Dichlorobenzene	- - -	- - -	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	J	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
1,4-Dichlorobenzene	110	120	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
1,2-Dichlorobenzene	35	110	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
1,2,4-Trichlorobenzene	31	64	ug/kg dw	5	U	4.6	U	4.7	U	4.9	U	4.8	U	4.7	U	4.8	U	4.7	U	4.6	U	4.4	U	4.4	U	4.8	U
Hexachlorobenzene (HCB)	22	230	ug/kg dw	0.47	U	0.48	U	0.48	U	0.49	U	0.48	U	0.47	U	0.48	U	0.47	U	0.47	U	0.47	U	0.47	U	4.7	U
PHTHALATES[6]																											
Dimethyl phthalate	71	1400	ug/kg dw	5	U	4.6	U	4.7	U	4.9	U	4.8	U	4.7	U	4.8	U	4.7	U	4.6	U	4.9	U	4.6	U	4.8	U
Diethyl phthalate	200	1200	ug/kg dw	50	U	46	U	47	U	49	U	48	U	47	U	48	U	47	U	46	U	49	U	46	U	48	U
Di-n-butyl phthalate	1400	5100	ug/kg dw	20	U	19	U	19	U	20	U	19	U	19	U	19	U	19	U	18	U	20	U	18	U	19	U
Butyl benzyl phthalate	63	970	ug/kg dw	5	U	4.6	U	5.1	Q	3.3	J	2.8	J	4.7	U	4.8	U	4.7	U	4.6	U	3.4	J	4.6	U	4.8	U
Bis(2-ethylhexyl) phthalate	1300	8300	ug/kg dw	25	U	27		24	U	17	J	24	U	17	J	24	U	24	U	23	U	25	U	23	U	24	U
Di-n-octyl phthalate	6200	6200	ug/kg dw	20	U	19	U	19	U	20	U	19	U	19	U	19	U	19	U	18	U	20	U	18	U	19	U
PHENOLS																											
Phenol	420	1200	ug/kg dw	20		23		37		30		21		19	U	12	J	14	J	18	U	20	U	18	U	13	J
2-Methylphenol	63	77	ug/kg dw	5.0	U	5.9		3.6	J	24		4.8	U	4.7	U	4.8	U	4.7	U	4.6	U	4.9	U	4.6	U	4.8	U
4-Methylphenol	670	3600	ug/kg dw	40	U	16	J	13	J	23	J	32	J	37	U	27	J	11	J	37	U	40	U	36	U	22	J
2,4-Dimethylphenol	29	210	ug/kg dw	20	U	6.8	J	4.3	J	21		19	U	19	U	3.8	J	3.3	J	18	U	20	U	18	U	3.4	J
Pentachlorophenol	400	690	ug/kg dw	50	U	46	U	47	U	49	U	48	U	47	U	48	U	47	U	46	U	49	U	46	U	48	U
MISCELLANEOUS EXTRACTABLES																											
Benzyl alcohol	57	870	ug/kg dw	20	U	19	U	19	U	7.5	J	19	U	19	U	19	U	19	U	18	U	20	U	18	U	19	U
Benzoic acid	650	760	ug/kg dw	400	U	370	U	110	J	390	U	380	U	370	U	380	U	380	U	370	U	400	U	360	U	380	U
Dibenzofuran	540	1700	ug/kg dw	19	J	80		28		43		40		29		40		38		17	J	20	U	18	U	100	
Hexachloroethane	- - -	- - -	ug/kg dw	20	U	19	U	19	U	20	U	19	U	19	U	19	U	19	U	18	U	20	U	18	U	19	U
Hexachlorobutadiene	11	270	ug/kg dw	0.47	U	0.48	U	0.48	U	0.49	U	0.48	U	0.47	U	0.48	U	0.47	U	0.47	U	0.47	U	0.47	U	4.8	U
N-Nitrosodiphenylamine	28	130	ug/kg dw	20	U	19	U	19	U	20	U	19	U	4.8	J	19	U	19	U	18	U	20	U	18	U	6.7	J
VOCs																											
Trichloroethene	- - -	- - -	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
Tetrachloroethene	- - -	- - -	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
Ethylbenzene	- - -	- - -	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
m,p-Xylene	- - -	- - -	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
o-Xylene	- - -	- - -	ug/kg dw	1.1	U	1.2	U	1.3	U	1.4	U	1.1	U	1.2	U	1	U	1.1	U	0.9	U	0.9	U	0.9	U	1.1	U
Total Xylene[7]	- - -	- - -	**ug/kg dw**	**2.2**	**U**	**2.4**	**U**	**2.6**	**U**	**2.7**	**U**	2.3	U	**2.4**	**U**	**1.9**	**U**	**2.2**	**U**	1.9	U	**1.7**	**U**	**1.8**	**U**	**2.3**	**U**
PESTICIDES & PCBs																											
4,4'-DDD	16	- - -	ug/kg dw	1.5		0.96	U	0.96	U	0.97	U	0.96	U	0.95	U	1.8		0.93	U	0.94	U	0.94	U	0.93	U	9.5	U
4,4'-DDE	9	- - -	ug/kg dw	0.93	U	0.96	U	0.96	U	0.97	U	0.96	U	0.95	U	0.95	U	0.93	U	0.94	U	0.94	U	0.93	U	9.5	U
4,4'-DDT	12	- - -	ug/kg dw	1.4	UY	0.96	U	2.7	UY	0.97	U	2.6	UY	0.95	U	0.95	U	0.93	U	1.7	UY	0.94	U	0.93	U	9.5	U
Total DDT[8]	- - -	**69**	**ug/kg dw**	**1.5**		**0.96**	**U**	**2.7**	**UY**	**0.97**	**U**	**2.6**	**UY**	**0.95**	**U**	**1.8**		**0.93**	**U**	**1.7**	**UY**	**0.94**	**U**	**0.93**	**U**	**9.5**	**U**
Aldrin	9.5	- - -	ug/kg dw	0.47	U	0.48	U	0.48	U	0.49	U	0.48	U	0.47	U	0.48	U	0.47	U	0.47	U	0.47	U	0.47	U	4.7	U
cis-Chlordane	- - -	- - -	ug/kg dw	0.47	U	0.48	U	0.48	U	0.49	U	0.48	U	0.47	U	0.48	U	0.47	U	0.47	U	0.47	U	0.47	U	4.7	U
trans-Chlordane	- - -	- - -	ug/kg dw	1.1	UY	1.9	U	0.48	U	1.9	U	0.94	UY	1.9	U	0.48	U	0.47	U	0.61	UY	0.5	U	0.47	U	4.7	U
cis-Nonachlor	- - -	- - -	ug/kg dw	1.9	U	0.48	U	1.9	U	0.68	UY	1.9	U	0.47	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	19	U
trans-Nonachlor	- - -	- - -	ug/kg dw	7.1		1.9	U	11		2.2	UY	8.6		1.9	U	1.9	U	2.7		4.6		1.9	U	1.9	U	19	U
oxy Chlordane	- - -	- - -	ug/kg dw	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	19	U
Total Chlordane[4,9]	**2.8**	**- - -**	**ug/kg dw**	**7.1**		**1.9**	**U**	**11**		**2.2**	**UY**	**8.6**		**1.9**	**U**	**1.9**	**U**	**2.7**		**4.6**		**1.9**	**U**	**1.9**	**U**	**19**	**U**
Dieldrin	1.9	1700	ug/kg dw	0.93	U	0.96	U	0.96	U	0.97	U	0.96	U	0.95	U	0.95	U	0.93	U	0.94	U	0.94	U	0.93	U	9.5	U
Heptachlor	1.5	270	ug/kg dw	0.47	U	0.48	U	0.60	UY	0.49	U	0.63	UY	0.47	U	0.48	U	0.47	U	0.47	U	0.47	U	0.47	U	4.7	U
gamma-BHC (Lindane)	- - -	- - -	ug/kg dw	0.47	U	0.48	U	0.48	U	1.2	UY	0.48	U	0.47	U	0.48	U	0.47	U	0.47	U	0.47	U	0.47	U	4.7	U
Aroclor 1016	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Aroclor 1221	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Aroclor 1232	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Aroclor 1242	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Aroclor 1248	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Aroclor 1254	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Aroclor 1260	- - -	- - -	ug/kg dw	9.5	U	9.5	U	9.6	U	9.4	U	9.6	U	9.2	U	9.5	U	9.5	U	9.7	U	9.6	U	9.4	U	9.4	U
Total PCBs[10]	**130**	**3100**	**ug/kg dw**	**9.5**	**U**	**9.5**	**U**	**9.6**	**U**	**9.4**	**U**	**9.6**	**U**	**9.2**	**U**	**9.5**	**U**	**9.5**	**U**	**9.7**	**U**	**9.6**	**U**	**9.4**	**U**	**9.4**	**U**
PETROLEUM HYDROCARBONS																											
Gasoline Range Hydrocarbons	- - -	- - -	mg/kg dw	11	U	- - -		15	U	- - -		12	U	- - -		9.5	U	12	U	9	U	6.3	U	6.6	U	11	U
Diesel Range Hydrocarbons	- - -	- - -	mg/kg dw	44		- - -		37		- - -		24		- - -		17		34		25		5.4	U	5.6	U	120	
Motor Oil	- - -	- - -	mg/kg dw	100		- - -		46		- - -		28		- - -		33		72		39		11	U	11	U	300	

Non-Detect SL Exceedance U

SL Exceedance

1) As no SL value exists to trigger toxicity testing, this chemical w ill only be evaluated for its bioaccumulative potential.
2) Bulk sediment measurement of TBT is used only w hen porew ater extraction cannot be accomplished.
3) 2-Methylnaphthalene is not included in the summation for total LPAH.
4) Components of benzofluoranthenes and chlordane w ere clarified at the 2007 SMARM.
5) Sum of b,j, k-Benzofluoranthenes.
6) Based on 1998 LAET/HAET's; see http://w w w .nw s.usace.army.mil/PublicMenu/Doc_list.cfm?sitename=dmmo&pagename=17th_ARM_MAy_5_2004.
7) Sum of m,p and o-Xylenes.
8) Sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT.
9) Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor and oxychlordane.
10) Sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260.
11) Qualifier (Q)
U - The target analyte w as not detected at the reported concentration.
J - Estimated concentration w hen the value is less than the laboratory's established reporting limits.
UY - Compound not detected at or above reported concentration. How ever, the analyte reporting limit is raised due to a positive chromatographic interference thus the analyte may be present below the increased limit.
JM - Estimated (Maximum Possible) Concentration is less than the laboratory's established reporting limits

Table 3.2 source"Mukilteo Multimodal Project Y-10936 TAA; Sediment Sampling Data Report," by Parametrix for WSDOT, November 2012

Table 3-3 - Comparison to Washington State SMS

	SMS Screening Criteria			0' - 4' intervals												4' - 8' intervals						8' - 12' intervals					
ANALYTE	SQS	CSL	UNITS	V1/V6	Q[11]	D1	Q[11]	V2/V5	Q[11]	D2	Q[11]	V3/V4	Q[11]	D3	Q[11]	V1/V6	Q[11]	V5	Q[11]	V3/V4	Q[11]	V1	Q[11]	V5	Q[11]	V4	Q[11]
METALS (mg/kg)																											
Arsenic	57	93	mg/kg dw	20	U	20	U	40	U	20	U	40	U	6	U	6	U	20	U	30	U	5	U	5	U	20	U
Cadmium	5.1	6.7	mg/kg dw	0.7	U	0.6	U	2	U	0.8	U	2	U	0.3		0.2	U	0.7	U	1	U	0.2	U	0.2	U	0.7	U
Chromium	260	270	mg/kg dw	31		23		15		51		22		24		35.2		33		23		21.3		22.9		25	
Copper	390	390	mg/kg dw	12.8		11.9		12		13.3		10		10.2		17		17.9		20		6.1		7.7		22	
Lead	450	530	mg/kg dw	7	U	6	U	20	U	8	U	20	U	14		4		10		20		2	U	2	U	25	
Mercury	0.41	0.59	mg/kg dw	0.03	U	0.04		0.03	U	0.05		0.03		0.03		0.08		0.07		0.03		0.02	U	0.03	U	0.25	
Silver	6.1	6.1	mg/kg dw	1.0	U	1.0	U	3	U	1.0	U	2	U	0.4	U	0.4	U	1	U	2	U	0.3	U	0.3	U	1.0	U
Zinc	410	960	mg/kg dw	52		32		40		33		32		28		32		50		96		23		29		100	
PAHs																											
Naphthalene	99	170	mg/kg oc	3.1		9.7		4.2		9.0		10.7		2.6		9.3		7.9		2.7		5.9	U	17.3	U	17.9	
Acenaphthylene	66	66	mg/kg oc	1.5		2.5		1.9		3.7		3.1		1.4		2.1		3.3		1.9		5.9	U	17.3	U	4.0	
Acenaphthene	16	57	mg/kg oc	2.0		6.3		1.0		2.3		3.3		2.1		4.4		2.4		1.2	J	5.9	U	17.3	U	11.9	
Fluorene	23	79	mg/kg oc	2.1		5.7		1.8		3.1		5.7		2.7		5.1		4.0		2.1		5.9	U	17.3	U	11.2	
Phenanthrene	100	480	mg/kg oc	15.9		14.9		10.8		9.6		30.4		8.7		16.2		12.7		11.9		5.9	U	17.3	U	32.1	
Anthracene	220	1200	mg/kg oc	3.8		8.0		3.9		6.8		10.7		6.4		6.7		7.5		6.1		5.9	U	17.3	U	18.7	
Total LPAHs	**370**	**780**	**mg/kg oc**	**28**		**47**		**23**		**35**		**64**		**24**		**44**		**38**		**26**		**5.9**	**U**	**17.3**	**U**	**96**	
2-Methylnaphthalene[3]	38	64	mg/kg oc	1.5	U	1.8		0.6	J	2.4		2.2		0.6	J	2.4		1.7		0.7	J	5.9	U	17.3	U	3.7	
Fluoranthene	160	1200	mg/kg oc	41.7		19.4		40.8		20.3		142.9		11.6		24.8		17.5		51.1		5.9	U	17.3	U	89.6	
Pyrene	1,000	1400	mg/kg oc	57.6		108.6		41.7		107.3		169.6		104.7		60.0		95.2		96.3		5.9	U	26.0		350.7	
Benzo(a)anthracene	110	270	mg/kg oc	7.5		14.9		12.5		16.4		31.3		14.0		11.4		11.9		14.8		5.9	U	17.3	U	41.0	
Chrysene	110	460	mg/kg oc	16.7		27.4		25.0		31.6		69.6		31.4		17.1		23.8		31.1		5.9	U	17.3	U	74.6	
Total Benzofluoranthenes[4,5]	230	450	mg/kg oc	24.2		91.4		36.3		79.1		125.0		104.7		38.1		71.4		66.7		5.9	U	10.6	J	201.5	
Benzo(a)pyrene	99	210	mg/kg oc	10.6		39.4		13.8		33.3		50.9		47.7		19.0		33.3		27.4		5.9	U	17.3	U	97.0	
Indeno(1,2,3-cd)pyrene	34	88	mg/kg oc	4.5		17.7		6.7		17.5		25.9		19.8		8.3		13.5		13.3		5.9	U	17.3	U	39.6	
Dibenz(a,h)anthracene	12	33	mg/kg oc	1.7		6.9		2.4		6.8		8.7		8.1		3.1		5.3		4.7		1.4	U	4.4	U	13.4	
Benzo(g,h,i)perylene	31	78	mg/kg oc	4.6		17.1		6.3		18.1		25.0		19.8		9.0		13.5		13.3		5.9	U	17.3	U	42.5	
Total HPAHs	**960**	**5300**	**mg/kg oc**	**169**		**343**		**185**		**331**		**649**		**362**		**191**		**285**		**319**		**5.9**	**U**	**37**		**950**	
CHLORINATED HYDROCARBONS																											
1,4-Dichlorobenzene	3.1	9	mg/kg oc	0.08	U	0.07	U	0.05	U	0.08	U	0.10	U	0.07	U	0.10	U	0.09	U	0.07	U	0.27	U	0.87	U	0.08	U
1,2-Dichlorobenzene	2.3	2.3	mg/kg oc	0.08	U	0.07	U	0.05	U	0.08	U	0.10	U	0.07	U	0.10	U	0.09	U	0.07	U	0.27	U	0.87	U	0.08	U
1,2,4-Trichlorobenzene	0.81	1.8	mg/kg oc	0.38	U	0.26	U	0.20	U	0.28	U	0.43	U	0.27	U	0.46	U	0.37	U	0.34	U	1.30	U	4.23	U	0.36	U
Hexachlorobenzene (HCB)	0.38	2.3	mg/kg oc	0.04	U	0.03	U	0.02	U	0.03	U	0.04	U	0.03	U	0.05	U	0.04	U	0.03	U	0.14	U	0.45	U	0.35	U
PHTHALATES[6]																											
Dimethyl phthalate	53	53	mg/kg oc	0.4	U	0.3	U	0.2	U	0.3	U	0.4	U	0.3	U	0.5	U	0.4	U	0.3	U	1.4	U	4.4	U	0.4	U
Diethyl phthalate	61	110	mg/kg oc	3.8	U	2.6	U	2.0	U	2.8	U	4.3	U	2.7	U	4.6	U	3.7	U	3.4	U	14.5	U	44.2	U	3.6	U
Di-n-butyl phthalate	220	1700	mg/kg oc	1.5	U	1.1	U	0.8	U	1.1	U	1.7	U	1.1	U	1.8	U	1.5	U	1.3	U	5.9	U	17.3	U	1.4	U
Butyl benzyl phthalate	4.9	64	mg/kg oc	0.4	U	0.3	U	0.2	Q	0.2	J	0.3	J	0.3	U	0.5	U	0.4	U	0.3	U	1.0	J	4.4	U	0.4	U
Bis(2-ethylhexyl) phthalate	47	78	mg/kg oc	1.9	U	1.5		1.0	U	1.0	J	2.1	U	1.0	J	2.3	U	1.9	U	1.7	U	7.4	U	22.1	U	1.8	U
Di-n-octyl phthalate	58	4500	mg/kg oc	1.5	U	1.1	U	0.8	U	1.1	U	1.7	U	1.1	U	1.8	U	1.5	U	1.3	U	5.9	U	17.3	U	1.4	U
MISCELLANEOUS EXTRACTABLES																											
Dibenzofuran	15	58	mg/kg oc	1.4	J	4.6		1.2		2.4		3.6		1.7		3.8		3.0		1.3	J	5.9	U	17.3	U	7.5	
Hexachlorobutadiene	3.9	6.2	mg/kg oc	0.04	U	0.03	U	0.02	U	0.03	U	0.04	U	0.03	U	0.05	U	0.04	U	0.03	U	0.14	U	0.45	U	0.36	U
N-Nitrosodiphenylamine	11	11	mg/kg oc	1.5	U	1.1	U	0.8	U	1.1	U	1.7	U	0.3	J	1.8	U	1.5	U	1.3	U	5.9	U	17.3	U	0.5	J
Total PCBs[10]	**12**	**65**	**mg/kg oc**	**0.72**	**U**	**0.54**	**U**	**0.40**	**U**	**0.53**	**U**	**0.86**	**U**	**0.53**	**U**	**0.90**	**U**	**0.75**	**U**	**0.72**	**U**	**2.8**	**U**	**9.0**	**U**	**0.70**	**U**
Aroclor 1016	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
Aroclor 1221	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
Aroclor 1232	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
Aroclor 1242	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
Aroclor 1248	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
Aroclor 1254	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
Aroclor 1260	- - -	- - -	mg/kg oc	0.72	U	0.54	U	0.40	U	0.53	U	0.86	U	0.53	U	0.90	U	0.75	U	0.72	U	2.8	U	9.0	U	0.70	U
IONIZABLE ORGANIC COMPOUNDS																											
Phenol	420	1200	ug/kg dw	20		23		37		30		21		19	U	12	J	14	J	18	U	20	U	18	U	13	J
2-Methylphenol	63	63	ug/kg dw	5.0	U	5.9		3.6	J	24		4.8	U	4.7	U	4.8	U	4.7	U	4.6	U	4.9	U	4.6	U	4.8	U
4-Methylphenol	670	670	ug/kg dw	40	U	16	J	13	J	23	J	32	J	37	U	27	J	11	J	37	U	40	U	36	U	22	J
2,4-Dimethylphenol	29	29	ug/kg dw	20	U	6.8	J	4.3	J	21		19	U	19	U	3.8	J	3.3	J	18	U	20	U	18	U	3.4	J
Pentachlorophenol	360	690	ug/kg dw	50	U	46	U	47	U	49	U	48	U	47	U	48	U	47	U	46	U	49	U	46	U	48	U
Benzyl alcohol	57	73	ug/kg dw	20	U	19	U	19	U	7.5	J	19	U	19	U	19	U	19	U	18	U	20	U	18	U	19	U
Benzoic acid	650	650	ug/kg dw	400	U	370	U	110	J	390	U	380	U	370	U	380	U	380	U	370	U	400	U	360	U	380	U
CONVENTIONALS																											
Total Solids	- - -	- - -	%	68.7		69.8		55.8		59.6		65.4		85.2		76.1		68.3		66.9		92.9		87.6		64.7	
Preserved Total Solids	- - -	- - -	%	67.7		75.7		55.0		69.3		67.6		80.7		77.9		68.5		75.6		86.2		84.1		71.1	
Total Volatile Solids	- - -	- - -	%	2.94		2.6		5.31		5.5		2.72		1.45		1.88		2.72		2.68		0.68		0.67		3.71	
N-Ammonia	- - -	- - -	mg-N/kg dw	12.2		2.92		6.5		3.36		8.2		2.30		16.7		2.5		13.9		0.7		0.6		28.5	
Sulfide	- - -	- - -	mg/kg dw	218		153		376		159		409		6.99		32		402		246		6.8		1.19	U	530	
Acid Volatile Sulfide	- - -	- - -	mg/kg dw	231		173		15.6		18.8		12		56		126		707		136		6.2		1.14	U	474	
Total Organic Carbon	- - -	- - -	%	1.32		1.75		2.40		1.77		1.12		1.72		1.05		1.26		1.35		0.339		0.1		1.34	
GRAIN SIZE																											
Gravel	- - -	- - -	**%**	**16.5**		**25.1**		**25.6**		**26.5**		**30.5**		**30.7**		**6.7**		**16.6**		**34.2**		**4.2**		**26.2**		**34.5**	
Total Sand	- - -	- - -	%	71.8		65.1		57.0		58.1		56.0		64.0		73.6		64.5		53.8		94.1		72.2		44.6	
Total Fines	- - -	- - -	%	11.8		9.9		17.4		15.4		13.4		5.3		19.8		19.0		12.0		1.6	U	1.6	U	20.9	

Non-Detect SQS Exceedance U

SQS Exceedance

1) As no SL value exists to trigger toxicity testing, this chemical will only be evaluated for its bioaccumulative potential.
2) Bulk sediment measurement of TBT is used only when porewater extraction cannot be accomplished.
3) 2-Methylnaphthalene is not included in the summation for total LPAH.
4) Components of benzofluoranthenes and chlordane were clarified at the 2007 SMARM.
5) Sum of b,j, k-Benzofluoranthenes.
6) Based on 1998 LAET/HAET's; see http://www.nws.usace.army.mil/PublicMenu/Doc_list.cfm?sitename=dmmo&pagename=17th_ARM_MAy_5_2004.
7) Sum of m,p and o-Xylenes.
8) Sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT.
9) Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor and oxychlordane.
10) Sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260.
11) Qualifier (Q)
U - The target analyte was not detected at the reported concentration.
J - Estimated concentration when the value is less than the laboratory's established reporting limits.
UY - Compound not detected at or above reported concentration. However, the analyte reporting limit is raised due to a positive chromatographic interference thus the analyte may be present below the increased limit.
JM - Estimated (Maximum Possible) Concentration is less than the laboratory's established reporting limits

Table 3.3 source: "Mukilteo Multimodal Project Y-10936 TAA; Sediment Sampling Data Report," by Parametrix for WSDOT, November 2012

Table 3-4. Dioxin/Furan Results

				0' - 4' Interval								
	ANALYTE	TEF	Units	V1/V6	TEQ	Q	V2/V5	TEQ	Q	V3/V4	TEQ	Q
Dioxins	2,3,7,8-TCDD	1	pg/g dw	0.166	0.166	JM	0.168	0.168	JM	0.157	0.157	JM
	1,2,3,7,8-PeCDD	1	pg/g dw	0.535	0.535	J	0.585	0.585	J	0.52	0.52	J
	1,2,3,4,7,8-HxCDD	0.1	pg/g dw	0.6	0.06	J	0.737	0.0737	J	0.33	0.033	JM
	1,2,3,6,7,8-HxCDD	0.1	pg/g dw	1.69	0.169	J	3.16	0.316		1.9	0.19	J
	1,2,3,7,8,9-HxCDD	0.1	pg/g dw	1.19	0.119	J	1.65	0.165	J	1.02	0.102	JM
	1,2,3,4,6,7,8-HpCDD	0.01	pg/g dw	48.8	0.488		150	1.5		36.5	0.365	
	OCDD	0.0003	pg/g dw	479	0.1437		2400	0.72		342	0.1026	
Furans	2,3,7,8-TCDF	0.1	pg/g dw	1.09	0.109		1.44	0.144		1.4	0.14	
	1,2,3,7,8-PeCDF	0.03	pg/g dw	0.284	0.00852	JM	0.275	0.00825	J	0.247	0.00741	J
	2,3,4,7,8-PeCDF	0.3	pg/g dw	0.355	0.1065	J	0.355	0.1065	J	0.3	0.09	J
	1,2,3,4,7,8-HxCDF	0.1	pg/g dw	0.529	0.0529	J	0.699	0.0699	J	0.393	0.0393	J
	1,2,3,6,7,8-HxCDF	0.1	pg/g dw	0.367	0.0367	JM	0.361	0.0361	J	0.347	0.0347	J
	2,3,4,6,7,8-HxCDF	0.1	pg/g dw	0.452	0.0452	J	0.351	0.0351	J	0.402	0.0402	J
	1,2,3,7,8,9-HxCDF	0.1	pg/g dw	0.296	0.0296	J	0.178	0.0178	JM	0.104	0.0104	JM
	1,2,3,4,6,7,8-HpCDF	0.01	pg/g dw	6.36	0.0636		11.8	0.118		6.01	0.0601	
	1,2,3,4,7,8,9-HpCDF	0.01	pg/g dw	0.592	0.00592	J	0.964	0.00964	J	0.296	0.00296	JM
	OCDF	0.0003	pg/g dw	19.5	0.00585		49.2	0.01476		15.9	0.00477	
			Total TEQ		**2.14449**			**4.08775**			**1.89944**	

Qualifier (Q)

U - The target analyte was not detected at the reported concentration.

J - Estimated concentration when the value is less than the laboratory's established reporting limits.

UJY - Compound not detected at or above reported concentration but may be present below that limit because the analyte reporting limit is raised due to a positive chromatographic interference.

JM - Estimated (Maximum Possible) Concentration is less than the laboratory's established reporting limits

Table 3.source: "Mukilteo Multimodal Project Y-10936 TAA; Sediment Sampling Data Report," by Parametrix for WSDOT, November 2012

Table 3-5. Ordnance Residue

		0' - 12' intervals (March 7, 2012)						0' - 4' intervals (April 25, 2012)					
Analyte	**Units**	**V1/V6**	**Q[1]**	**V2/V5**	**Q[1]**	**V3/V4**	**Q[1]**	**D1**	**Q[1]**	**D2**	**Q[1]**	**D3**	**Q[1]**
Total Solids	%	80.7		69.7		70.9		69.7		62.6		81	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
1,3,5-Trinitrobenzene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
1,3-Dinitrobenzene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
3,5-Dinitroaniline	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
Nitrobenzene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
4-Amino-2,6-dinitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
2-Amino-4,6-dinitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
2,4,6-Trinitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
2,6-Dinitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
2,4-Dinitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
2-Nitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
3-Nitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
4-Nitrotoluene	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
Nitroglycerin	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.28	U	0.25	U	0.31	U
Pentaerythritol Tetranitrate	mg/Kg dw	0.33	U	0.38	U	0.38	U	0.4	U	0.4	U	0.4	U

1) Qualifier (Q)

U - The target analyte was not detected at the reported concentration

Table 3.5 source: "Mukilteo Multimodal Project Y-10936 TAA; Sediment Sampling Data Report," by Parametrix for WSDOT, November 2012

Appendix B
Sample Containers, Holding Times, Volume, and Chemical Analytical Methods and QA/QC Criteria

Table B-1. Sample Analytical Methods and Storage criteria.

SAMPLE TYPE	Analytical Methods	HOLDING TIME	SAMPLE SIZE (1)	TEMPERATURE (2)	CONTAINER	ARCHIVE(3)
Particle Size	**PSEP(1986)/ASTM D-422**	6 Months	100-200 g (75-150 ml)	4 degrees C	1-liter Glass (combined)	X
Total Solids	**2540 B-97 / PSEP(1986)**	14 Days	125 g (100 ml)	4 degrees C		
Total Volatile Solids	**160.4 / 2540 E PSEP(1986)**	14 Days	125 g (100 ml)	4 degrees C		
Total Organic Carbon	**Plumb,1981**	14 Days	125 g (100 ml)	4 degrees C		
Ammonia	**Plumb, 1981, 350.1 / 4500-NH3 G-97**	7 Days	25 g (20 ml)	4 degrees C		
Metals (except Mercury)	**6010 / 6020 / 7000 & 200 Series**	6 Months	50 g (40 ml)	4 degrees C	4 oz. glass jar	
		2 years		-18 degrees C		
Semi-volatiles, Pesticides and PCBs	**8082/8270**	14 Days until extraction	150 g (120 ml)	4 degrees C	8 oz. glass jar	
		1 Year until extraction		-18 degrees C		
		40 Days after extraction		4 degrees C		
Total Sulfides	**PSEP(1986)**	7 Days	50 g (40 ml)	4 degrees C (4)	125 ml Glass or polyethylene	
Mercury	**7470/7471**	28 Days	50 g (40 ml)	-18 degrees C	125 ml Teflon or polyethylene	

SAMPLE TYPE	Analytical Methods	HOLDING	SAMPLE SIZE (1)	TEMPERATURE (2)	CONTAINER	ARCHIVE(3)
Tributyltin (porewater)	**Krone/Unger**	7 Days	Sediment sufficient to collect 200-500 ml of porewater	4 degrees C (5)	Field: Polycarbonate, glass, or steel Lab (post extraction): Polycarbonate	
Volatile Organics	**524.2/624/8260/8260-SIM**	14 Days	100 g (2-40 ml jars)	4 degrees C	2-40 ml Glass	
Dioxins/Furans	**EPA 1613B**	1 year	8 oz	4 degrees C	8 oz glass (amber)	X
Bioassay	**10-day amphipod mortality test (acute toxicity)** **20-day juvenile infaunal growth test (chronic toxicity)** **Sediment larval test (acute toxicity)**	8 Weeks	5 liters	4 degrees C (5)	5-1 liter Glass or polyethylene	X; bioassay archives are not frozen

(1) Recommended minimum field sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.

(2) During transport to the lab, samples will be stored on ice. The mercury and archived samples will be frozen immediately upon receipt at the lab.

(3) For every DMMU, a 250 ml container is filled and frozen to run any or all of the analyses indicated.

(4) The sulfides sample will be preserved with 5 ml of 2 Normal zinc acetate for every 30 g of sediment.

(5) Headspace purged with nitrogen.

Table B-2. Laboratory Chemical Analytical QA/QC Requirements

Analysis Type	Method Blanks[1]	Replicates[1]	Triplicates[1]	CRM/RM	MS/MSD[1]	Surrogates[2]
Volatile Organics[3,4]	X	X[6]			X	X
Semivolatiles[3,4]	X[5]	X[6]		X	X	X
Pesticides/PCBs[3,4]	X[5]	X[6]		X	X	X
Dioxins/Furans	X[5]	X[6]		X	X	X
Metals	X	X[6]		X	X	
TBT	X				X	X
Ammonia	X		X			
Total Sulfides	X		X			
Total Organic Carbon	X		X	X		
Total Solids			X			
Total Volatile Solids			X			
Particle Size			X			

Notes:

CRM = Certified Reference Material; RM = Reference Material; MS/MSD = matrix spike/matrix spike duplicate

1 Frequency of Analysis (FOA) = 5 percent or one per batch, whichever is more frequent.

2 Surrogate spikes required for every sample, including matrix spiked samples, blanks, and reference materials.

3 Initial calibrations required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria.

4 Ongoing calibration required at the beginning of each work shift, every 10–12 samples or every 12 hours (whichever is more frequent), and at the end of each shift.

5 FOA = one per extraction batch.

6 Matrix spike duplicates may be used.

Table B-3. Solid Phase Bioassay Performance Standards and Evaluation Guidelines						
Bioassay	**Negative Control Performance Standard**	**Reference Sediment Performance Standard**	**Dispersive Disposal Site Interpretation Guidelines**		**Nondispersive Disposal Site Interpretation Guidelines**	
			1-hit rule	2-hit rule	1-hit rule	2-hit rule
Amphipod	MC ≤10%	MR - MC ≤ 20%	MT - MC > 20% and MT vs. MR SS (p=.05) and		MT - MC > 20% and MT vs. MR SS (p=.05) and	
			MT - MR > 10%	NOCN	MT - MR > 30%	NOCN
Larval	NC÷I ≥0.70	NR÷NC ≥ 0.65	NT ÷ NC < 0.80 and NT/NC vs. NR/NC SS (p=.10) and		NT ÷ NC < 0.80 and NT/NC vs. NR/NC SS (p=.10) and	
			NR/NC - NT/NC > 0.15	NOCN	NR/NC - NT/NC > 0.30	NOCN
Neanthes growth	MC ≤ 10% and MIGC > 0.38	MR ≤ 20% and MIGR÷MIGC ≥ 0.80	MIGT ÷ MIGC < 0.80 and MIGT vs. MIGR SS (p=.05) and		MIGT ÷ MIGC < 0.80 and MIGT vs. MIGR SS (p=.05) and	
			MIGT/MIGR < 0.70	NOCN	MIGT/MIGR < 0.50	MIGT/MIGR < 0.70

M = mortality
N = normal larvae
I = initial count
MIG = mean individual growth rate (mg/individual/day)
SS = statistically significant
NOCN = no other conditions necessary
N/A = not applicable
Subscripts: R = reference sediment, C = negative control, T = test sediment

Appendix C
Analytical Resources, Inc. Sediment Reference Certificates

BNAs - Sandy Loam

Certificate of Analysis

CERTIFIED REFERENCE MATERIAL

Number CRM143-050
Lot 016496
Solvent (Matrix) Sandy Loam
Hazard Irritant
Storage & Handling Store at 4°C. Mix well before sampling.
Expiration Date See Sample Label
Certification Date: October 07, 2009
Certified By: Christopher Rucinski - QA Director

Analyte	*Units*	*Certified[1,4] Value*	*k*[5]	*Standard[2] Deviation*	*Confidence Interval*	*Prediction Interval*
Pyrene	µg/Kg	1450 ± 98.3	1.96	305	1350 - 1540	839 - 2050
2,4,6-Trichlorophenol	µg/Kg	7570 ± 435	1.96	1380	7140 - 7990	4840 - 10300

Additional Information

Sample Description

The sample size provided as a pack of 5 x 10g units of soil.

The soil has been sterilized to minimize degradation of the sample.

The sample has been sized to 100 mesh.

The sample has been intentionally prepared with an apparent headspace.

USEPA Method 8270C was the primary method for certification (GC-MS). Contact RTC for further method details.

Storage

The sample should be stored at 4°C. It has been determined to be stable for the duration of the expiration date.

After sub-sampling replace cap securely and store remaining sample at 4°C.

The shelf life of the product was determined by historic stability of similar CRM's. The expiration date may be extended based on stock and popularity upon successful stability testing by a 17025 accredited laboratory.

Stability and shelf life after opening must be determined by the user, taking into account sampling frequency/volume and all local conditions.

Recommended Preparation

Extract an accurately weighed portion (recommended minimum sample is 10 grams) using SW846 Method 3540C, Soxhlet Extraction; 3541, Automated Soxhlet Extraction; 3550, Ultrasonic Extraction or other technique identified by the method to be acceptable for the analytes of interest.

In addition to the solvent systems listed in Method 3540C,the methylene chloride/acetone (1:1 v/v) system is acceptable.

Note: Sample extracts and calibration solutions should be in the same solvent.

Transfer the entire amount of one vial to your extraction system. Rinse the vial with a 2-5 mL your extraction solvent. Assume 10g for the sampling size. Smaller amounts may be sampled but RTC does not maintain homogeneity for sample sizes less than 10g.

Results based on as provided basis assume each vial contains 10g of dry soil.

Scope and Application

The Base Neutral Acid (BNA) Compounds in Soil Certified Reference Material (CRM) consists of four amber glass sample jar, with a Teflon lined closure containing approximately 10 grams of soil, fortified with 49 semi-volatile organics. Being a natural matrix waste sample the analyst is challenged by the same preparation problems, analytical interferences, etc. as is typical for similar matrices received by the laboratory for analysis. Rigorous analysis identified, quantified, and certified various aliphatic and aromatic banding which are listed on the enclosed Certificate of Analysis. The sample has been analyzed by 41 independent laboratories in a round-robin to meet the requirements specified by the ISO Guides 34 and 35, and ISO 17025.

BNAs - Sandy Loam

Certificate of Analysis

CERTIFIED REFERENCE MATERIAL

ISO Guide 34
Cert# AR-1470

ISO/IEC 17025
Cert# AT-1467

Number CRM143-050
Lot 016496
Solvent (Matrix) Sandy Loam
Hazard Irritant
Storage & Handling Store at 4°C. Mix well before sampling.
Expiration Date See Sample Label
Certification Date: October 07, 2009
Certified By: Christopher Rucinski - QA Director

Analyte	*Units*	*Certified[1,4] Value*	*k[5]*	*Standard[2] Deviation*	*Confidence Interval*	*Prediction Interval*
1,3-Dichlorobenzene	µg/Kg	5470 ± 494	1.96	1550	4990 - 5960	2400 - 8550
1,4-Dichlorobenzene	µg/Kg	7770 ± 716	1.96	2250	7080 - 8470	3310 - 12200
Hexachlorobutadiene	µg/Kg	4300 ± 312	1.96	977	3990 - 4610	2360 - 6240
Hexachloroethane	µg/Kg	6100 ± 542	1.96	1660	5570 - 6640	2820 - 9390
Naphthalene	µg/Kg	4460 ± 255	1.96	829	4210 - 4710	2820 - 6110
Nitrobenzene	µg/Kg	5510 ± 385	1.96	1210	5130 - 5890	3110 - 7910
1,2,4-Trichlorobenzene	µg/Kg	1240 ± 93.4	1.96	277	1150 - 1330	693 - 1790
Acenaphthene	µg/Kg	2050 ± 104	1.96	344	1940 - 2150	1360 - 2730
Acenaphthylene	µg/Kg	4040 ± 166	1.96	533	3880 - 4200	2980 - 5090
Anthracene	µg/Kg	2810 ± 154	1.96	505	2660 - 2960	1810 - 3810
Benzo(a)anthracene	µg/Kg	4000 ± 213	1.96	696	3790 - 4210	2620 - 5380
Benzo(a)pyrene	µg/Kg	3860 ± 220	1.96	724	3640 - 4070	2420 - 5290
Benzo(b)fluoranthene	µg/Kg	3670 ± 252	1.96	795	3420 - 3910	2090 - 5250
Benzo(g,h,i)perylene	µg/Kg	5050 ± 303	1.96	996	4760 - 5340	3080 - 7020
Benzo(k)fluoranthene	µg/Kg	3870 ± 250	1.96	786	3630 - 4120	2310 - 5430
4-Bromophenyl phenyl ether	µg/Kg	11200 ± 712	1.96	2170	10600 - 11900	6940 - 15600
Butyl benzyl phthalate	µg/Kg	6480 ± 578	1.96	1870	5910 - 7050	2770 - 10200
Carbazole	µg/Kg	1730 ± 94.9	1.96	256	1630 - 1830	1220 - 2240
bis(2-Chloroethoxy)methane	µg/Kg	6830 ± 544	1.96	1710	6280 - 7380	3440 - 10200
bis(2-Chloroethyl) ether	µg/Kg	9680 ± 906	1.96	2810	8750 - 10600	4090 - 15300
4-Chlorophenyl phenylether	µg/Kg	4810 ± 264	1.96	822	4550 - 5070	3180 - 6440
Chrysene	µg/Kg	3630 ± 193	1.96	630	3440 - 3810	2380 - 4880
Dibenzo(a,h)anthracene	µg/Kg	2280 ± 143	1.96	467	2140 - 2420	1350 - 3210
Dibenzofuran	µg/Kg	3820 ± 202	1.96	630	3630 - 4020	2570 - 5070

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RTC

2931 Soldier Springs Road
Laramie, WY 82070
Phone: 307.742.5452
Fax: 307.745.7936
Web: www.RT-Corp.com

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BNAs - Sandy Loam

CERTIFIED REFERENCE MATERIAL

Number CRM143-050
Lot 016496
Solvent (Matrix) Sandy Loam
Hazard Irritant
Storage &Handling Store at 4°C. Mix well before sampling.
Expiration Date See Sample Label
Certification Date: October 07, 2009
Certified By: Christopher Rucinski - QA Director

Analyte	*Units*	*Certified[1,4] Value*	*k[5]*	*Standard[2] Deviation*	*Confidence Interval*	*Prediction Interval*
2,4-Dichlorophenol	µg/Kg	6810 ± 370	1.96	1160	6440 - 7170	4500 - 9110
Diethyl phthalate	µg/Kg	7340 ± 485	1.96	1560	6870 - 7820	4250 - 10400
2,4-Dimethylphenol	µg/Kg	3640 ± 390	1.96	1230	3260 - 4020	1200 - 6070
Dimethyl phthalate	µg/Kg	5900 ± 318	1.96	1010	5590 - 6200	3880 - 7910
2,4-Dinitrophenol	µg/Kg	1630 ± 252	2.12	365	1370 - 1900	814 - 2450
2,4-Dinitrotoluene (2,4-DNT)	µg/Kg	5880 ± 371	1.96	1160	5520 - 6240	3570 - 8180
2,6-Dinitrotoluene (2,6-DNT)	µg/Kg	8710 ± 508	1.96	1540	8210 - 9200	5650 - 11800
Di-n-octyl phthalate	µg/Kg	9910 ± 762	1.96	2460	9160 - 10700	5020 - 14800
bis(2-Ethylhexyl) phthalate (DEHP)	µg/Kg	4840 ± 367	1.96	1160	4480 - 5210	2550 - 7140
Fluoranthene	µg/Kg	6520 ± 415	1.96	1370	6130 - 6920	3810 - 9230
Fluorene	µg/Kg	5370 ± 268	1.96	874	5110 - 5640	3640 - 7110
Indeno(1,2,3-cd) pyrene	µg/Kg	1000 ± 115	1.96	350	884 - 1120	306 - 1700
Isophorone	µg/Kg	4580 ± 366	1.96	1140	4220 - 4950	2320 - 6850
2-Methylnaphthalene	µg/Kg	2880 ± 164	1.96	517	2720 - 3040	1850 - 3900
2-Methylphenol (o-Cresol)	µg/Kg	4040 ± 313	1.96	995	3720 - 4350	2060 - 6010
4-Methylphenol (p-Cresol)	µg/Kg	4490 ± 725	2.10	1240	3790 - 5190	1790 - 7180
2-Nitroaniline	µg/Kg	2510 ± 146	1.96	431	2370 - 2650	1650 - 3360
2-Nitrophenol	µg/Kg	5780 ± 441	1.96	1390	5340 - 6210	3010 - 8550
4-Nitrophenol	µg/Kg	4680 ± 521	1.96	1490	4160 - 5210	1720 - 7650
n-Nitrosodiphenylamine	µg/Kg	4480 ± 551	1.96	1530	3940 - 5020	1430 - 7530
Pentachlorophenol	µg/Kg	2890 ± 391	1.96	1250	2490 - 3280	399 - 5380
Phenanthrene	µg/Kg	8080 ± 474	1.96	1550	7620 - 8550	5000 - 11200
Phenol	µg/Kg	7250 ± 565	1.96	1790	6700 - 7810	3700 - 10800

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BNAs - Sandy Loam

CERTIFIED REFERENCE MATERIAL

Number **CRM143-050**
Lot 016496
Solvent (Matrix) Sandy Loam
Hazard Irritant
Storage & Handling Store at 4°C. Mixwell before sampling.
Expiration Date See Sample Label
Certification Date: October 07, 2009
Certified By: Christopher Rucinski - QA Director

Evaluation of Results

The Reference Value, 95% confidence interval(C.I.) for the Reference Value and 95% Prediction Interval (P.I.) around the Reference Value were obtained by the methods identified in the 'Scope and Application' section of this Certificate of Analysis. Samples were selected in a random fashion from the beginning to the end of the bottling sequence and sent for analysis by an independent laboratory round-robin. The data produced in the round-robin was used to calculate reference values by the USEPA EMSL-CINN's computer program "BIWEIGHT".

The generated BIWEIGHT mean, BIWEIGHT standard deviation and BIWEIGHT standard deviation of the mean are used to calculate the 95% Confidence Interval (CI) for the mean and the 95% Prediction Interval (PI). For normally distributed data, the BIWEIGHT 95% CI compares well to the classical calculation method used to generate a 95% CI. For non-Gaussian data sets, the BIWEIGHT method is more robust in data treatment.

BIWEIGHT data are also used to calculate a 95% PI. The 95% PI compares well to a 95% tolerance limit calculated using classical methods. For normally distributed data, the BIWEIGHT 95% PI typically represents approximately a ±2 BIWEIGHT standard deviation window around the BIWEIGHT mean. Again, the BIWEIGHT method is more robust than classical methods when handling non-Gaussian data sets.

Laboratories performing the same analytical procedures on a sample whose values have been determined by the BIWEIGHT method can assume that the true mean, as determined by the method, is within the 95% CI window. Laboratories analyzing the sample should have results within the 95% PI window 19 out of 20 analyses. Laboratories should use the PI as guidance for laboratory performance.

Additional information on the program may be obtained by referring to the reference or by downloading the program from the EMSL-CINN web site. Additionally contact RTC for additional guidance - 1(307)742-5452 - support@rt-corp.com - www.rt-corp.com

Health and Safety Information

All RTC Certified Reference Materials are intended only for professional use by properly trained laboratory personnel. This CRM has been reviewed for both health and safety and shipping risks. It is classified as non hazardous and is not classified as hazardous goods for shipping by road, sea or air transport.

A full international MSDS as a downloadable pdf file is available at www.rt-corp.com

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1 Certified values are the robust statisitical mean when prepared according to instructions from an Interlaboratory Study and internal rigorous testing.
2 The standard deviation is the robust statistical standard deviation from the round robin interlaboratory study.
4 Expanded Uncertainty (Ucm) - All uncertainty values in this document expressed as ± *value* are expanded uncertainties.
5 ***k***: Coverage factor derived from a t-distribution table, based on the degrees of freedom of the data set. **Confidence interval = 95%**

Traceability: The standard was manufactured under an ISO 17025 certified quality system. The balance used to weigh raw materials is accurate to +/- 0.0001g and calibrated regularly using mass standards traceable to NIST. All dilutions were preformed gravimetrically. Additionally, individual analytes are traceable to NIST SRMs where available and specified above.

THIS PRODUCT WAS DESIGNED, PRODUCED AND VERIFIED FOR ACCURACY AND STABILITY IN ACCORDANCE WITH ISO 17025 (AClass Cert AT-1467) and ISO GUIDE 34 (AClass Cert AR-1470).

MSDS reports for components comprising greater than 1.0% of the solution or 0.1% for components known to be carcinogens are available upon request.

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Pesticides - Loamy Sand

Certificate of Analysis

CERTIFIED REFERENCE MATERIAL

ISO Guide 34
Cert# AR-1470

ISO/IEC 17025
Cert# AT-1467

Number CRM860-50G
Lot 010760
Solvent (Matrix) Loamy Sand Soil
Hazard Irritant
Storage & Handling Store at 4°C.
Expiration Date See Sample Label
Certification Date: August 23, 2010
Certified By: Christopher Rucinski - QA Director

Analyte	*Units*	*Certified[1,4] Value*	*k[5]*	*Standard[2] Deviation*	*Confidence Interval*	*Prediction Interval*
Hexachlorobenzene	µg/Kg	83.3 ± 6.09	2.00	18.0	71.2 - 95.4	41.5 - 125
delta-BHC	µg/Kg	65.7 ± 4.57	2.31	13.5	61.2 - 70.2	38.8 - 92.6
alpha-BHC (alpha-Hexachlorocyclohexane)	µg/Kg	115 ± 8.87	2.31	26.2	106 - 124	62.9 - 167
beta-BHC (beta-Hexachlorocyclohexane)	µg/Kg	109 ± 10.8	2.31	31.8	98.7 - 120	45.9 - 172
alpha-Chlordane	µg/Kg	74.0 ± 5.04	2.00	14.9	68.8 - 79.3	44.3 - 104
gamma-Chlordane	µg/Kg	101 ± 6.33	2.00	18.7	94.6 - 107	63.8 - 138
4,4'-DDD	µg/Kg	116 ± 6.13	2.00	18.1	111 - 122	80.4 - 152
4,4'-DDE	µg/Kg	70.8 ± 4.37	2.31	12.9	66.7 - 75.0	45.3 - 96.4
4,4'-DDT	µg/Kg	49.4 ± 4.23	2.00	12.5	45.4 - 53.4	24.6 - 74.2
Dieldrin	µg/Kg	79.7 ± 4.40	2.00	13.0	75.4 - 83.9	53.8 - 106
Endosulfan I	µg/Kg	91.5 ± 6.77	2.31	20.0	74.9 - 98.0	51.7 - 131
Endosulfan II	µg/Kg	111 ± 7.75	2.00	22.9	103 - 118	65.1 - 156
Endosulfan sulfate	µg/Kg	58.6 ± 4.16	2.00	12.3	54.6 - 62.7	34.2 - 83.1
Endrin aldehyde	µg/Kg	50.2 ± 6.09	2.00	18.4	43.9 - 56.5	13.6 - 86.9
Endrin ketone	µg/Kg	119 ± 9.95	2.00	29.4	108 - 130	57.5 - 180
Endrin	µg/Kg	75.3 ± 6.09	2.00	18.0	69.6 - 81.1	39.5 - 111
Heptachlor	µg/Kg	68.1 ± 8.60	2.00	25.4	59.6 - 76.6	17.7 - 119
Heptachlor epoxide	µg/Kg	106 ± 6.43	2.00	19.0	100.00 - 113	68.7 - 144
Methoxychlor	µg/Kg	96.6 ± 8.60	2.00	25.4	88.0 - 105	46.0 - 147

Additional Information

Description, Storage and Handling

The soil has been sterilized to minimize degradation of the sample.

The sample has been sized to 100 mesh.

Required storage condition is 4°C.

ACLASS ACCREDITED REFERENCE MATERIAL PRODUCER

ACLASS ACCREDITED TESTING

RTC

2931 Soldier Springs Road
Laramie, WY 82070
Phone: 307.742.5452
Fax: 307.745.7936
Web: www.RT-Corp.com

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Pesticides - Loamy Sand

CERTIFIED REFERENCE MATERIAL

Number **CRM860-50G**
Lot 010760
Solvent (Matrix) Loamy Sand Soil
Hazard Irritant
Storage &Handling Store at 4°C.
Expiration Date See Sample Label
Certification Date: August 23, 2010
Certified By: Christopher Rucinski - QA Director

Description, Storage and Handling

The sample has been intentionally prepared with an apparent headspace. After sampling replace cap immediately and return to the refrigerator.

Preparation Instructions

The entire sample lot has been tested and certified for inter-sample homogeneity; due to potential settling and stratification in storage, shipping and handling the sample must be thoroughly mixed as stated in the method.

Recommended minimum sampling size is 1 gram.

Report on a dry weight basis.

Note: Sample extracts and calibration solutions should be in the same solvent.

Scope and Application

The Pesticides on Soil Certified Reference Material (CRM) consists of a single amber glass sample jar, with a Teflon lined closure containing approximately 50 grams of soil, fortified with 23 chlorinated pesticide compounds. Being a natural matrix waste sample the analyst is challenged by the same preparation problems, analytical interferences, etc. as is typical for similar matrices received by the laboratory for analysis.

Rigorous analyses identified, quantified, and certified 23 compounds which are listed on the enclosed Certificate of Analysis. The sample has been analyzed by 47 independent laboratories in a round-robin to meet the requirements specified by the ISO Guides 34 and 35, and ISO 17025. The sample was certified by USEPA SW846, 3rd edition Methods 3540B\3541 (Soxhlet extraction), 3550A (Sonication) and 8081A (Organochlorine Pesticides by GC). The sample is suitable for use by these and other similar methods.

Evaluation of Results

The Reference Value, 95% confidence interval(C.I.) for the Reference Value and 95% Prediction Interval (P.I.) around the Reference Value were obtained by the methods identified in the 'Scope and Application' section of this Certificate of Analysis. Samples were selected in a random fashion from the beginning to the end of the bottling sequence and sent for analysis to an independent laboratory round-robin. The data produced in the round-robin was used to calculate reference values by the USEPA EMSL-CINN's computer program "BIWEIGHT".

The generated BIWEIGHT mean, BIWEIGHT standard deviation and BIWEIGHT standard deviation of the mean are used to calculate the 95% Confidence Interval (CI) for the mean and the 95% Prediction Interval (PI). For normally distributed data, the BIWEIGHT 95% CI compares well to the classical calculation method used to generate a 95% CI. For non-Gaussian data sets, the BIWEIGHT method is more robust in data treatment.

BIWEIGHT data are also used to calculate a 95% PI. The 95% PI compares well to a 95% tolerance limit calculated using classical methods. For normally distributed data, the BIWEIGHT 95% PI typically represents approximately a ±2 BIWEIGHT standard deviation window around the BIWEIGHT mean. Again, the BIWEIGHT method is more robust than classical methods when handling non-Gaussian data sets.

Laboratories performing the same analytical procedures on a sample whose values have been determined by the BIWEIGHT method can assume that the true mean, as determined by the method, is within the 95% CI window. Laboratories analyzing the sample should have results within the 95% PI window 19 out of 20 analyses. Laboratories should use the PI as guidance for laboratory performance.

Additional information on the program may be obtained by referring to the reference or by downloading the program from the EMSL-CINN web site. Additionally contact RTC for additional guidance - 1(307)742-5452 - support@rt-corp.com - www.rt-corp.com

Health and Safety Information

All RTC Certified Reference Materials are intended only for professional use by properly trained laboratory personnel. This CRM has been reviewed for both health and safety and shipping risks. It is classified as non hazardous and is not classified as hazardous goods for shipping by road, sea or air transport.

A full international MSDS as a downloadable pdf file is available at www.rt-corp.com

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Pesticides - Loamy Sand

Certificate of Analysis

CERTIFIED REFERENCE MATERIAL

Number	**CRM860-50G**
Lot	010760
Solvent (Matrix)	Loamy Sand Soil
Hazard	Irritant
Storage &Handling	Store at 4°C.
Expiration Date	See Sample Label
Certification Date:	August 23, 2010
Certified By:	Christopher Rucinski - QA Director

1 Certified values are the robust statisitical mean when prepared according to instructions from an interlaboratory Study and internal rigorous testing.
2 The standard deviation is the robust statistical standard deviation from the round robin interlaboratory study.
4 Expanded Uncertainty (Ucm) - All uncertainty values in this document expressed as ± *value* are expanded uncertainties.
5 *k*: Coverage factor derived from a t-distribution table, based on the degrees of freedom of the data set. **Confidence Interval = 95%**

Traceability: The standard was manufactured under an ISO 17025 certified quality system. The balance used to weigh raw materials is accurate to +/- 0.0001g and calibrated regularly using mass standards traceable to NIST. All dilutions were preformed gravimetrically. Additionally, individual analytes are traceable to NIST SRMs where available and specified above.

THIS PRODUCT WAS DESIGNED, PRODUCED AND VERIFIED FOR ACCURACY AND STABILITY IN ACCORDANCE WITH ISO 17025 (AClass Cert AT-1467) and ISO GUIDE 34 (AClass Cert AR-1470).

MSDS reports for components comprising greater than 1.0% of the solution or 0.1% for components known to be carcinogens are available upon request.

ACLASS ACCREDITED REFERENCE MATERIAL PRODUCER

ACLASS ACCREDITED TESTING

RTC

2931 Soldier Springs Road
Laramie, WY 82070
Phone: 307.742.5452
Fax: 307.745.7936
Web: www.RT-Corp.com

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