

**Results of Sampling and Analysis
Preliminary Sediment
Quality Assessment
Martha Lake
Snohomish County, Washington**

**Prepared for
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Department of Transportation**

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INTRODUCTION

This report presents the results of sediment sampling and analysis conducted in support of proposed dredging activities of Martha Lake Sediments. The characterization of the sediments will be used in support of permitting applications and exploring various disposal options for the dredge material from the WSDOT stormwater outfall (SR 5 MP) at Martha Lake. This sediment sampling and analysis was conducted in general accordance with the Preliminary Sediment Quality Assessment Sampling and Analysis Plan (SAP) (Hart Crowser, 1995) and included physical and chemical testing of the sediments.

This report is divided into the following sections:

- Summary of Findings;
- Sediment Sampling Locations;
- Sediment Sampling, Handling, and Analysis;
- Sediment Physical Characteristics; and
- Sediment Chemical Characteristics.

These sections are supported by tables and figures which are presented at the end of the text. Table 1 presents a summary of the chemistry data. Table 2 presents field observations from sediment sampling activities. Figure 1 presents the sediment sampling locations.

In addition, three appendices present supporting information concerning the following:

- Appendix A - Analytical Chemistry Data
- Appendix B - Grain Size Data
- Appendix C - Sediment Sampling Field Data.

SUMMARY OF FINDINGS

Three sediment core samples and three surface sediment samples were collected from locations as shown on Figure 1. The three core samples (S-1, S-2, and S-3) were composited into one sample (C-1) and the three surface sediment samples (P-1, P-2, and P-3) were composited into sample C-2. Depths of cores and surface sediment sampling observations are presented in Table 2. These sediments were submitted to Analytical Resources Inc. of Seattle, Washington, for analysis of total organic carbon, total metals, toxicity characteristics leaching procedure (TCLP) metals, polynuclear aromatic hydrocarbons, pesticides, and total petroleum hydrocarbons.

Sample C-1 was comprised of clayey, gravelly, very silty SAND (see Appendix B). This sample contained 14 percent gravel. Sample C-2 was comprised of sandy, clayey SILT and contained no gravel. The percentage of sand in the samples ranged from 41 percent for sample C-1 to 18 percent for sample C-2. Total organic carbon (TOC) ranged from 5.3 percent in sample C-1 to 14 percent in sample C-2.

Five of the seven WSDOT-requested metals were detected in sample C-1 and six of the seven were detected in sample C-2. The C-1 metals detected are cadmium, chromium, copper, lead, and mercury. The C-2 metals detected are cadmium, chromium, copper, lead, mercury, and zinc. Arsenic was not detected above detection limits in any of the sediment samples analyzed (see Table 1).

TCLP metals were analyzed for sample C-1 only for WSDOT-requested metals. Low concentrations of TCLP copper, lead, and zinc were reported (see Table 1).

Polynuclear aromatic hydrocarbons (PAHs) of concern (phenanthrene, fluoranthene, and pyrene) were detected at concentrations just above detection limits in Sample C-1 only. No PAHs were detected in sample C-2.

Low concentrations of pesticides were detected in samples C-1 (4,4-DDE', and 4,4-DDT) and C-2 (4,4-DDE', 4,4-DDT, and methoxychlor).

No total petroleum hydrocarbons (gasoline, diesel, and oil) were detected in the two samples.

SEDIMENT SAMPLING LOCATIONS

Sediment sampling locations were designed to be representative of sediment conditions directly adjacent to the WSDOT storm water outfall (SR 5 MP) located at Martha Lake. Locations were selected to provide a baseline assessment of the quality of sediments directly adjacent to the storm water outfall.

As identified in the SAP, sediment core samples were collected at three locations within the delta area of interest. Three surface sediments (0 to 2 cm) were also collected outside the delta area of interest (see Figure 1).

Based on the close proximity to the shore and dock, accurate (± 2 feet) sampling location positioning were achieved by site-related methods. Each sediment sample location was determined by documenting the linear distance from two permanent points on the dock.

SEDIMENT SAMPLING AND HANDLING

The collection of the delta area sediments was based on PSEP Protocols (Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Tetra Tech, 1986).

Sediment Core Sampling

Three sediment cores were collected within the proposed dredge prism area by utilizing the Hart "Tent Peg" sediment sampler. Immediately after retrieval for the core sampling, the acceptability of each sediment core was assessed. All sediment samples were accepted, and no samples were rejected. A sufficient quantity of sample was collected from each location to perform the required chemical analyses. The sediment core samples were composited into one sample (C-1) based upon volume weighting of the three sediment core samples. The composite sample was submitted for chemical and physical analyses, as discussed below. The remaining sample volumes were frozen for further analyses if necessary. Based upon holding time requirements, future analyses of the archived samples may result in qualified data that may limit data usability.

Surface Sediments Sampling

Three surface sediment samples representative of baseline surface sediments adjacent to the delta were collected from 0 to 2 centimeters (cm) by a Ponar Method. Immediately after retrieval for the surface sample, the sample acceptability were assessed. All surface sediment samples were accepted, and no samples was rejected. A sufficient quantity of sample was collected from each location to perform required chemical analyses. Each surface sediment sample was homogenized separately and placed in a sample jar. The three surface sediments were composited into one sample (C-2). The composite sample was submitted for chemical and physical analyses, as discussed below. The remaining sample volumes were frozen for further analyses if necessary. Based upon holding time requirements, future analyses of the archived samples may result in qualified data that may limit data usability.

Field observations were maintained in field log notes (presented in Appendix C). These observations include the following:

- Sampling Location;
- Water Depth;
- Date and Time;
- Characteristics/Observations of Sediment Sample;
- Penetration Depth; and
- Other Comments.

To prevent sample contamination, all sampling equipment (sampler and stainless steel spoons and bowls) were cleaned (Alconox, tap water, deionized water) prior to and between collection activities. Guidance provided in the PSEP Protocols for preventing metals and organic sample contamination were followed.

Proper custody documentation procedures were followed at all times. All sample containers were clearly labeled with the project name and number, sampling location, sample identification, date, and the field representative's initials. Chain of custody forms were completed for all samples and the forms will accompanied sealed coolers to the laboratory for analyses.

SEDIMENT PHYSICAL CHARACTERISTICS

Grain size distribution tests were performed on the two composited sediment samples by wet-sieving and pipet methods outlined in PSEP Protocols at the Hart Crowser sediment testing laboratory in Seattle. After analysis, these samples were classified in general accordance with the Unified Soil Classification (USC) System (Figure B-1). Appendix B presents grain size distributions for each composite sediment sample (Figures B-2, B-3, and B-4). These grain size distribution results are presented as percent gravel (>0.85 mm), sands (0.062 to 0.85 mm), and fines (0.004 to 0.062 mm). The percentage of sand in the samples ranged from 18 to 41 percent. Sample C-1 is comprised of clayey, gravelly, very silty SAND and sample C-2 is comprised of sandy, clayey SILT (according to the USC system).

The triangular classification system classifies these samples as clayey and sandy SILT, and clayey SILT, respectively. For the purpose of this classification we considered the 14 percent gravel in sample C-1 as sand.

Total solids ranged from 10.2 percent in sample C-2 to 41.2 percent in sample C-1.

SEDIMENT CHEMICAL CHARACTERISTICS

Two composite (1 core composite and 1 ponar composite) sediment samples were submitted for chemical analysis as detailed in the SAP. The chemical analyses were performed at Analytical Resources, Inc. (ARI) in Seattle. Table 1 presents a summary of the qualified chemistry results. These chemistry data are provided in Appendix A.

Based on PSEP protocols, a review of the analytical data quality was performed on the results submitted by ARI in accordance with the SAP. We reviewed holding times, method blanks, surrogate spike results, matrix spike/matrix spike duplicate results, duplicate results, and detection limits. Based on this review, the data were deemed acceptable for use, as reported. No data qualifiers were required.

Total Organic Carbon

Total organic carbon ranged from 5.3 percent in sample C-1 to 14 percent in sample C-2.

Total Metals

None of these metals concentrations exceeded the SQS. The only metals that were detected above the detection limit were cadmium, chromium, copper, lead, and mercury for sample C-1 and cadmium, chromium, copper, lead, mercury, and zinc for sample C-2. The maximum reported concentrations of these metals are 103 mg/kg for copper (sample C-1) and 208 mg/kg for zinc (sample C-2).

TCLP Metals

Sample C-1 was analyzed for TCLP metals. Copper (0.004 mg/L), lead (0.06 mg/L), and zinc (0.277 mg/L) were detected above the detection limit.

PAH Compounds

Low concentrations of phenanthrene (32 ug/kg), fluoranthene (25 ug/kg), and pyrene (38 ug/kg) were detected in Sample C-1. No PAH compounds were detected in Sample C-2.

Pesticides

Low concentrations of 4,4'-DDE (2.2 mg/kg) and 4,4'-DDD (4.3 mg/kg) were detected in sample C-1. Sample C-2 had detections of 4,4'-DDD (3.2 J mg/kg), 4,4'-DDD (4.3 J mg/kg), and methoxychlor (21 J mg/kg).

Total Petroleum Hydrocarbons

Samples C-1 and C-2 were analyzed for total petroleum hydrocarbons, and no compounds (gasoline, diesel, oil) were detected above the detection limits.

LIMITATIONS

Work for this project was performed, and this letter report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the Washington State Department of Transportation for specific application to the referenced property. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

Any questions regarding our work and this report, the presentation of the information, and the interpretation of the data are welcome and should be referred to Albert Shen or David Templeton at (206) 324-9530.

We trust that this report meets your needs.

Sincerely,

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REFERENCES

Hart Crowser, 1995. Preliminary Sediment Quality Assessment, Sampling and Analysis Plan, Martha Lake, Washington. Prepared for Washington State Department of Transportation, July 1995.

Tetra Tech, Inc., 1986 as updated in 1989 and 1991. "Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound." Puget Sound Estuary Program.

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Table 1 - Analytical Results for Sediment Samples

Sample ID: Sampling Date:	Wash. Sediment Quality Stds. (a)	C-1 7/31/95	C-2 7/31/95
Conventionals (%)			
Total Solids		41.2	10.2
TOC		5.3	14
TPH (mg/kg)			
Gasoline		28 U	99 U
Diesel		28 U	99 U
Oil		69 U	250 U
Pesticides/PCBs (ug/kg)			
Alpha-BHC		0.92U	3.3 U
Beta-BHC		0.92 U	3.3 U
Delta-BHC		0.92 U	3.3 U
Gamma-BHC		0.92 U	3.3 U
Heptachlor		0.92 U	3.3 U
Aldrin		0.92 U	3.3 U
Heptachlor Epoxide		0.92 U	3.3 U
Endosulfan I		0.92 U	3.3 U
Dieldrin		1.8U	6.6 U
4,4'-DDE		2.2	3.2 J
Endrin		1.8 U	6.6 U
Endosulfan II		1.8 U	6.6 U
4,4'-DDD		4.3	4.3 J
Endosulfan Sulfate		1.8 U	6.6 U
4,4'-DDT		1.8 U	6.6 U
Methoxychlor		9.2 U	21 J
Endrin Ketone		1.8 U	6.6 U
Endrin Aldehyde		1.8 U	6.6 U
Gamma Chlordane		0.92 U	3.3 U
Alpha Chlordane		0.92 U	3.3 U
Toxaphene		92 U	330 U

PAHs (mg/kg)					
Naphthalene	99	0.34	U	1.25	U
2-Methylnaphthalene	38	0.34	U	1.25	U
Acenaphthylene	66	0.34	U	1.25	U
Acenaphthene	16	0.34	U	1.25	U
Fluorene	23	0.34	U	1.25	U
Phenanthrene	100	0.60		1.25	U
Anthracene	220	0.34	U	1.25	U
Fluoranthene	160	0.47		1.25	U
Pyrene	1,000	0.72		1.25	U
Benzo(a)anthracene	110	0.34	U	1.25	U
Chrysene	110	0.34	U	1.25	U
Benzo(b)fluoranthene	230(b)	0.34	U	1.25	U
Benzo(k)fluoranthene	230(b)	0.34	U	1.25	U
Benzo(a)pyrene	99	0.34	U	1.25	U
Indeno(1,2,3-cd)pyrene	34	0.34	U	1.25	U
Dibenz(a,h)anthracene	12	0.34	U	1.25	U
Benzo(g,h,i)perylene	31	0.34	U	1.25	U
Dibenzofuran	15	0.34	U	1.25	U

Total Metals (mg/kg)					
Arsenic	57	10	U	40	U
Cadmium	5.1	0.6		3	
Chromium	260	36		30	
Copper	390	103		44	
Lead	450	79		160	
Mercury	0.41	0.08		0.26	
Zinc	410	12	U	208	

TCLP Metals (mg/L)					
Arsenic		0.05	U	NA	
Cadmium		0.002	U	NA	
Chromium		0.005	U	NA	
Copper		0.004		NA	
Lead		0.06		NA	
Mercury		0.0001	U	NA	
Zinc		0.277		NA	

Grain Size Distribution (%)					
Percent Gravel		14		0	
Percent Sand		41		18	
Percent Silt		32		61	
Percent Clay		13		21	

Notes:

U Not detected at indicated detection limit.

J Estimated value.

NA Not analyzed.

(a) Ecology's Marine Sediment Management Standards

(b) Sediment Quality Standard for Total

Benzofluoranthenes is 230 mg/kg OC 4340\TBL-1.XLS