

**DUWAMISH/DIAGONAL SEDIMENT REMEDIATION
DREDGING AND CAPPING OPERATIONS
WATER QUALITY MONITORING
SAMPLING AND ANALYSIS PLAN**

**Prepared by the
King County Department of Natural Resources and Parks
Water and Land Resources Division**



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NAME OF PROJECT: Duwamish/Diagonal Sediment Remediation, Dredging and Capping Operation Water Quality Monitoring

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1 Introduction

Two Sampling and Analysis Plans (SAPs) will be prepared and submitted to regulatory agencies for approval to address the following monitoring needs specified in the May 2003 monitoring plan for the Duwamish/Diagonal (Du/Di) project. Water Quality monitoring during construction is addressed in this SAP. A second SAP will address monitoring dredging and capping depth and measuring chemical levels in various sediments collected before, during, and after construction of the cap.

The primary focus of this SAP is to monitor water quality in the Duwamish River during the first five to seven days of both the dredging and the capping operations conducted for the Du/Di sediment remediation project. The SAP describes the planned scope of work, field sampling procedures, and laboratory analytical requirements for the Du/Di Water Quality Monitoring during dredging and capping (DuDi WQM). The discussion contained in the May 2003 monitoring plan provides the specific information used in preparing this detailed SAP.

The revised and finalized construction and post-construction monitoring plan for the expanded Du/Di sediment remediation was prepared in accordance with the Washington Department of Ecology (Ecology) Sediment Management Standards (Chapter 173-204 WAC). The original monitoring plan was included as Appendix Q of the 2001 Cleanup Study Report and addressed a cleanup area about 5 acres in size (Cleanup Area A) that had a preferred cleanup method of "Capping with no change in existing elevation" (Alternative 3). It was envisioned that the initial monitoring plan in Appendix Q would need to be updated and revised during final design and permitting, but when the project was expanded to include another 2-acres (Cleanup Area B), additional revisions were needed.

The first revision to the monitoring plan was dated January 2003 and responded to comments obtained from both regulatory and public review. After January 2003 regulatory agencies submitted additional comments about the monitoring plan during the permitting process. The monitoring plan was revised and finalized in the document dated May 2003, which addresses all comments received from regulatory agencies during the permit process. The May 2003 monitoring plan have been reviewed and approved by both Ecology and EPA. Ecology is the lead agency that approving the project under MTCA, but both Ecology and EPA have been reviewing project documents because the lower Duwamish River was designated a Superfund site in 2001.

1.1 Project Background

The primary goal of the Du/Di project is to remediate contaminated sediments in the lower Duwamish River estuary by installing an isolating sediment cap after a layer of contaminated sediment is removed to make room for the cap. The Du/Di sediment cleanup project includes two rectangular cleanup areas, which are located adjacent to

each other and total about 7 acres in size. Cleanup Area A is the largest (about 5 acres) and was the first cleanup area identified for remediation. Sediments in both cleanup areas have concentrations that exceed the state Sediment Quality Standards (SQS) values for PCBs, mercury, bis(2-ethylhexyl)phthalate and butyl benzyl phthalate. Even though cleanup Area B is smaller in size (about 2 acres), this area has the highest PCBs and represents a potential source of PCB recontamination to Area A unless Area B is cleaned up prior to cleaning up Area A. When the project underwent outside review, there were recommendations to include the upstream PCB "hot spot" in the cleanup action so the cleanup site was expanded to include Cleanup Area B.

The cleanup project is being conducted by the King County Department of Natural Resources and Parks (KCDNRP, formerly Metro) on behalf of the Elliott Bay/Duwamish Restoration Program (EBDRP) Panel. The EBDRP Panel selected the Du/Di site as a priority site for cleanup under the EBDRP Sediment Remediation program established by the 1991 consent decree settling a Natural Resources Damages lawsuit. The consent decree stipulates that sediment remediation will be conducted at CSO and storm drain locations owned by the City of Seattle and Metro (now King County). The consent decree also stipulates that cleanup must comply with state Sediment Management Standards (SMS). The Du/Di cleanup project officially started in 1994 under SMS where the Washington State Department of Ecology (Ecology) is the lead agency. Ecology issued the final Cleanup Action Decision Document to approve the project in July 2002.

The Du/Di cleanup project is within the Lower Duwamish Waterway Superfund site that was listed by the U.S. Environmental Protection Agency (EPA) on September 13, 2001. The EPA is the lead agency for Superfund cleanup projects so the Du/Di project is being coordinated with EPA to ensure compliance with Superfund requirements. As part of the Superfund work, both EPA and Ecology have agreed with the plan to identify sites that pose the greatest hazard and start cleanup efforts on these sites as soon as possible. These sites are designated as early-action sites. It was decided that the Du/Di site would be an early-action site because of the elevated PCB, mercury, BEHP and butyl benzyl phthalate levels and the significant progress made on the cleanup plan since 1994. Ecology and EPA consider the Du/Di project to be a partial cleanup action due to the potential for additional cleanup needs to be identified in the sediments adjacent to the site, which would be addressed at a future time.

Construction work for the Du/Di cleanup project is scheduled to begin with dredging at the beginning of November 2003, and the capping work will be completed by March 1, 2004.

1.2 Project Objectives

The goal of the monitoring plan is to assess the effectiveness of the preferred alternative in maintaining protection of the environment (and related human health) during and after implementation of the cleanup action. Environmental monitoring includes both short-term activities that are limited to the construction period and long-term activities that

track conditions at the sediment cap for at least 10 years. Short-term monitoring activities are needed to determine that all dredging and capping activities are performed according to plan specifications and that water quality standards are not exceeded during construction. The long-term monitoring tracks both the stability of the cap and any recontamination of the cap.

The long term monitoring strategy is to conduct sampling more frequently during the early years after capping and then reduce the frequency of sampling over time. A baseline-sampling event would be conducted within three months of cap placement, and the cap would be sampled each year during the first 5 years after cap completion. The frequency of sampling events during the next 5 years would be determined based on the rate of recontamination observed during the first 5 years of monitoring. If recontamination appears to have stabilized after 5 years, then monitoring could be reduced to alternating years.

There are eight main objectives associated with the monitoring plan as listed below. A summary of the sampling activities and schedule are provided in Section 5 and sampling stations are shown in Figure 1.

OBJECTIVE 1: To ensure that water quality standards or guidelines are met during dredging and transport of contaminated sediment to an approved disposal facility (either landfill or nearshore confined disposal).

OBJECTIVE 2: To insure that the dredging and capping constructions are performed according to plan specifications.

OBJECTIVE 3: To identify dredge material that is above the PCB dangerous waste level (50 ppm) so this dredge material can be sent to a TSCA approved landfill.

OBJECTIVE 4: To insure that capping materials (sand and habitat mix) are chemically clean prior to placement.

OBJECTIVE 5: To document whether the dredging of contaminated sediments leads to any increases in chemical levels in sediments located beyond the cleanup site boundary.

OBJECTIVE 6: To document whether chemistry levels in areas beyond the cleanup site boundary are high enough that they could be a source of PCB recontamination to the cap and should be considered for sediment remediation action.

OBJECTIVE 7: To document potential future recontamination of the cap by continuing point source discharges of storm water or combined sewer overflow.

OBJECTIVE 8: To document cap stability for isolating contaminants over time.

1.3 Project Area Description

The Du/Di cleanup area is located at approximately river kilometer 3 in the lower portion of the Duwamish River, within the south industrial section of Seattle, Washington. The cleanup site includes two rectangular cleanup areas that are located on the east side of the river (opposite Kellogg Island) near Port of Seattle's terminals T-106 (Cleanup Area A) and T-108 (Cleanup Area B). The combined size totals about 7 acres.

Cleanup Area A is about 5 acres and is located offshore from two discharge pipes. The Duwamish CSO pipe is submerged and is controlled to less than one overflow per year. Stormwater primarily comes out the Diagonal CSO/SD, which has a large outfall structure along the shoreline. Two parallel sewer lines called the Duwamish Siphon cross the river under Cleanup Area A and were installed in 1967 below the river bottom in a dredged trench. Cleanup Area A extends from the shoreline to the edge of the navigation channel.

Cleanup Area B is about 2 acres in size and is located offshore from an abandoned sewage treatment plant that closed in 1969. Cleanup Area B is on the offshore side of a tie-up loading pier at T-108; therefore, in this area the cap was designed with armor rock to protect it from erosion due to prop wash from tug boats that move barges to and from the pier. Part of Cleanup Area B extends into the navigation channel so over-dredging will be conducted in the area extending into the channel to insure the surface of the cap is at minus 32 feet (MLLW), which is two feet deeper than channel depth of minus 30 feet (MLLW). Cleanup Area B does not extend to the shoreline behind the pier because this area had lower chemical values. In 1977, before the pier was present, the area was dredged to create a deeper berthing area near shore, and a new shoreline was created about 100 feet further inshore from the old shoreline.

Figure 1. Duwamish/Diagonal Sediment Remediation Area.

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2 Study Objectives

Water quality monitoring is primarily designed to accomplish Objective 1, which is to insure that water quality standards are met during the dredging and capping operations (including dewatering). This data can be used to decide whether any changes are necessary in the cleanup activities to meet marine water quality standards (see Table 1). Of the four chemicals of concern (COC) identified for the site (mercury, PCB, Bis(2-ethylhexyl) phthalate and Butyl benzyl phthalate), there are acute marine criteria values for only dissolved mercury and total PCB. A secondary objective is to document the amount of dredged sediment in the water column, which provides an indication of whether significant amounts of dredged sediment are likely to move beyond the cleanup site boundary.

Table 1 Fresh and Marine acute water quality limits

Parameter or Analyte	FW Acute Value	MW Acute Value
Turbidity	<10NTU if bkg < 50NTU, <20% if bkg >50NTU	<10NTU if bkg < 50NTU, <20% if bkg >50NTU
Mercury	2.1 ug/L	1.8 ug/L
Biphenyls (PCBs)	2.0 ug/L	10.0 ug/L
BEP (Bis(2-ethylhexyl) phthalate)	5.9 ug/L	N/A
BBP (Butyl benzyl phthalate)	N/A	N/A

In general, water quality monitoring will be performed during the first work week of the 36-day dredging schedule and during the first work week of the 36-day capping schedule; however, this monitoring could be extended if results show that water quality standards are exceeded. A work week will be defined as the weekly working schedule of the dredging subcontractor. Both turbidity and TSS will be measured during two tidal cycles per day and at two depths per station (such as 60 cm from water surface and 90 cm above the river bottom) because the Duwamish River is a stratified tidal estuary. COCs will be measured once per day (one tidal cycle and two depths) during the first week of dredging. COC samples will be collected during both tides and the sample set from the highest measured turbidity will be sent to the lab for analysis. No COC measurements will be needed during capping.

Water column sampling will occur twice daily: once during the flood tide and once during the ebb tide. Two water quality stations will be located 150 feet and 300 feet downstream from the dredging and capping activities. They will represent one-half of the

designated mixing zone distance and its outer edge, respectively. A single reference station will be located upstream of these operations in an effort to represent a body of water outside of their influence.

The timing and frequency of monitoring and sampling during dredging and dewatering activities are intended to be representative of conditions during a given work day and also to capture worst-case turbidity plume. For example, the worst-case turbidity conditions could occur several hours after a tide reversal. This is because a plume moving in one direction prior to the reversal could move back through the dredging/dewatering area after the reversal and thereby be superimposed on the plume being generated by the activities at the time.

The timing of monitoring and sampling during the day will be directed toward one event on a flood tide and one event on an ebb tide. In addition, timing will preferentially be near the initiation of daily activities and the termination of daily activities. Thus, the person directing the field sampling effort must use some discretion concerning how early or how late to sample in view of the priorities of capturing worst-case conditions and doing so on a flood and an ebb tide on a given day.

During the incoming tide when the river flow reverses, the juxtaposition of these three station locations will be reversed such that the two "downstream" stations will then be located upriver of the dredging operation. Distance will be the primary factor governing positioning of the two downstream stations. These two stations will be moved laterally (across current) to intersect with any observed turbidity plumes from the dredging and capping operations, but should each remain on an arc drawn 150 and 300 feet from the dredging and capping operations.

One additional sampling station will be used to monitor the turbidity plume from potential dewatering of haul-barges in the Duwamish River. This station will be located at the edge of the mixing zone (300 feet downstream), and the sampling depth will be based on how deep the turbidity plume extends. If the turbidity plume is found to be limited to the surface water layer, then sampling at this station will focus on the upper layer and omit the deep sample from the high-salinity salt wedge.

3 Project Team and Responsibilities

Project team members and their responsibilities are summarized in Table 2. All team members are staff of the King County Department of Natural Resources and Parks, either within the Water and Land Resources Division or Wastewater Treatment Division.

Table 2 Project team members and responsibilities.

Name/Telephone	Title	Affiliation	Responsibility
Pat Romberg (206) 296-8251	Water Quality Planner/	Science, Monitoring and Data Management	Sediment Cleanup Advisor, Duwamish Diagonal Sediment Remediation Project
Colin Elliott (206) 684-2343	Quality Assurance Officer	Environmental Laboratory	Overall analytical and Field QA/QC
Fritz Grothkopp (206) 684-2327	Laboratory Project Manager	Environmental Laboratory	Coordination of sampling and analytical activities, laboratory QA/QC, and data reporting
Priscilla Hackney (206) 684-791	KC Engineer, Project Manager		Manager Duwamish Diagonal Sediment Remediation Project

4 Schedule

Sampling will take place during the months of November 2003 (dredging) and January 2004 (capping). Sampling will occur during the flood and ebb tides while the dredging and capping operations are active.

5 Sample Design

Water quality sampling will occur twice daily: once during the flood tide and once during the ebb tide. During the ebb tide, one station will be located at the edge of the mixing zone 300 feet downstream of the dredging operation, while a second station will be positioned at the midway point (150 feet downstream of the dredging operation) representing one-half the mixing zone distance. Finally, a single reference station will be located upstream of the dredging operation so as to be outside of its influence. On the incoming flood tide, the pattern of sampling stations will be reversed: the 150 and 300-foot stations will be located upstream of the dredging operation, and the reference station will be positioned downstream of it. Sampling stations will be positioned within any visible plume from the dredging operation and/or through the use of a hydroacoustic tracking device (e.g. fish-finder).

Distance will be the primary factor governing positioning of the two downstream stations. However, if the turbidity plume is not moving directly downstream, then the position of the two downstream stations will be moved laterally (across the current) to intersect with the plume where visible, or when detected by a hydroacoustic device (e.g. fish finder). On a recording fish locator device, the turbidity plume from the dredging operation shows up as a dark band.

One additional sampling station will be used to monitor the turbidity plume from potential dewatering of haul-barges in the Duwamish River (one option contractor could choose). This station will be located at the edge of the mixing zone (300 feet downstream) and the sampling depth will be based on how deep the turbidity plume extends. If the turbidity plume is found to be limited to the surface water layer, then sampling at this station will focus on the upper layer and omit the deep sample from the high salinity salt wedge. Limited dewatering of haul-barges could be needed for upland disposal, but any water allowed to drain back to the river must pass through a filter device designed to remove particulate material. The dredging specifications require that all openings in the rail of flat-top barges be covered with a filter device consisting of hay bales plus 3 layers of filter fabric to provide filtration before water is allowed to return to the river.

The following table show the expected tidal sampling opportunities for the first fourteen days of the dredging operation. Each row represents one sampling event. The time periods for each tide are calculated as follows. The Flood tide period is (low tide + 2

hours) to (high tide – 1 hour). The Ebb tide period is (high tide + 2 hours) to (low tide – 1 hour). In addition, the following guidelines will be used to insure that the optimum sample is collected during the dredging operation.

- Wait one hour after dredging starts before taking the first sample of the day to insure there has been sufficient time for suspended material to move with the tide.
- During the flood tide, stop sample collection one hour before high tide to avoid decreased flow velocities as the tide reaches maximum level.
- Avoid sampling during the one hour slack water period that occurs after high tide.
- After high tide, allow a minimum of 2 hours to pass before taking the first ebb tide sample. This will allow enough time for water movement to start after the slack water period.
- During ebb tide stop sample collection one hour before low tide to avoid decreased flow velocities as the tide reaches minimum level.
- Assume one hour is needed to collect all samples for one tide event.
- The last sampling event for the day must begin a minimum of one hour before the end of dredging operations

Projected Tidal Sampling Windows and Sample Collection Counts

Date	Tide ¹	Time ²	Ref site ³	150' site ³	300' site ³	Dewater site ⁴	Total Conv	Total COC ⁵
11/10/03	Ebb	822 to 1038	2	2	2	1 or 2	7 to 8	7 to 8
11/10/03	Flood	1338 to 1531	2	2	2	1 or 2	7 to 8	7 to 8
11/10/03	Ebb*	1831 to 2238	2	2	2	1 or 2	7 to 8	7 to 8
11/11/03	Ebb	902 to 1118	2	2	2	1 or 2	7 to 8	7 to 8
11/11/03	Flood	1318 to 1557	2	2	2	1 or 2	7 to 8	7 to 8
11/11/03	Ebb*	1857 to 2313	2	2	2	1 or 2	7 to 8	7 to 8
11/12/03	Ebb	944 to 1203	2	2	2	1 or 2	7 to 8	7 to 8
11/12/03	Flood	1503 to 1625	2	2	2	1 or 2	7 to 8	7 to 8
11/13/03	Flood*	250 to 731	2	2	2	1 or 2	7 to 8	7 to 8
11/13/03	Ebb	1031 to 1253	2	2	2	1 or 2	7 to 8	7 to 8
11/13/03	Flood	1553 to 1657	2	2	2	1 or 2	7 to 8	7 to 8
11/14/03	Flood*	332 to 822	2	2	2	1 or 2	7 to 8	7 to 8
11/14/03	Ebb	1122 to 1354	2	2	2	1 or 2	7 to 8	7 to 8
11/14/03	Flood	1654 to 1736	2	2	2	1 or 2	7 to 8	7 to 8

- 1) * indicates that the tidal period may be too short to safely and accurately sample the dredging operation.
- 2) Time period are for optimal tidal sampling.
- 3) Samples for each site include two sample depths.
- 4) This site may have one or two depths depending on the extent of turbidity. Sampling will occur only when a barge is being dewatered.
- 5) Only one set of COC samples will be submitted for analysis per day.

Samples will be taken to the laboratory after the last sampling event of each day. The last event of each day is projected to be completed between 5 and 6 pm. The samples will be officially received by the lab at 8am of the following day. Analysis can begin after sample receipt activities are completed. Samples will be batched per two day increments with the exception of the final batch which will consist of the last three days of either a 5 or 7 day work week period.

5.1 Sampling Station Locations

There are no exact sample locations for this portion of the project, however, the defined edge of the mixing zone is 300 ft from the dredging or dewatering operations. The exact locations will be determined by the movement of the plume generated by the dredging or dewatering operation and the direction and intensity of the tide. Geographic coordinate information will be recorded for each sample collected.

5.2 Data Quality Objectives

The following data quality objectives have been established to meet these needs of this project.

5.2.1 Precision, Accuracy, and Bias of Field and Laboratory Measurements

Precision is the agreement of a set of results among themselves and is a measure of the ability to reproduce a result. Accuracy is an estimate of the difference between the true value and the determined mean value. The accuracy of a result is affected by both systematic and random errors. Bias is a measure of the difference, due to a systematic factor, between an analytical result and the true value of an analyte. Precision, accuracy, and bias for analytical chemistry may be measured by one or more of the following quality control (QC) procedures:

- Analysis of various laboratory QC samples such as method blanks, matrix spikes, certified reference materials, and laboratory duplicates (laboratory and field measurement QC results will be evaluated against the control limits presented in Section 9).
- Collection and analysis of replicate field samples for laboratory and field measurement (replicate results should exhibit a relative percent difference less than 50% in order for the evaluation of the spatial and temporal chemical concentrations to be meaningful)
- Collection and analysis of total metals in field blanks (results should be less than the method detection limit or 10 times lower than the measured sample concentrations).

5.2.2 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at the sampling point, or an environmental condition. Samples are to be collected to minimize potential contamination and other types of degradation in the chemical and physical composition of the water. Laboratory representativeness is achieved by proper preservation and storage of samples along with appropriate subsampling and preparation for analysis. Data that is not representative as defined above should not be used.

5.2.3 Completeness

Completeness is defined as the total number of samples analyzed for which acceptable and representative analytical data are generated, compared to the total number of samples to be analyzed. The goal for completeness is 100%. The samples from each event should

produce greater than 90% acceptable chemical data under the QC conditions mentioned in Section 9.

5.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal is achieved through using standard techniques to collect and analyze representative samples, along with standardized data validation and reporting procedures. Changes or updates to analytical methods and sampling techniques midway into the project must be validated and shown to be equivalent to existing methods before being implemented.

5.2.5 Sensitivity

The methods performed must be capable of achieving detection limits at or below the appropriate water quality criteria (see table added to Section 2).

6 Sample Collection Procedures

This section describes sample collection procedures that will be followed throughout the project to help ensure that project data quality objectives are met. Included in this section are general health and safety requirements, general sample locations, sample collection and processing procedures, and field documentation. Sampling equipment will be prepared at the laboratory following appropriate procedures, and sampling personnel will be trained in any specialized sampling techniques.

6.1 General Health and Safety Requirements

The following general health and safety guidelines have been provided in lieu of a project-specific Health and Safety Plan. These guidelines will be read and understood by all members of the sampling crew prior to any sampling activities.

- Sampling personnel will wear chemical-resistant gloves whenever coming into contact with samples.
- No eating or drinking by sampling personnel will be allowed during active sampling operations.
- All accidents, "near misses," and symptoms of possible exposure will be reported to a sampler's supervisor within 24 hours of occurrence.
- All crewmembers will be aware of the potential hazards associated with chemicals used during the sampling effort.

6.2 General Geographical Sample Locations

The samples for this effort will be collected at the following locations: 150 and 300 feet downstream and at least 300 to 500 feet upstream of the dredging operation. Exact locations and their coordinates will be recorded during the sampling activity. See description of sampling locations in Section 2 of this document for more details.

6.3 Field Measurements and Analysis

Field measurements will be taken at each sampling location either just prior or just after grab sampling for chemical analysis. A Hydrolab Mini sonde or a YSI probe will be used to analyze the surface water temperature, pH, turbidity, specific conductance, salinity and dissolved oxygen. The field meters will be calibrated according to Environmental Support Services (ESS) Standard Operating Procedure (SOP # 02-01-005) within 24 hours of the sampling event. See Section 9.3 for specific QC requirements for field measurements.

The EPA has reported that a recording fish locator can be used to locate the submerged sediment plume from dredging. Particulates in the water column produce a darkened area on the recording. The boat will run transects perpendicular to the shore at 150 and 300 feet downstream and the fish locator trace will show if there is an identifiable submerged turbidity plume. Station locations would be positioned in the plume if one was readily apparent.

Depths of the field measurements would be determined by first taking a fathometer reading to determine total river depth of the stations. This measurement will be used to properly position the Niskin bottles on the hydrowire.

6.4 Water Sampling

6.4.1 Station Positioning

A range finder device that is accurate to five feet will be used to position the boat and sampling apparatus to the specified 150 and 300 foot distances from the operations. The range finder will be used as received and no other field or lab calibration will be necessary. The exact distances of the sampling location from the operations will be recorded on the field sheet along with the other field parameters.

6.4.2 Sample Collection

Samples will be collected at 90 cm from the bottom and 60 cm from the surface of the water at all three sampling locations.

Grab samples will be collected according to ESS SOP # 02-02-003-000 using a hydro wire and Niskin sampling apparatus. The hydrowire will be deployed using the on-board winch and boom system. The exact positions of the Niskin samples on the hydrowire will be determined using the fathometer reading at each sample location. The Niskin will then be affixed to the hydrowire to provide the required sample depths of 60 cm below the water surface and 90 cm above the river bottom. A teflon coated messenger will be used to trip the samplers. The collected samples will be transferred to sample bottles and stored in ice chests until transported to the lab for analysis. A field blank will be collected during each event while metals samples are being collected.

6.4.3 Sampler Decontamination

The Niskin sampler devices will be decontaminated between stations using surface water. The deck mounted hose system on board the sampling vessel will be used to provide the ambient surface water. At least three sampler volumes will be passed through the sampler to effect proper cleaning.

6.5 Field QC

In addition to the field blanks described in Section 6.4, field replicates will be collected once per event. Replicate samples at one randomly selected grab site will be collected for all parameters. A field replicate is a separate sample collection done repeating the sampling steps and appropriate rinsing procedures but with separate sample containers.

6.6 Sample Documentation

This section provides guidance for documenting sampling and data gathering activities. The documentation of field activities provides important project information and data that can support data generated by laboratory analyses.

6.6.1 Sample Numbers and Labels

Unique sample numbers will be assigned to each sampling location for which water samples are collected for field and lab analysis. Sample numbers will be assigned prior to the sampling event and waterproof labels generated for each sample container.

6.6.2 Field Notes

Field notes will be maintained for all field activities, including the collection of samples and the gathering of field meter data. Field notes will be kept on water-resistant paper and all field documentation will be recorded in indelible, black ink. Field notes will be recorded on pre-printed field sheets prepared specifically for this project. A sample field sheet is shown in Figure 3. Information recorded on field notes will include, but not be limited to:

- name of recorder,
- sample number,
- sample station locator information, field coordinates for each individual grab?
- date and time of sample collection,
- results for all field measurements (temperature, pH, turbidity , dissolved oxygen, conductivity, salinity and depth),
- River flow rate and tidal direction

Additional information that may be recorded on the field sheets includes sampling methodology (sample code) and any deviations from established sampling protocols.

Additional anecdotal information pertaining to observations of unusual sampling events or circumstances may also be recorded on the field sheets.

Figure 2. Sample field sheet.

Login Number: T_DUDI_PRMSD

Page: 1

DUDI SEDIMENT REMEDIATION PROJECT

Project Number: 423056-120

Personnel: _____

Sample Number	T_DUDI_PRMSD-1	T_DUDI_PRMSD-2	T_DUDI_PRMSD-3	
Locator	DUD201	DUD202	DUD203	
Short Loc. Desc.				
Locator Desc.				
Site	DUWAMISH RIVER	DUWAMISH RIVER	DUWAMISH RIVER	
Start Time				
End Time				
Sample Depth				
Collect Date				
Comments				
Dept., Matrix, Prod	<input type="checkbox"/> SALTWRSED BNALLFULL <input type="checkbox"/> SALTWRSED CLIENT LOC <input type="checkbox"/> SALTWRSED PCBLL <input type="checkbox"/> SALTWRSED PESTLL <input type="checkbox"/> SALTWRSED PSD <input type="checkbox"/> SALTWRSED SAMP DEPTH <input type="checkbox"/> SALTWRSED SAMP DESCRIP <input type="checkbox"/> SALTWRSED SAMP METH <input type="checkbox"/> SALTWRSED SAMP TEMP <input type="checkbox"/> SALTWRSED SAMPCOORDX1 <input type="checkbox"/> SALTWRSED SAMPCOORDX10 <input type="checkbox"/> SALTWRSED SAMPCOORDX2 <input type="checkbox"/> SALTWRSED SAMPCOORDX3 <input type="checkbox"/> SALTWRSED SAMPCOORDX4 <input type="checkbox"/> SALTWRSED SAMPCOORDX5 <input type="checkbox"/> SALTWRSED SAMPCOORDX6 <input type="checkbox"/> SALTWRSED SAMPCOORDX7 <input type="checkbox"/> SALTWRSED SAMPCOORDX8 <input type="checkbox"/> SALTWRSED SAMPCOORDX9 <input type="checkbox"/> SALTWRSED SAMPCOORDY1 <input type="checkbox"/> SALTWRSED SAMPCOORDY10 <input type="checkbox"/> SALTWRSED SAMPCOORDY2 <input type="checkbox"/> SALTWRSED SAMPCOORDY3 <input type="checkbox"/> SALTWRSED SAMPCOORDY4	<input type="checkbox"/> SALTWRSED BNALLFULL <input type="checkbox"/> SALTWRSED CLIENT LOC <input type="checkbox"/> SALTWRSED PCBLL <input type="checkbox"/> SALTWRSED PESTLL <input type="checkbox"/> SALTWRSED PSD <input type="checkbox"/> SALTWRSED SAMP DEPTH <input type="checkbox"/> SALTWRSED SAMP DESCRIP <input type="checkbox"/> SALTWRSED SAMP METH <input type="checkbox"/> SALTWRSED SAMP TEMP <input type="checkbox"/> SALTWRSED SAMPCOORDX1 <input type="checkbox"/> SALTWRSED SAMPCOORDX10 <input type="checkbox"/> SALTWRSED SAMPCOORDX2 <input type="checkbox"/> SALTWRSED SAMPCOORDX3 <input type="checkbox"/> SALTWRSED SAMPCOORDX4 <input type="checkbox"/> SALTWRSED SAMPCOORDX5 <input type="checkbox"/> SALTWRSED SAMPCOORDX6 <input type="checkbox"/> SALTWRSED SAMPCOORDX7 <input type="checkbox"/> SALTWRSED SAMPCOORDX8 <input type="checkbox"/> SALTWRSED SAMPCOORDX9 <input type="checkbox"/> SALTWRSED SAMPCOORDY1 <input type="checkbox"/> SALTWRSED SAMPCOORDY10 <input type="checkbox"/> SALTWRSED SAMPCOORDY2 <input type="checkbox"/> SALTWRSED SAMPCOORDY3 <input type="checkbox"/> SALTWRSED SAMPCOORDY4	<input type="checkbox"/> SALTWRSED BNALLFULL <input type="checkbox"/> SALTWRSED CLIENT LOC <input type="checkbox"/> SALTWRSED PCBLL <input type="checkbox"/> SALTWRSED PESTLL <input type="checkbox"/> SALTWRSED PSD <input type="checkbox"/> SALTWRSED SAMP DEPTH <input type="checkbox"/> SALTWRSED SAMP DESCRIP <input type="checkbox"/> SALTWRSED SAMP METH <input type="checkbox"/> SALTWRSED SAMP TEMP <input type="checkbox"/> SALTWRSED SAMPCOORDX1 <input type="checkbox"/> SALTWRSED SAMPCOORDX10 <input type="checkbox"/> SALTWRSED SAMPCOORDX2 <input type="checkbox"/> SALTWRSED SAMPCOORDX3 <input type="checkbox"/> SALTWRSED SAMPCOORDX4 <input type="checkbox"/> SALTWRSED SAMPCOORDX5 <input type="checkbox"/> SALTWRSED SAMPCOORDX6 <input type="checkbox"/> SALTWRSED SAMPCOORDX7 <input type="checkbox"/> SALTWRSED SAMPCOORDX8 <input type="checkbox"/> SALTWRSED SAMPCOORDX9 <input type="checkbox"/> SALTWRSED SAMPCOORDY1 <input type="checkbox"/> SALTWRSED SAMPCOORDY10 <input type="checkbox"/> SALTWRSED SAMPCOORDY2 <input type="checkbox"/> SALTWRSED SAMPCOORDY3 <input type="checkbox"/> SALTWRSED SAMPCOORDY4	

continue ...

CHAIN OF CUSTODY

RELINQUISHED BY	Date	RECEIVED BY	Date
Signature		Signature	
Printed Name	Time	Printed Name	Time
Sample Number(s)	(All)	Sample Number(s)	(All)

6.6.3 Field Analytical Results

Field analytical and QC results will be recorded on field sheets in a manner that easily identifies the information as analytical or QC data. Daily field instrument calibration records will be recorded in instrument-specific logbooks. All entries will be recorded in waterproof, indelible black ink.

7 Sample Handling Procedures

Consistent sample handling procedures are necessary to maintain sample integrity and provide data that is as high a quality as possible under the sampling conditions. This section provides requirements for proper sample containers, labeling, preservation and storage and chain-of-custody practices.

7.1 Sample Containers and Labels

All samples will be collected or split into pre-cleaned, laboratory-supplied containers affixed with computer-generated labels. All low-level metals analysis sample bottles will be bagged in ziplock closure bags. Information contained on sample labels will include: a unique sample number; information about the sampling location; the collection date; the requested analyses; and information about any chemical used in sample preservation. Sample containers required for the various analyses are summarized in Table 3.

Table 3 Sample containers, preservation, and holding times.

Analysis	Container	Preservation	Holding Time*
Total Suspended Solids	1-Liter HDPE, CWM	Refrigerate, 4 °C	7 days
Salinity	125ml HDPE CNM	Refrigerate, 4 °C	28 days
Turbidity	500-ml HDPE, CWM	Refrigerate, 4 °C	2 days
Mercury, Total and Dissolved (by CVAA)	500-ml Teflon, Acid washed	HCl, pH <2	28 days
Organic Analysis, BN & PCB	1000-ml Amber Glass with Teflon lined cap	Refrigerate, 4 °C	7 days to extraction 40 days to extract analysis

* The start of the holding time for grab samples is the date and time collected in the field.

7.2 Sample Preservation and Storage Requirements

All water samples will be stored refrigerated at a temperature of approximately 4° C, or preserved appropriately. Sample preservation requirements and storage conditions as well as analytical holding times are summarized in Table 3, above.

7.3 Chain-of-Custody Practices

During sample collection, all sample bottles will be either locked in a secure housing , or in the custody of the sampling personnel. The fieldsheets generated by the Laboratory Information Management System (LIMS) will be used to provide Chain of Custody (COC) transfer of the samples to the laboratory. A COC signature area will be provided at the bottom of each field sheet. Only one signature section will need to be signed if all samples are delivered at the same time. Any unused signature areas on the fieldsheets will be crossed off and initialed by the Sample Custodian. If any samples require analyses that are to be conducted by a subcontracting laboratory, then samples are released according to ESS SOP # 11-02-002-000 (Subcontracting Samples).

7.4 Sample Retention and Disposal

The laboratory will hold, where practical, any unused sample that has not exceeded holding time for at least 30 days after the release of results. Unused samples categorized as hazardous according to state or federal guidelines will either be returned to the client or special arrangements will be made to dispose of the samples at the laboratory.

8 Laboratory Analytical Methods

Adherence to standardized analytical protocols and associated QA/QC guidelines for chemical testing will help produce data able to meet the project goals and objectives. Water quality analyses are to be done in accordance with the requirements in 40 CFR 136.

8.1 Chemical Testing

This section presents the chemical analytical methodologies that will be employed during this project, along with associated detection limits. The King County Environmental Laboratory distinguishes between a *method* detection limit (MDL) and a *reporting* detection limit (RDL).

- The MDL is defined as *the minimum concentration of a chemical constituent that can be detected.*
- The RDL is defined as *the minimum concentration of a chemical constituent that can be reliably quantified.*

8.1.1 Conventional Analyses and Detection Limits

Conventional analyses, analytical methods, and associated detection limits are summarized in Table 4. All conventional analyses will be performed at the King County Environmental Laboratory.

Table 4. Conventional analyses.

Analysis/Method	Method Summary	MDL	RDL
Total Suspended Solids SM 2540 D	Gravimetric	0.5 mg/L	1 mg/L
Salinity SM2520-B	Amperometric	2 PSS	3 PSS
Turbidity SM 2130-B	Nephelometry	0.5 NTU	2 NTU

8.1.2 Metal Analyses and Detection Limits

Target elements, analytical methods and associated detection limits are summarized in Table 5. Sample collection methods and methods of analysis are designed to achieve the multiple project goals. Analysis of mercury by Cold Vapor Atomic Absorption Spectroscopy (CVAA) will be performed at the King County Environmental Laboratory.

Table 5. Total and Dissolved Mercury Analysis.

Element	Analytical Method	MDL (mg/L)	RDL (mg/L)
Mercury	CVAA (245.2)	0.000005	0.000015

8.1.3 Organic Analyses and Detection Limits

Organic analyses, methodologies, and associated detection limits are summarized in Table 6. All organic analyses will be performed by the King County Environmental Laboratory.

Table 6. Organic analyses.

Analysis/Method	Method Summary	MDL (µg/L)	RDL (µg/L)
BN, EPA 3520C or 3535/8270C (PAH & Phthalates)	Continuous Liquid—Liquid Extraction, or Solid Phase Extraction (for samples having <1% suspended solids) Gas Chromatography with Mass Spectroscopy	0.2 to 0.8	0.4 to 1.5
PCBs, EPA 3520C or 3535/8082	Continuous Liquid—Liquid Extraction, or Solid Phase Extraction (for samples having <1% suspended solids) Gas Chromatography with Electron Capture Detector	0.05	0.1

9 Quality Control (QC) Practices

9.1 QC Practices for Chemistry Analysis

The QC samples that will be analyzed in association with chemical testing are summarized in Table 7.

Table 7. Chemistry QC samples for water analysis.

Parameter	Blank	Replicate ¹	Matrix Spike	Blank Spike Duplicate ²	LCS ³ / CS ⁴	Surrogates
Turbidity	No	1 Per Batch ⁵	No	No	1 Per Batch	No
Salinity	No	1 Per Batch	No	No	1 Per Batch	No
Total Suspended Solids	1 Per Batch	1 Per Batch	No	No	1 Per Batch	No
Mercury, CVAA	1 Per Batch	1 Per Batch	1 Per Batch	No	1 Per Batch	No
BN	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No	Yes
PCBs	1 Per Batch	1 Per Batch	1 Per Batch	1 Per Batch	No	Yes

¹Replicate - Duplicate analysis for all conventional parameters, duplicate analysis for metal parameters, and matrix spike duplicate (MSD) for organic parameters.

²A Blank Spike Duplicate will be prepared and analyzed in the absence of sufficient sample for Matrix Spike & Duplicate. An LCS may be substituted in metals analysis.

³Laboratory Control Standard. The BN and PCB analysis use a matrix matched spiked blank in place of the LCS

⁴Check Standard

⁵Batch - A group of samples analyzed together for QC purposes containing a maximum of 20 samples.

The recommended QC limits associated with chemistry testing are summarized in Table 8.

Table 8. Recommended chemistry QC limits for water samples.

Parameter	Blank ¹	Replicate ²	Matrix Spike ³	Blank Spike ³	LCS/CS ³	Surrogates ³
Total Suspended Solids	< MDL	≤ 25%	N/A	N/A	80 – 120%	N/A
Salinity	N/A	± 0.05PSS Units	N/A	N/A	98.5 – 101.5 %	N/A
Turbidity	N/A	≤ 20%	N/A	N/A	90 – 110%	N/A
Mercury CVAA	< MDL	≤ 20%	80 – 120%	85 – 115%	80 – 120%	N/A
BN	< MDL	Cmpd Spec ⁵	Cmpd Spec ⁵	Cmpd Spec ⁵	N/A	Cmpd Spec ⁵
PCBs	< MDL	Cmpd Spec ⁵	Cmpd Spec ⁵	Cmpd Spec ⁵	N/A	Cmpd Spec ⁵

¹Concentration of all analytes should be less than the method detection limit (< MDL).

²Relative percent difference (RPD) for duplicate analysis.

³Percent recovery for matrix spike, standard reference material, and surrogates.

⁴Acceptance limits for the Relative Percent Difference of the Matrix Spike and Matrix Spike Duplicate

⁵Compound Specific

N/A = Not applicable.

9.2 QC Practices for Field Measurements

Calibration QC requirements for attended Hydrolab or YSI field measurements involve determination of post-deployment calibration drift for the parameters of interest (except temperature). Calibration drift is determined by measuring the check standard solution at the conclusion of the field measurements. This check must be done within 12 hours of the last field measurement. The post-deployment checks must be done in the same order used for initial calibration and must be done before any maintenance or calibrations are performed.

Table 9. Acceptance limits for post-deployment calibration checks.

Parameter	Calibration Drift Check
Dissolved Oxygen	± 4 %
Temperature	Done annually only
Turbidity	± 5 NTU
Conductivity	± 10 %
PH	± 0.2 pH units

QC for field measurements is typically limited to measuring precision by collection of replicate field measurements. Replicates are done at a minimum frequency of 5% of measurements or at a minimum, once per day. A field replicate is defined as a separate in-situ measurement made following all procedures typically done between individual samples. The probe would typically be removed from the water body then returned to the same depth and position used in the original measurement. The following table describes the acceptance limits for field replicates.

Table 10. Acceptance limits for field replicates measurements.

Parameter	Duplicate Samples
Dissolved Oxygen	RPD ¹ ≤ 20%
Temperature	± 0.3 °C
Turbidity	± 5 NTU
Conductivity	RPD ≤ 10%
PH	± 0.2 pH units

¹ RPD (Relative Percent Difference) = $100 \times [(r_1 - r_2)] / ((r_1 + r_2)/2)$, where r_1 = result 1 r_2 = result 2

Data sets that do not meet the field QC acceptance limits may require that the field measurement data be flagged. Comments on field QC results should be included in the QA review.

10 Data Analysis, Record Keeping, and Reporting

The King County Environmental Laboratory will provide a 3 and 14-day turnaround time for all analytical data based on the batching described in section 5. Mercury, TSS, Turbidity and PCB results will be reported in three working days, all other analyses will be reported in 14 calendar days. The summarized numerical results values will be transmitted to the EPA and Ecology in an excel spreadsheet called the Laboratory Comprehensive Report. A full data package consisting of a technical memo, summarized data sheets and raw instrument and laboratory data sheets will be provided within 45 calendar days based also on the sample batching described in section 5.

10.1 Interpretation of Chemical Data

Analytical results will be compared with existing water quality criteria for Class B surface water and other appropriate water quality criteria. The results will be used to assess the impact of the dredging operation on water quality and to make adjustments, if necessary, to the dredging operations to minimize water quality impacts.

10.2 Quality Assurance Reviews

Chemistry and field measurement data will undergo standard QA review within each laboratory group according to the Environmental Laboratory QA Manual and method-specific SOPs. Data will be flagged accordingly. A description of the laboratory qualifiers is provided in Table 11.

Table 11. Laboratory qualifiers.

Qualifier	Description
<i>General</i>	
H	Indicates that a sample handling criterion was not met in some manner prior to analysis. The sample may have been compromised during the sampling procedure or may not comply with holding times, storage conditions, or preservation requirements. The qualifier will be applied to applicable analyses for a sample.
R	Indicates that the data are judged unusable by the data reviewer. The qualifier is applied based on the professional judgment of the data reviewer rather than any specific set of QC parameters and is applied when the reviewer feels that the data may not or will not provide any useful information to the data user. This qualifier may or may not be analyte-specific.
<MDL	Applied when a target analyte is not detected or detected at a concentration less than the associated method detection limit (MDL). MDL is defined as the lowest concentration at which an analyte can be detected. The MDL is the lowest concentration at which a sample result will be reported.
<RDL	Applied when a target analyte is detected at a concentration greater than or equal to the associated MDL but less than the associated reporting detection limit (RDL). RDL is defined as the lowest concentration at which an analyte can reliably be quantified. The RDL represents the minimum concentration at which method performance becomes quantitative and is not subject to the degree of variation observed at concentrations between the MDL and RDL.
RDL	Applied when a target analyte is detected at a concentration that, in the raw data is equal to the RDL.
TA	Applied to a sample result when additional narrative information is available in the text field. The additional information may help to qualify the sample result but is not necessarily covered by any of the standard qualifiers.
<i>Chemistry</i>	
B	Applied to a sample result when an analyte was detected at a concentration greater than the MDL in the associated batch method blank. The qualifier is applied in Organics analyses when the sample analyte concentration is less than five times the blank concentration and is applied in Conventionals and Metals analysis when the sample concentration is less than ten times the blank concentration. The qualifier indicates that the analyte concentration in the sample may include laboratory contamination. This is an analyte-specific qualifier.
E	Applied to a parameter result when the reported result should be used as an estimate of the true value based on the professional judgment of the analyst or reviewer. Due to observed interferences or compromised analysis conditions the measured result is likely to be outside the expected accuracy limits of the method. The E flag is intended to indicate matrix interference problems that can not be resolved with available corrective actions. The E flag is not be used for situations already covered by the B, H, >MR or R flags. A text comment must be added to each parameter with an E flag to indicate the specific reason for the qualifier
>MR	Applied when a target analyte concentration exceeds the instrument or method capacity to measure accurately. The qualifier is primarily in the organics section. It is applied when the detected analyte concentration exceeds the upper instrument calibration limit and further dilution is not feasible. The reported value is an estimated analyte concentration.

10.3 Record Keeping

All field analysis and sampling records, custody documents, raw laboratory data, data summaries, and case narratives will be stored according to King County Environmental Laboratory policy.

10.4 Reporting

Project data will be presented to the project and program managers in a format that will include the following:

- King County Environmental Laboratory Comprehensive Reports consisting of spreadsheets of chemical and field parameters;
- Section narratives of chemistry and microbiology data including supporting QC documentation (provided by the King County Environmental Laboratory);
- A technical memorandum, summarizing field sampling, analytical work, and interpretation of the QC results (provided by the King County Environmental Laboratory).

11 References

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- Soerens, T. S., Nelson, M. A., and Spooner, J. 1999. Optimum Sampling for Determining Pollution Loads in Streams. Proceedings of the 1999 International Water Resources Engineering Conference, Seattle, Washington.
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