
Duwamish/Diagonal Sediment Remediation Project

2008/2009 Monitoring Report

May 2010



King County

Department of
Natural Resources and Parks
Water and Land Resources Division

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Duwamish/Diagonal Sediment Remediation Project 2008/2009 Monitoring Report

Elliott Bay/Duwamish Restoration Program Panel

Prepared for:

King County Department of Natural Resources and Parks
Elliott Bay/Duwamish Restoration Program

Prepared by:

King County Department of Natural Resources and Parks

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Elliott Bay/Duwamish Restoration Program
NOAA Damage Assessment and Restoration Center Northwest
7600 Sand Point Way Northeast
Seattle, Washington 98115-0070

206-526-6029
FAX 206-526-6665

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Individuals and organizations needing further information about the Elliot Bay/Duwamish Restoration Program should contact the Administrative Director at the following address and telephone number:

John Kern, Administrative Director
Elliot Bay/Duwamish Restoration Program
NOAA Damage Assessment and Restoration Center Northwest
7600 Sand Point Way NE
Seattle, WA 98115-0070
206-526-6029 FAX: 206-526-6665

The Panel of Managers holds regularly scheduled meetings that are open to the public. Technical Working Group and committee meetings are scheduled on an as-needed basis, and are also open to the public. Meetings are generally held at the National Oceanic and Atmospheric Administration, National Marine Fisheries Service–Regional Directorate Conference Room, Building 1, 7600 Sand Point Way NE, Seattle. The Panel recommends that you contact the Administrative Director at the above phone number to confirm meeting schedules and locations. The panel also holds periodic special evening and weekend public information meetings and workshops.

General Schedule for Panel and Committee Meeting Dates

Panel: quarterly, first Thursday of January, April, July, October, 9:30 A.M.–12:30 P.M.
Habitat Development Technical Working Group: third Thursday of every month, 9:30 A.M.–12:30 P.M.

Sediment Remediation Technical Working Group: scheduled as needed.

Public Participation Committee: scheduled as needed.

Budget Committee: scheduled as needed.

Environmental Review of Specific Products

Formal hearings and comment periods on appropriate environmental documents for proposed sediment remediation and habitat development projects will be observed. Please contact the Administrative Director for more information.

<p>This information is available in accessible formats on request at (206) 296-0600 (voice) and 1-800-833-6388 (TTY/TDD users only).</p>
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INTRODUCTION

This report presents results of the 2008 and 2009 annual monitoring events for the Duwamish/Diagonal Combined Sewer Overflow (CSO)/Storm Drain (SD) sediment remediation project. The report includes project background, descriptions of diver and bathymetric surveys, sampling and analytical methodologies, and results of sediment chemistry analyses. Appendices to the report include a bathymetric and diver survey report, complete sediment chemistry results and quality assurance reviews of the chemistry data. This work was performed in accordance with regulatory requirements outlined in the monitoring plan and detailed in the project Duwamish/Diagonal Sediment Remediation Dredging and Capping Operations Sediment Monitoring Sampling and Analysis Plan (SAP) (King County 2003).

This section provides project background and the station sampling history of the project. Section 2.0 includes summaries of the bathymetric and diver surveys and sample collection and analytical methods, laboratory quality assurance and quality control (QA/QC) review, and deviations from the SAP. The results of the 2008 monitoring activities are presented in Section 3.0 and Section 4.0 provides a report summary.

Project Background

Between November 2003 and March 2004, the Elliott Bay/Duwamish Restoration Program (EBDRP) implemented the Duwamish/Diagonal Sediment Remediation Project in the vicinity of the Duwamish/Diagonal CSO/SD (Figure 1). The Closure Report (EBDRP 2005) describes dredging, transport, disposal, and capping methods employed for the 2003/2004 project, the objective of which was to remediate contaminated sediment within a 7-acre area immediately adjacent to the Duwamish/Diagonal CSO/SD and the old Duwamish Treatment Plant outfall (denoted in EBDRP 2005 as Areas A and B, respectively). The 2003/2004 project included removal of a minimum of three to a maximum of five feet of contaminated sediments from Areas A and B from November 2003 to January 2004 and placement of an effective capping layer during January—February 2004, to isolate remaining chemicals from the environment and return the site to approximately the bottom elevations that existed prior to dredging. Baseline, post-construction sediment chemistry samples were collected from eight stations on the cap in Areas A and B in June 2004. These stations are shown on Figure 1 as 1A-5A and 1B-3B.

Sediment dredging residuals are defined as contaminated sediments found at the post-dredging surface of the sediment profile, either within or around the dredging footprint (Bridges et al. 2008). Some form of dredging residuals could be expected to occur at most sediment cleanup sites; however, the magnitude of release varies widely between projects based on a range of site-specific and operational factors (Desrosiers et al. 2005, EPA 2005, NRC 2007). Both the Washington State Department of Ecology (Ecology) and the United States Environmental Protection Agency (EPA) required King County to monitor for movement of dredging residuals beyond the site boundary by measuring the pre-construction and post-construction sediment chemistry at 12 perimeter stations outside the 2003/2004 dredging/capping project boundary, that had first been sampled in October 2003 prior to dredging (EBDRP 2005). These stations are shown in Figure 1 as 1C-12C.

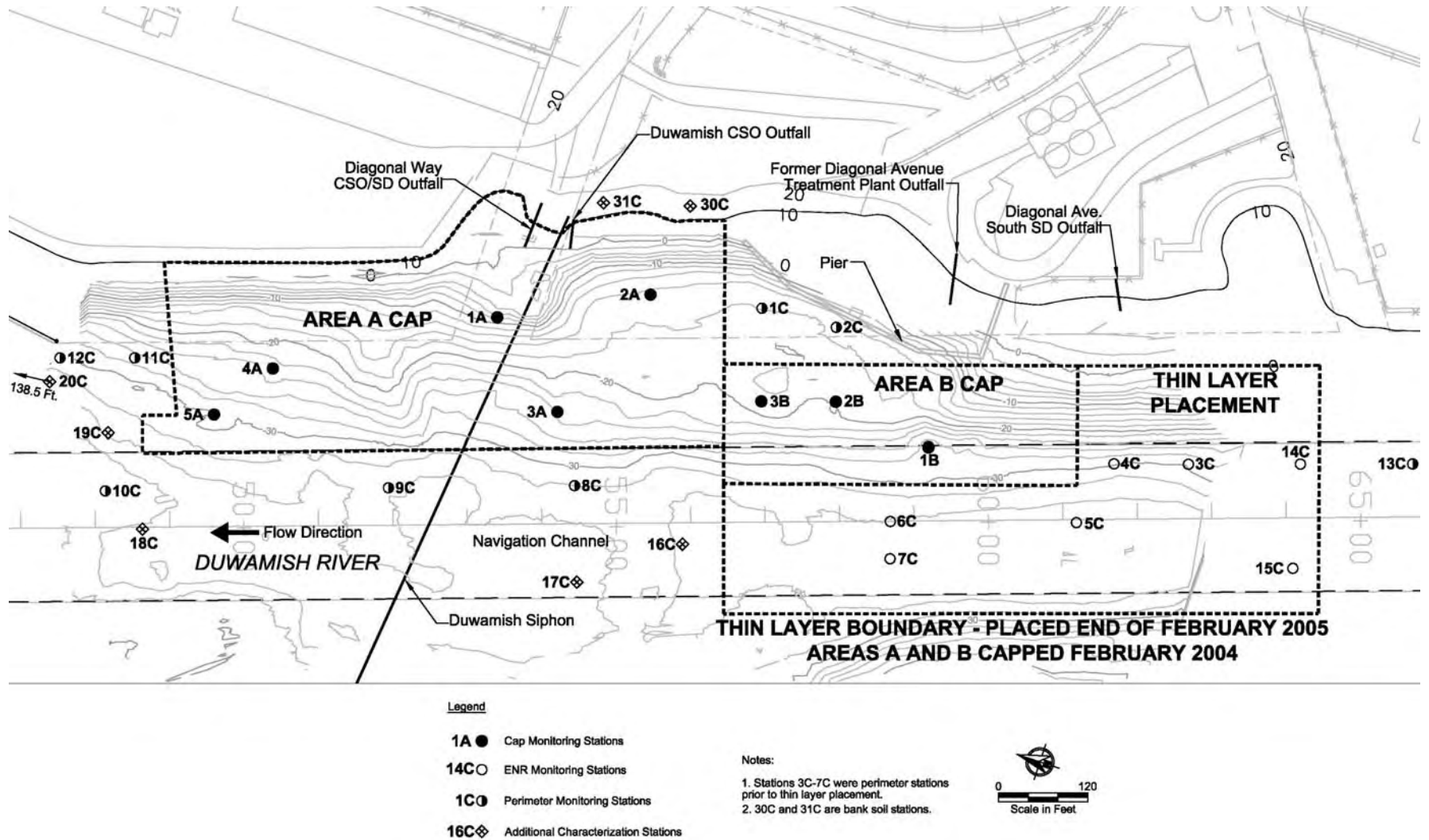


Figure 1. Duwamish Diagonal Site and Monitoring Stations

Analysis of the March 2004 sampling data from the perimeter stations revealed that 2003/2004 project dredging activities had increased surface sediment concentrations of polychlorinated biphenyls (PCBs) around the margin of Area B to a higher degree than dredging residuals adjacent to Area A (Figure 2). The occurrence of a greater amount of dredging residuals near Area B was consistent with the contractor’s initial operations in this area that did not consistently apply required best management practices (BMPs) to minimize spread of dredging residuals. As a result, King County examined six prospective remedial actions to reduce elevated PCB levels caused by the dredging residuals. After consultation with Ecology and EPA, King County selected the thin layer placement remedy, also known as Enhanced Natural Recovery (ENR), as the best way to reduce the elevated PCB levels within the 4-acre dredge residual area around Area B in the most expedient manner possible.

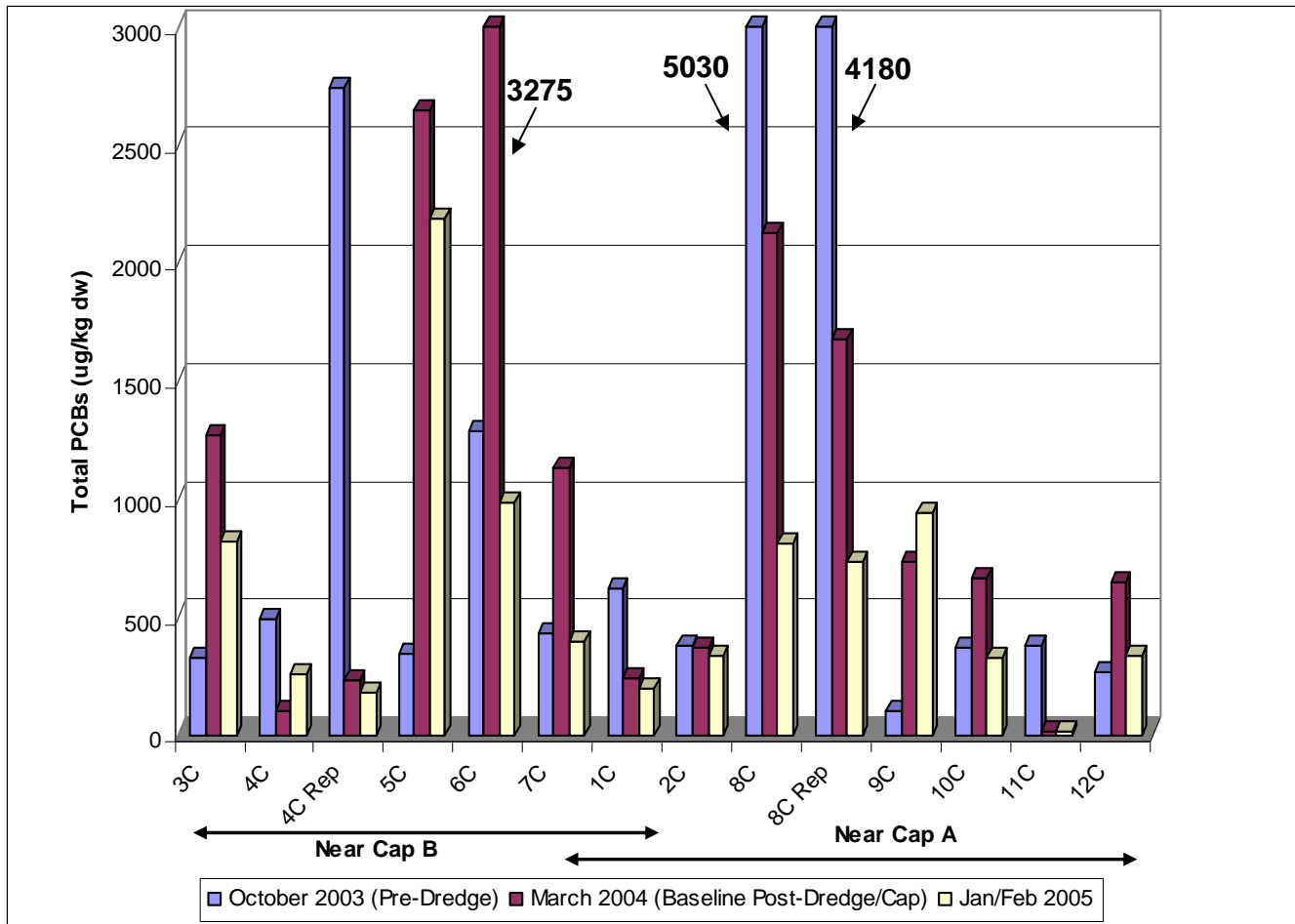


Figure 2. Changes in PCB Concentrations at Duwamish Diagonal Perimeter Stations (2003-2005)

The thin layer placement remedy involved the placement of clean sand material to a minimum thickness of six inches over a 4-acre area (Figure 1) of dredging residuals to immediately reduce exposure to elevated PCB levels and accelerate the natural recovery timeframe in this area. To ensure the minimum thickness of six inches, the design called for placing 7,100 tons of sand, which would yield an average thickness of nine inches, to help ensure that the entire 4-acre ENR

area would receive at least six inches of cover material. Over time, the natural process of bioturbation would be expected to mix clean sediment into underlying sediment containing PCBs. Monitoring would continue to be performed to document the effectiveness of the thin-layer placement and bioturbation process and to compare it to natural recovery rates in the area surrounding Area A, which had significantly lower dredge residuals.

Placement of the ENR sand occurred between February 19 and 25, 2005. Samples were collected for Year 2005 monitoring in January, prior to placement including Perimeter stations 1C-12C. Additional stations were added to this sampling to improve the general characterization of the area post remediation at EPA's request (13C-20C and bank stations 30C-31C – see Figure 1). Baseline sediment chemistry samples were then collected from seven stations within the ENR area in March 2005, five of which were the pre-existing stations 3C-7C and two of which were new stations added for spatial coverage (14C-15C). The major project events through 2005 are presented on a timeline in Figure 3.

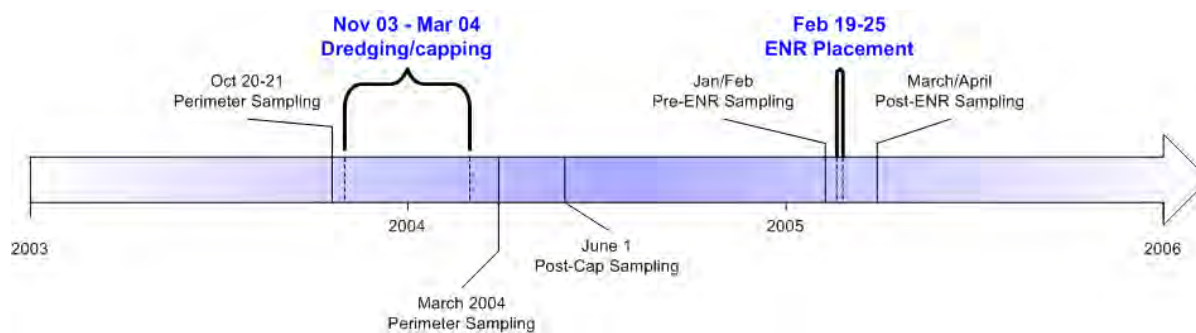


Figure 3. Duwamish Diagonal Project Timeline Through 2005

Sediment monitoring requirements for the Duwamish/Diagonal Sediment Remediation Project are described in the initial SAP (King County 2003) as well as the SAP addendum prepared to cover monitoring activities for the ENR area (King County 2004). The baseline post-capping data was presented in the Duwamish/Diagonal CSO/SD Sediment Remediation Project Closure Report (EBDRP 2005), the 2005 Monitoring Report (EBDRP 2007) and the 4-Acre Residuals Interim Action Closure Report (King County 2007).

Stations Sampled During the 2008/2009 Monitoring Events

Sediment samples were collected March 24 and 25, 2008 and April 27-29, 2009 from a total of 23 stations in four monitoring areas at the Duwamish/Diagonal site: Sediment Cap Area A, Sediment Cap Area B, the thin layer cap or ENR area, and from perimeter stations outside the areas of remediation and ENR. Figure 1 presents the locations of the 23 monitoring stations described in the following sections.

Sediment Cap Area A

Samples were collected from five stations in Sediment Cap Area A in 2008 and 2009, which represent Years Four and Five of post-construction monitoring, respectively. Table 1 provides a stations list and history of sample collection dates.

Table 1. Sample Dates for Sediment Cap Area A Stations

Station	2004– Baseline	2005– Year One	2006– Year Two	2007– Year Three	2008– Year Four	2009– Year Five
DUD_1A	06/01/04	04/27/05	03/07/06	04/03/07	03/24/08	04/28/09
DUD_2A	06/01/04	04/27/05	03/07/06	04/03/07	03/24/08	04/28/09
DUD_3A	--	04/27/05	03/07/06	04/03/07	03/24/08	04/28/09
DUD_4A	06/01/04	04/27/05	03/07/06	04/03/07	03/24/08	04/28/09
DUD_5A	06/01/04	04/27/05	03/07/06	04/03/07	03/24/08	04/28/09

A baseline sediment sample was not collected from Station DUD_3A in 2004 because only coarse gravel was found during repeated attempts to sample this location; thus, precluding the ability to chemically analyze the sediment.

Sediment Cap Area B

Samples were collected from three stations in Sediment Cap Area B in 2008 and 2009, which also represent Years Four and Five of post-construction monitoring, respectively. Table 2 provides a stations list and history of sample collection dates.

Table 2. Sample Dates for Sediment Cap Area B Stations

Station	2004– Baseline	2005– Year One	2006– Year Two	2007– Year Three	2008– Year Four	2009– Year Five
DUD_1B	06/01/04	04/27/05	03/07/06	04/03/07	03/24/08	04/27/09
DUD_2B	06/01/04	08/17/05	03/07/06	04/03/07	03/24/08	04/27/09
DUD_3B	06/01/04	--	03/07/06	04/03/07	03/24/08	04/27/09

Note: Coarse gravel at 2B required repeated sampling in Year One with success in August 2005

A Year One sediment sample was not collected from Station DUD_3B in 2005 because only coarse gravel was found during repeated attempts to sample this location; thus, precluding the ability to chemically analyze the sediment. Year One sediment sample was collected at Station DUD_2B in August, 2005 rather than April because of the presence of coarse gravel in April that precluded sample collection and analysis.

Enhanced Natural Recovery (ENR) Area

Samples were collected from seven stations in the ENR area in both 2008 and 2009, which represent Years Three and Four of post-construction monitoring for the thin-layer placement, respectively. Table 3 provides a stations list and history of sample collection dates.

Table 3. Sample Dates for ENR Stations

Station	2005– Baseline	2006– Year One	2007– Year Two	2008– Year Three	2009– Year Four
DUD_3C	03/16/05	03/10/06	04/03/07	03/25/08	04/28/09
DUD_4C	03/16/05	03/10/06	04/03/07	03/25/08	04/28/09
DUD_5C	03/24/05	03/10/06	04/03/07	03/25/08	04/28/09
DUD_6C	03/24/05	03/10/06	04/03/07	03/25/08	04/28/09
DUD_7C	03/24/05	03/10/06	04/04/07	03/25/08	04/28/09
DUD_14C	03/16/05	03/10/06	04/04/07	03/25/08	04/28/09
DUD_15C	03/16/05	03/10/06	04/04/07	03/25/08	04/28/09

Perimeter Stations

Samples were collected from eight perimeter stations in 2008 and 2009, all located outside of the remediation areas. Table 4 provides a stations list and history of sample collection dates. Unlike the Cap and ENR monitoring stations, monitoring dates beginning prior to the remedial action are included in this table. Station DUD_13C was added to the monitoring program in 2005 to represent conditions upstream of the ENR area.

Table 4. Sample Dates for Perimeter Stations

Station	2003–Pre- Construction	2004– Baseline	2005– Year One	2006– Year Two	2007– Year Three	2008– Year Four	2009– Year Five
DUD_1C	10/20/03	03/29/04	02/01/05	03/08/06	04/02/07	03/24/08	04/27/09
DUD_2C	10/20/03	03/29/04	01/31/05	03/08/06	04/02/07	03/24/08	04/27/09
DUD_8C	10/21/03	03/30/04	02/01/05	03/08/06	04/02/07	03/24/08	04/28/09
DUD_9C	10/21/03	03/30/04	01/31/05	03/08/06	04/02/07	03/24/08	04/29/09
DUD_10C	10/21/03	03/30/04	02/01/05	03/08/06	04/02/07	03/24/08	04/29/09
DUD_11C	10/21/03	03/30/04	02/01/05	03/09/06	04/02/07	03/25/08	04/29/09
DUD_12C	10/21/03	03/30/04	02/02/05	03/09/06	04/02/07	03/25/08	04/29/09
DUD_13C	--	--	02/02/05	03/09/06	04/04/07	03/25/08	04/29/09

SAMPLE COLLECTION AND ANALYSIS

This section summarizes the field methods used in the bathymetric and diver surveys and describes the methods employed to collect representative sediment samples from the Duwamish/Diagonal sediment remediation site and analyze them for sediment chemistry parameters. A discussion of laboratory QA/QC review and deviations from the SAP are also presented.

Bathymetric and Diver Surveys

Blue Water Engineering conducted a bathymetric survey and Research Support Services (RSS) conducted a diver and video survey of the site in 2009. Both companies were under subcontract to Anchor QEA. The bathymetric survey was conducted following the same survey tracks and methods used for the 2004 as-built bathymetric survey to examine erosion/accretion patterns. RSS divers probed the sediment at the original 11 stake locations in the ENR area to estimate thin layer thickness and erosion/accretion of the surface sediments. In addition, RSS conducted a video survey across all areas, including the site perimeter, to document surface disturbances such as barge line tracks, propeller wash, spud holes, etc. The methods used for the bathymetric and diver surveys are described in Appendix A.

Sample Collection

In 2008 and 2009, 26 samples (including field replicates) were collected each year from 23 stations located in Sediment Cap Areas A and B, the ENR area, and from perimeter stations. In both years, one field replicate sample was collected from each of the three monitoring areas. All sample collection followed protocols outlined in the Puget Sound Estuary Program's (PSEP) Puget Sound Protocols (PSEP 1997a, 1998). This section summarizes the sample collection and handling methods and details can be found in the project Sampling and Analysis Plan (King County 2003). Samples were collected according to the SAP methods as summarized below in Section 2.2.1 and 2.2.2.

Station Positioning

Sediment grab samples were collected from King County's research vessel *Liberty*, which is equipped with a differential global positioning system (DGPS). Field coordinates were recorded using DGPS for each sediment grab as the sampler contacted the sediment bed. Coordinates for each grab deployment are shown in Appendix B and are compared to the prescribed study coordinates.

Sample Collection and Handling

Sediment was obtained using two modified, stainless steel, 0.1 m² Van Veen grab samplers deployed in tandem from King County's research vessel *Liberty*. A single deployment of the tandem Van Veen grab samplers was considered "two grabs" when both of the grabs returned an

acceptable sample. The number of grabs varied depending on the area sampled but followed the original SAP requirements. A summary of the number of grabs obtained at each station is provided in Appendix B. The details of sample collection are summarized below and described in Appendix B.

Sediment chemistry samples targeted the top 10 cm of sediment and required a minimum grab penetration depth of 11 cm to ensure that sediment touching the sides of the grab sampler was not collected. This was not always possible given the substrate in the sediment cap and ENR areas. When penetration depth was less than 10 cm, sediment was sampled to a depth of 1 cm from the bottom of the grab. Penetration depth was determined by measuring the depth of sediment within each grab by sliding a ruler vertically along the inside of the sampler's side wall after each successful cast.

Undisturbed sediments in the grab were collected with a stainless steel spoon and then placed in a stainless steel bowl and stored covered with aluminum foil between grab deployments. Homogenization occurred in the bowl after sediment was collected from the requisite number of successful grabs (i.e., 1 grab for the perimeter, 3 grabs for the main cap; 10 grabs for the perimeter area). After thorough homogenization, sediment aliquots were transferred to appropriate laboratory containers.

Head space was left in all sediment chemistry sample containers to allow further mixing at the laboratory and for expansion should the containers be stored frozen. All sample containers were stored in insulated, ice-filled coolers while in the field.

The grab samplers were decontaminated between sampling stations by scrubbing with a brush and Detergent 8 (a phosphate-free soap) followed by a thorough *in situ* rinsing. A separate pre-cleaned stainless steel bowl and spoon were dedicated to each sampling station, precluding the need for decontamination of this equipment in the field.

While in the field, all samples were under direct possession and control of King County field staff. For chain of custody (COC) purposes, the research vessel was considered a "controlled area." Each day, all sample information was recorded on a COC form. This form was completed in the field and accompanied all samples during transport and delivery to the laboratory each day. Upon arrival at the King County Environmental Laboratory (KCEL), the sample delivery person relinquished all samples to the sample login person. The date and time of sample delivery was recorded and both parties then signed off in the appropriate sections on the COC form. Once completed, original COC forms were archived in the project file. Copies of all completed COC forms are included in Appendix B.

Laboratory Analyses

Sediment chemistry analyses were selected to allow comparison of sediment data to the SMS sediment chemical criteria found in Tables 1 and 3 of Chapter 173-204 WAC (Ecology 1995). Other chemicals of interest (chlorinated pesticides and additional metals), total organic carbon and sediment grain size were analyzed as well. A complete list of all parameters analyzed along with their respective detection limits is included in Appendix B. All laboratory analyses were

performed by the KCEL. The following subsections summarize the analyses performed as well as QA/QC analyses.

Conventionals

Conventional analyses included percent solids, total organic carbon (TOC), and grain size. Percent solids and TOC analyses were performed to provide data necessary to normalize sediment data to dry weight and organic carbon, respectively. Percent solids analysis was performed according to Standard Method (SM) 2540-G (APHA 1998), which is a gravimetric determination. TOC analysis was performed following EPA Method 9060 (EPA 1995), high-temperature combustion with infrared spectroscopy. Grain size analysis was performed according to ASTM Method D422 (ASTM 2002), which is a combination of sieve and hydrometer analyses.

Metals

Metal analytes included aluminum, antimony, arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, and zinc. With the exception of mercury, all metal analyses were performed following EPA Method 3050B/6010B (EPA 1995); strong-acid digestion with inductively coupled plasma optical emission spectroscopy (ICP-OES). Mercury was analyzed according to EPA Method 7471A (EPA 1995), cold vapor atomic absorption spectroscopy (CVAA).

Trace Organics

Trace organic analytes included base/neutral/acid extractable semivolatile compounds (BNAs), chlorinated pesticides, and polychlorinated biphenyls (PCBs) as Aroclors. BNA analysis was performed following EPA Method 8270 (EPA 1995), gas chromatography with mass spectroscopy (GC/MS). Chlorinated pesticides and PCBs were analyzed by EPA Method 8081A/8082 (EPA 1995), gas chromatography with electron capture detection (GC/ECD).

Laboratory Quality Assurance/Quality Control (QA/QC)

All analyses were performed following guidance recommended in the Puget Sound Protocols (PSEP 1986, 1997b, 1997c) including associated QA/QC practices. QC samples included method blanks, laboratory duplicates, standard reference materials, matrix spikes, and matrix spike duplicates. Chemistry data were reviewed following QA1 guidelines (Ecology 1989) and flagged with data qualifiers where appropriate. KCEL modified their data flags in early 2009 to adapt to changes in sediment data management at Washington Department of Ecology. Data flags applied to sediment data in 2008 are presented in Table 5. Those applied to 2009 sediment results are presented in Table 6.

Table 5. King County Data Qualifier Flags for 2008

Condition to Qualify	Flag
High duplicate or triplicate relative percent difference	E
Less than the reporting detection limit (RDL)	<RDL
Less than the method detection limit (MDL)	<MDL
Contamination detected in method blank	B
Biased data, low surrogate, matrix spike, or SRM recoveries	G
Biased data, high surrogate, matrix spike, or SRM recoveries	L
A sample handling criterion (e.g., preservation, holding time) has not been met	H

Notes: The individual surrogate recovery is used for all organic analyses with the following exception – for BNA analysis, one surrogate recovery per fraction is allowed to be outside acceptance limits without causing the associated sample data to be flagged.

SRM – standard reference material

Table 6. King County Data Qualifier Flags for 2009

Condition to Qualify	Flag
Result is above the calibration range; unknown bias	E
Less than the reporting detection limit (RDL)	<RDL
Less than the method detection limit (MDL)	<MDL
An estimated value when the measured response was outside the expected accuracy of the method.	J
The reported value is estimated with low bias	JG
The reported value is estimated with high bias	JL
A parameter in associated method blank was detected and sample result is within 5X of blank.	B
A common lab contaminant in associated method blank was detected and the sample result is > 5 and ≤ 10X the blank.	B2
A sample handling criterion was not met prior to analysis	SH
A holding time criterion has not been met prior to analysis.	H

Quality Assurance/Quality Control Review

Laboratory QA/QC practices produced chemistry data sufficient to pass QA1 review. QA1 review narratives are presented in Appendix B. This section highlights PCB and blank contamination issues from the QA1 review.

In analysis of 2008 samples, the concentration of 1,4-dichlorobenzene from 1A was unexpectedly high (179 mg/kg OC). For confirmation, another aliquot from the same extract was analyzed, and then, after a similar concentration was measured, the sample was re-extracted and analyzed. Analysis of the second extraction was congruent with the original result.

In analysis of 2009 samples, the laboratory duplicate recovery was outside the QC limits for most PAHs in the sediment sample from 2C. Therefore, a laboratory triplicate was analyzed resulting in similar concentrations. Relative percent difference (RPD) failure is not uncommonly seen for PAH results and is concluded to be caused by the heterogeneous nature of the sample. An object, such as a piece of decaying wood could cause this kind of (RPD) failure.

A QA issue that appears for the 2008 and 2009 PCB results is related to the overlap of Aroclor components (congeners) produced from the GC/ECD analysis. This is a consistent and common issue in the analysis of Aroclors. Aroclors 1248, 1254 and 1260 share some congeners with Aroclors 1016, 1232 and 1242 (the lower chlorinated Aroclors). When the more prominent Aroclors 1248, 1254, and 1260 are present, identification of some or all of Aroclors 1016, 1232, and 1242 is not possible for all samples because of the overlapping congeners. To account for this, and to acknowledge the uncertainty in the potential presence of these lower chlorinated Aroclors, detection limits (both the method detection limit [MDL] and reporting detection limit [RDL]) values are elevated. In the "Organic Chemistry" section of each QA review in Appendix B, the Aroclors for each sample that are impacted are presented. The quantitation of the Aroclors 1248, 1254 and 1260 is not affected by the peaks that overlap the three lower chlorinated Aroclors. The total PCB sum (sum of all detected Aroclors) should not be significantly impacted by the issue of elevated MDLs for 1016, 1232 and 1242 because the predominant detected Aroclors are 1248, 1254 and 1260.

The other main QA issue is method blank contamination for benzoic acid, BEHP and other phthalates. Phthalates are a common laboratory contaminant due to the abundance of plasticware and plastic piping in laboratories, as well as laboratory hood ventilation systems. Method blanks had detected concentrations of BEHP and other phthalates in several samples collected in 2008 and 2009. Thus, several sample results for specific phthalate compounds found in associated method blanks were flagged "B." KCEL 2008 QA/QC review added "B" flags whenever a contaminant is detected in the method blank.¹ No QA evaluation occurred examining the magnitude of the blank detection compared to the associated sample result value. This is significant only when the sample concentration is less than ten-times the method blank value for common lab contaminants²; thus, indicating a likely high bias or false positive identification of the analyte ("the 10X rule") (Ecology 2008, EPA 1999). However, if the sample result is greater than ten-times (for common lab contaminants) the method blank concentration, the bias is not considered significant to the sample concentration. No blank correction has been conducted on the data presented in this report. However, a preliminary scan of B-qualified results was

¹ This method of blank flagging occurs for all analytes found in method blanks but because this occurs most often for phthalates, only they are discussed here.

² SVOC common lab contaminates include bis(2-ethylhexyl)phthalate (BEHP), benzyl butyl phthalate (BBP), and di-N-butyl phthalate (DNBP).

conducted. Table 7 shows the stations where results would change from detect to nondetect at the sample concentration, after application of the 10X rule. This would affect one exceedance of BBP at station 11C in 2008.

The changes in flag definitions that occurred at KCEL prior to the 2009 sample runs make the equivalent evaluation for method blank contamination simpler. “B” and “B2” flags were applied when the sample result was within 5X or between 5X and 10X of the method blank result, respectively. B flags are no longer applied when an analyte is detected in a sample greater than 5-times (or 10-times for common lab contaminants) the concentration found in the method blank. Thus, applying the 10X rule would not result in any B-flagged results changing to nondetects or “U.”

Table 7. 2008 Stations Where Sample Results would be Qualified as Nondetect Following Blank Contamination Evaluation

Area	Benzoic Acid	BBP	BEHP	DNBP
Cap A	1A–5A	3A, 5A	5A	3A, 4A
Cap B	1B–3B	1B, 3B	NC	1B–3B
ENR	3C–7C, 14C, 15C	3C–7C, 14C, 15C	6C, 7C	3C–7C, 14C, 15C
Perimeter	8C–13C	9C-11C, 13C	NC	1C, 2C, 8C, 10C–13C

NC – No Change

BBP – Benzylbutylphthalate

BEHP – Bis(2-ethylhexyl)phthalate

DNBP – Di-N-Butylphthalate

Deviations from Sampling Plan

There were no deviations to the SAP or addendum (King County 2003, King County 2004) for sediment sampling in 2008. In accordance with the SAP, a bathymetric survey and a diver survey were conducted in 2009, as described in Appendix A. Although annual bathymetric surveys were specified in the SAP, no bathymetric survey was conducted in 2008 due to an oversight. However, the 2009 survey will allow net erosion/accretion estimates to be calculated at Year 5 of Cap A and Cap B placement.

Average penetration depths (see Appendix B) indicate that the minimum required depth was not recovered for all samples to return a 0- to 10-cm depth stratum sample. Less than 10 cm penetration depth was recovered for some samples at several stations in all areas in 2008 and at two perimeter stations and one cap station in 2009. Multiple attempts to achieve maximum sampler penetration are tried but at some stations, such as 5A, the underlying gravel mix prohibits penetration beyond the soft fines.

In 2009, too few decontaminated stainless steel bowls were brought into the field one day resulting in re-use of bowls for compositing. Due to this, composite samples at stations 7C, 8C,

14C and 15C were potentially cross-contaminated. However, used bowls were cleaned with soap and site water before being re-used thereby minimizing any contamination. In addition, the risk of cross-contamination is likely to be very low given the large volumes of sediment that are composited in proportion to the sample volume and the relatively low concentrations of chemicals detected. This deviation is not considered to be significant but is noted here for the record.

RESULTS OF 2009 DUWAMISH DIAGONAL BATHYMETRIC AND DIVER SURVEYS

This section presents a summary of the 2009 bathymetric and diver surveys, which are described in detail in Appendix A. Figures and Tables referred to in this summary can be found in Appendix A.

Figure 3 in Appendix A presents an isopach map comparing 2004 (pre-ENR) and 2009 surveys. This figure shows that the majority of the site has experienced net accretion after five years in the 0.5-1.5 foot range. In some areas, net accretion was up to 3+ feet. The largest of these areas is close to 1A and the Diagonal Way CSO/SD. Note that the estimated change in bathymetry, denoted with colors, does not cover the entire ENR area because the post-construction bathymetry was conducted prior to determining the need for an ENR area and only targeted the cap. Within the ENR area, the map does not reflect the addition of ENR material placed a year later. Based on post-placement measurements showing the thickness of the ENR layer was an average 7.7 inches (Anchor 2006), corresponding adjustments to Figure 3 (Appendix B) result in net accretion in essentially the entire portion of the ENR area surveyed. Net change was as low as -0.1 feet and as high as 3.6 feet³. Within approximately 100 feet inshore of this accretional area is a series of erosional spots located in front of the Diagonal Way CSO/SD and the Duwamish CSO Outfall. The net erosion in this area was 1+ feet after five years. This pattern would follow the expected scouring from active discharges directly in front of the outfalls and accretion nearby and downstream from immediate deposition of large-sized particles such as sand. A second large erosional area was observed in southeast corner of cap B, at the upstream end of the pier. This may reflect scouring from regular boat activity at the pier. As the cap is armored (under a 1.5 foot layer of habitat mix) in both these areas, observed scour does not represent a concern to cap integrity.

Divers hand-probed stations where stakes were originally placed to estimate thickness of the ENR layer and the overlying silt. Table 1 in Appendix A shows the estimated thickness at each location. After five years, the estimated overlying silt layer ranged from 1.25 to 7.60 inches in thickness. The lowest accretion of silt was observed at 26SP, the most downstream location. The highest accretion was observed at 7SP, further offshore but only about 160 feet away. No particular accretional pattern is evident across the ENR area.

³ The method error is ± 0.5 feet.

DUWAMISH DIAGONAL SEDIMENT SAMPLING RESULTS FOR 2008 AND 2009

This section summarizes the results of the chemistry analyses for 2008 and 2009 monitoring samples for sediment cap Areas A and B (Year 4 and 5 post-cap), the perimeter area (Year 4 and 5 after residuals) and the ENR (Year 3 and 4 post thin layer placement). The complete analytical results can be found in Appendix C. Results are first summarized for all analytes by area and compared to Sediment Management Standards (SMS) standards. Field duplicates were averaged before comparison to SMS. SMS (Ecology 1995) rules were followed in the calculation of sums (e.g., total PCBs and PAHs) and handling of undetected results.

Sediment Cap Area A Monitoring Results for 2008 and 2009

The analytical chemistry results, including TOC, for the five stations in Cap Area A sampled in 2008 and 2009 can be found in Tables 8 and 9, respectively, at the end of this section. The results are normalized to dry weight (dw) or organic carbon (OC) as appropriate for comparison to SMS. Concentrations of five chemicals in 2008 and one chemical in 2009 exceeded SMS in one or more samples as discussed below. TOC content at 1A, 2A and 5A in 2008 and 5A in 2009 were outside the range for appropriate comparison to OC-normalized sediment quality standards (SQS) and cleanup screening levels (CSL) and were, thus, compared to dw-based apparent effect thresholds (AETs). The lowest AET (LAET) and second lowest AET (2LAET) are the dry-weight equivalent values to the SQS and CSL, respectively.

In 2008, the SMS was exceeded for five chemicals. The dry weight concentration of total PCBs exceeded the LAET at 2A. Concentrations of 1, 4-dichlorobenzene and dimethylphthalate concentrations at 1A exceeded the 2LAET. The butylbenzylphthalate (BBP) concentration at 1A and 2A exceeded the LAET and at 4A, the SQS. Similarly, the bis(2-ethylhexyl)phthalate (BEHP) concentration exceeded the LAET at 2A and the SQS at 3A and 4A. In 2009, the SQS was exceeded once, by the BEHP concentration at 1A; the CSL was never exceeded at Cap Area A stations.

TOC content ranged from 0.13% to 3.6% in 2008 and 0.19% to 2.8% in 2009 (Tables 8 and 9). TOC composition was consistent from 2007 through 2009 at 3A, 4A, and 5A (Figure 4). At 1A and 2A, TOC composition changed substantially in 2008 compared to 2007. At 1A, located in front of the Diagonal Way combined stormwater overflow (CSO)/storm drain (SD), TOC lowered to less than 0.5% in 2008. TOC at 2A was observed to rise from just below 3% to 3.6% in 2008 and return to 2007 levels in 2009.

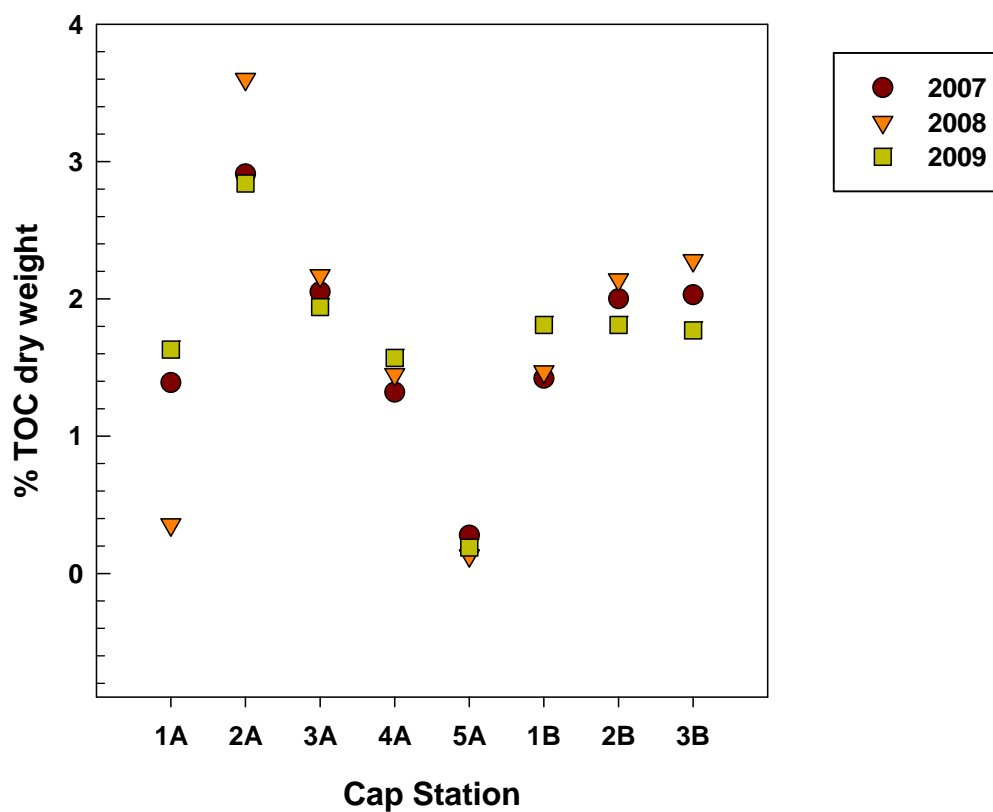


Figure 4. Percent TOC in Cap Areas A and B Samples, 2007-2009.

Relative grain size composition for 2008 and 2009 are compared with that for 2007 in Figure 5⁴. Overall, substantial shifts in categorical relative grain sizes were not observed from 2007 to 2009 except at 1A and potentially 2A. The proportion of fines did not change at 1A, but percent sand increased in 2008 commensurate with a decrease in percent gravel. The proportion of gravel increased in 2009 at 1A, potentially from erosion of sand and exposure of the underlying habitat mix. Change at 2A was less clear. The proportion of sand may have increased in 2008 and relative total fines appear to have increased in 2009. The changes in relative grain size composition at 3A, 4A, and 5A were small and may reflect method and/or natural variability. Generally, relative grain size at these stations appears consistent.

⁴ Due to analytical variability, the sum of the four size category percentages (i.e., clay, silt, sand and gravel) does not always equal 100%. Thus, slight changes may reflect method and/or sample variability.

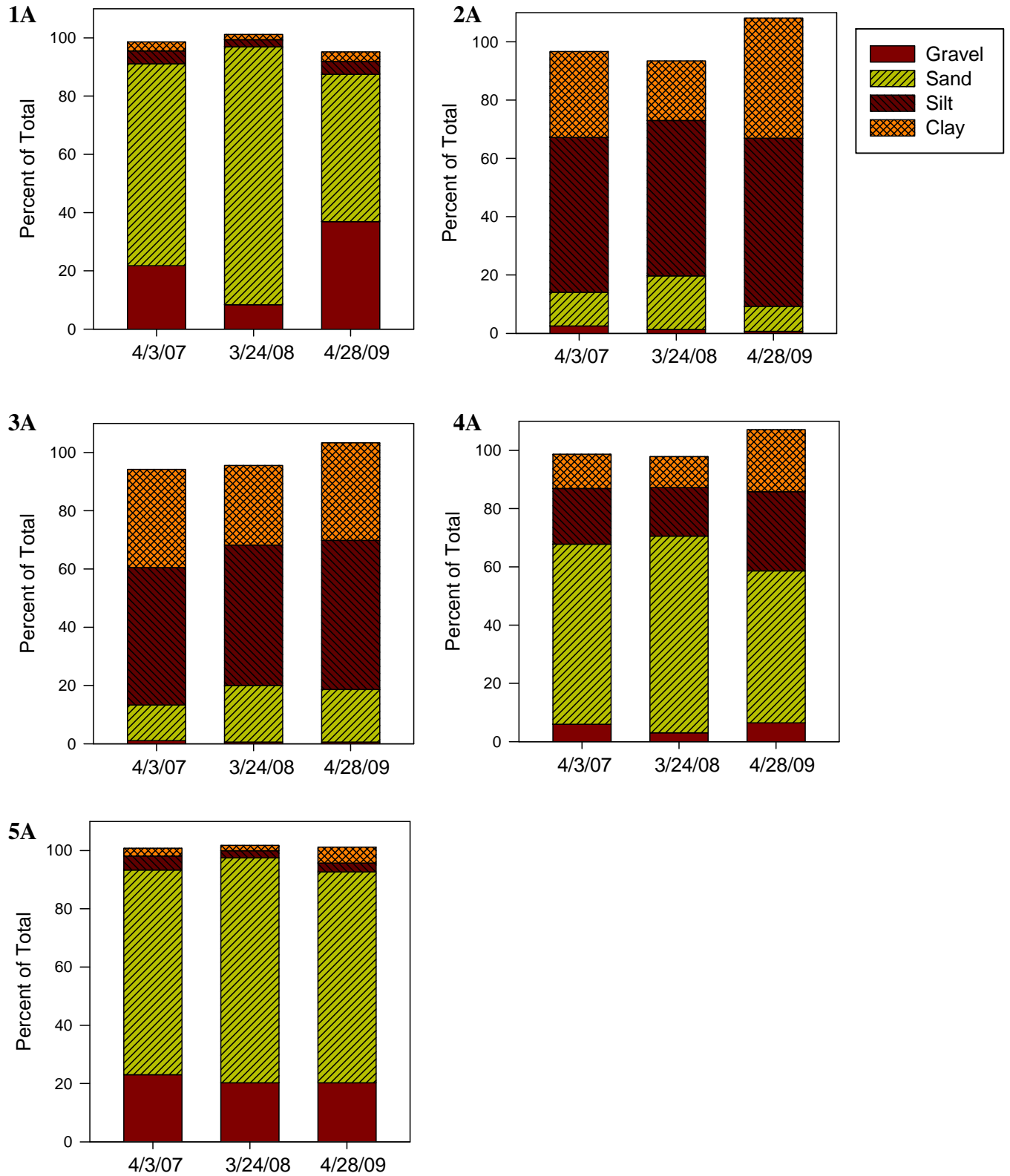


Figure 5. Changes in Grain Size on Cap A

Sediment Cap Area B Monitoring Results for 2008 and 2009 and 2009

The analytical chemistry results, including TOC, for the three stations in Cap Area B sampled in 2008 and 2009 can be found in Tables 8 and 9, respectively, at the end of this section. The results are normalized to dry weight (dw) or organic carbon (OC) as appropriate for comparison to SMS. Only one chemical exceeded SMS in 2008; phenol exceeded the SQS at 2B. No other concentrations at any station exceeded SMS in either 2008 or 2009.

Relative grain size distributions for 2008 and 2009 are compared with 2007 results in Figure 6. Substantive changes (>10%) in relative grain size occurred at 1B in 2009 and 3B in 2008 (Figure 6). The proportion of fines at 1B reached over 80% in 2009, about 50% greater than in 2007. The proportion of fines at 2B also increased to over 90% in 2009, approximately 10% greater than 2008. A similar change occurred in 2008 at 3B where relative fines rose above 95% and remained there in 2009.

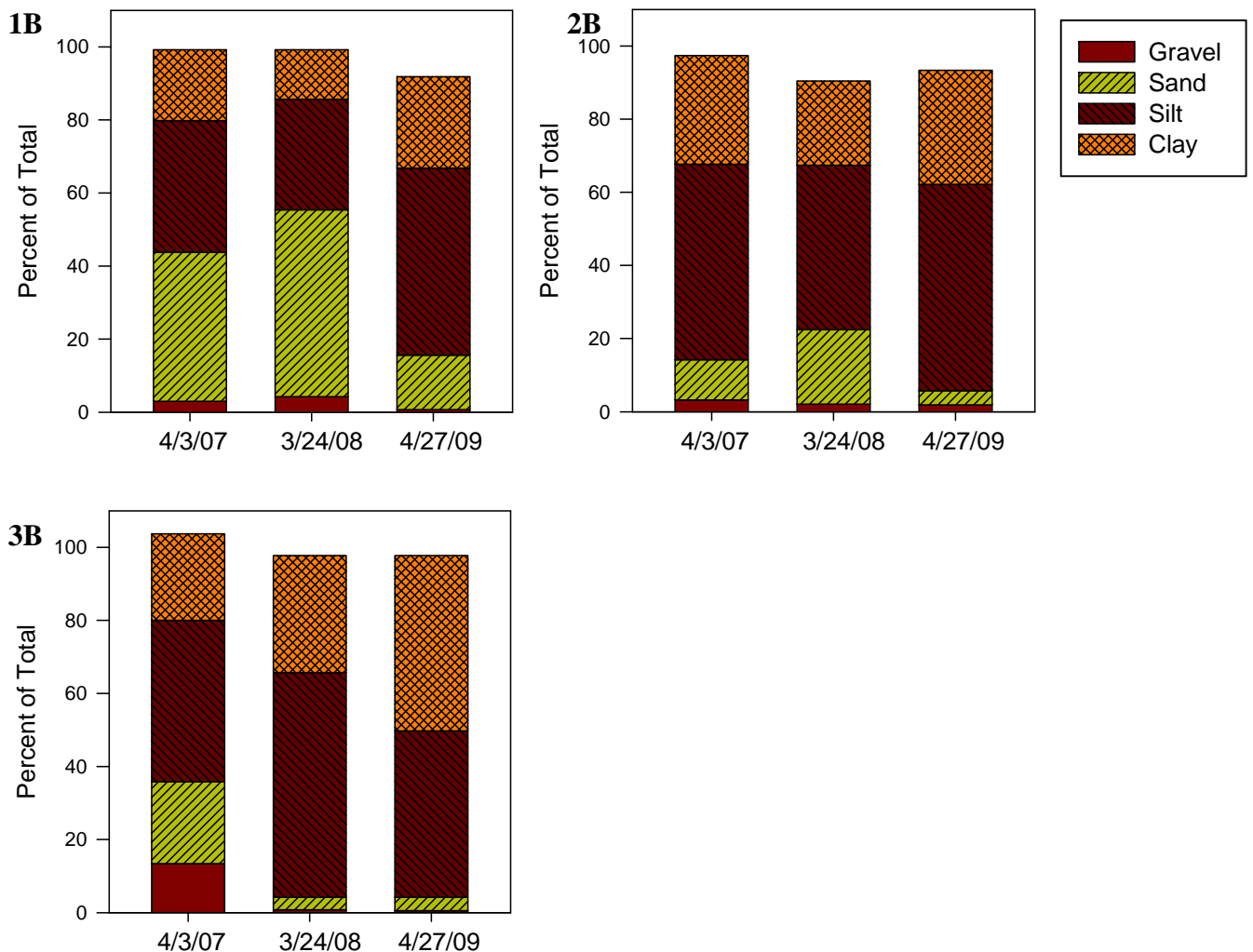


Figure 6. Changes in Grain Size on Cap B

These results indicate deposition of fine material on Cap B. TOC measurements in all Cap B samples ranged from 1.5 to 2.3% in 2008 and were consistently 1.8% in 2009. Little change occurred in relative TOC between 2007 and 2009 (Figure 4).

Enhanced Natural Recovery Area Monitoring Results for 2008 and 2009

The analytical chemistry results, including TOC, for the seven stations in the ENR Area sampled in 2008 and 2009 can be found in Tables 8 and 9, respectively. TOC content of samples from 4C and 6C in 2008 were outside the range for comparison to OC-normalized SMS and were compared to dw-normalized AETs. No concentrations exceeded SMS in 2008. The average concentration of BEHP in duplicates exceeded the SQS at 4C in 2009.

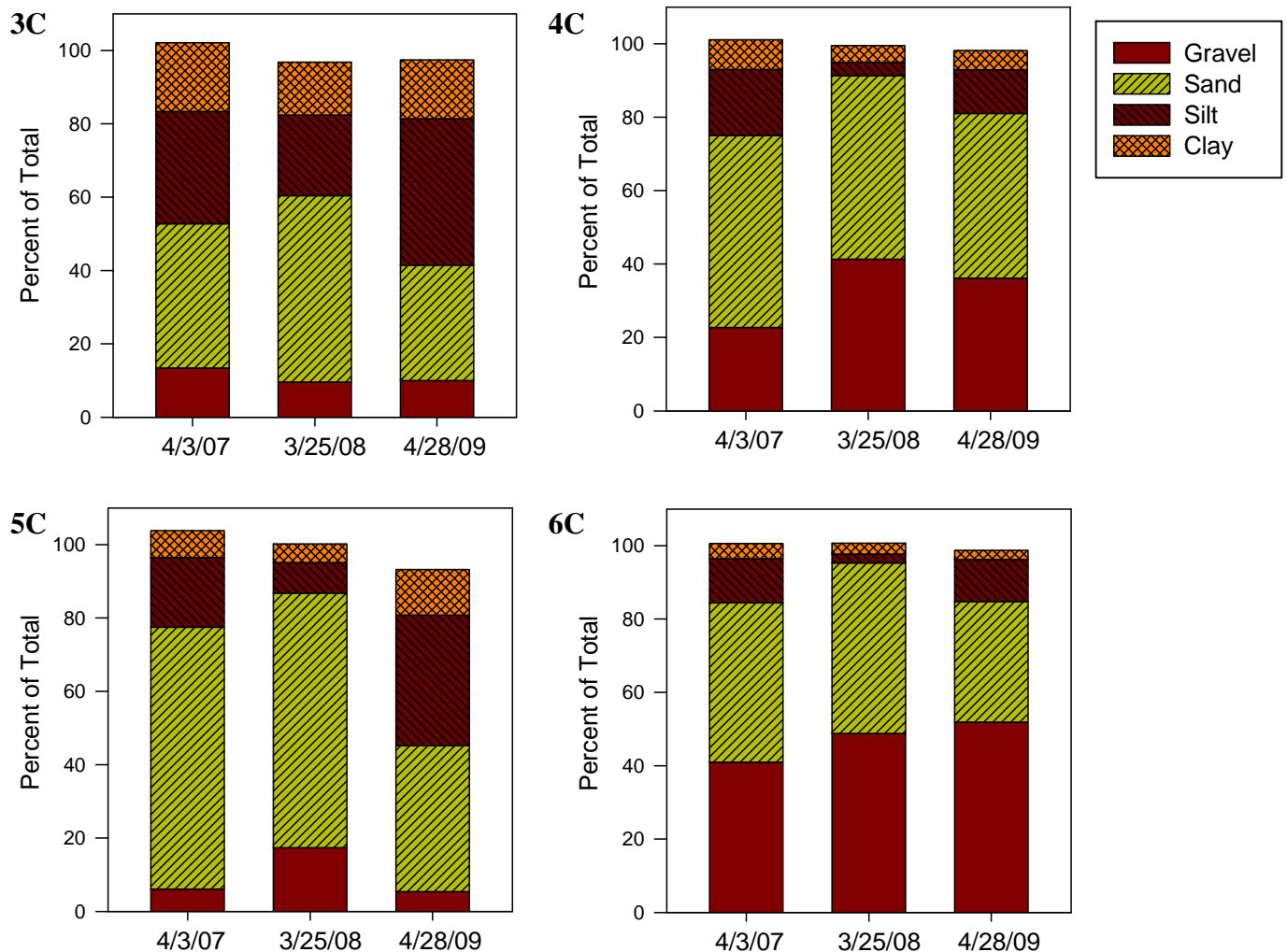


Figure 7. Changes in Grain Size at ENR Stations (Thin Layer Placement).

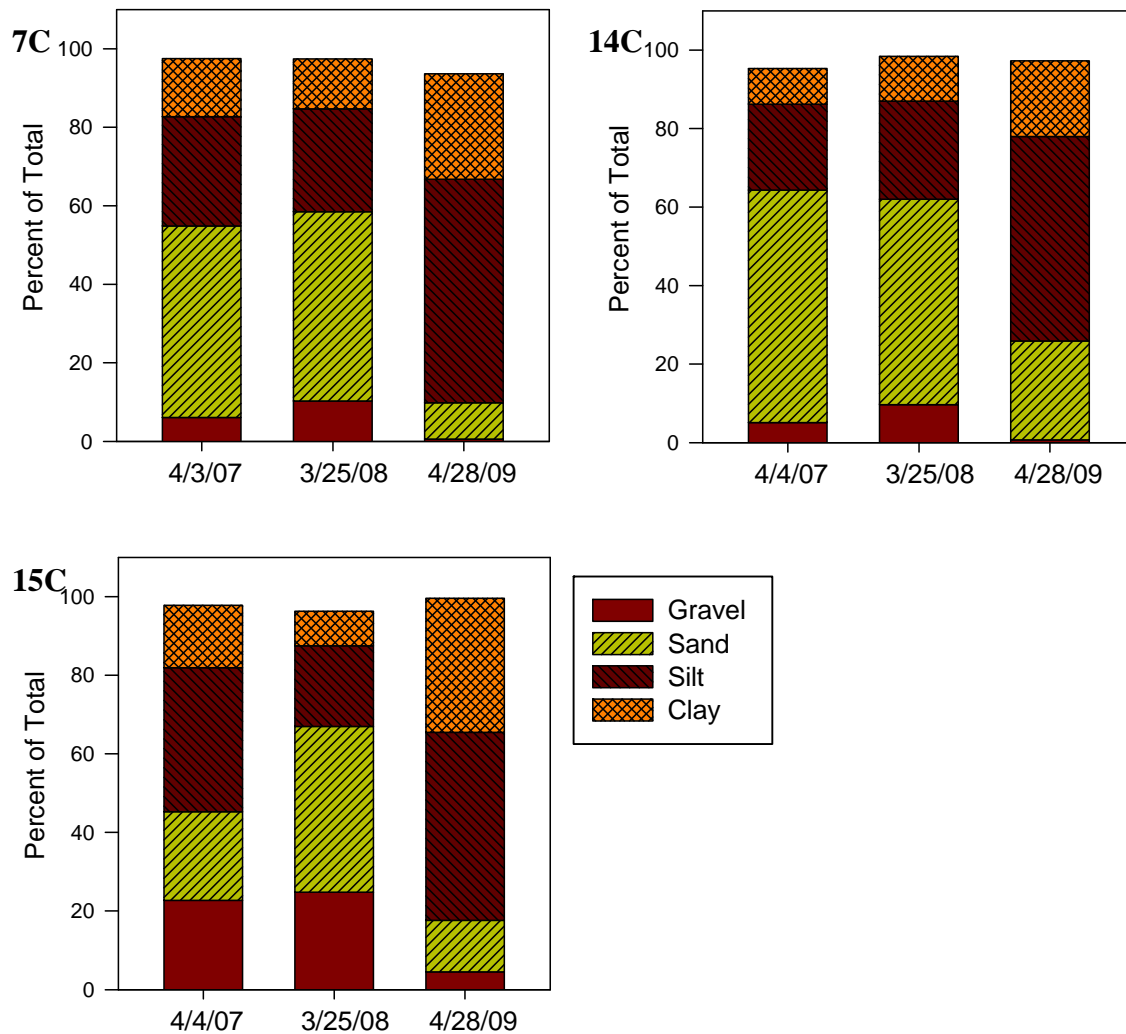


Figure 7. (Continued). Changes in Grain Size at ENR Stations (Thin Layer Placement)

Grain size distributions for 2008 and 2009 are shown in Figure 7. Grain size changes over time varied considerably across ENR area stations. Overall, the percent fines increased from 2007 to 2009 for all stations except 4C and 6C. Similarities in overall composition are shared between 4C and 6C and between 3C and 5C in 2009 (Figure 7). At individual stations, no substantial (>10%) changes in overall grain size composition were observed between 2007 and 2009 at 3C, 4C, or 6C. Between 2008 and 2009, substantial (>10%) changes were observed at four ENR stations. At 5C, sand was proportionally less and silt greater than the previous two years. Similar trends were seen at 7C and 14C where relative fines increased from <50% to near 80% in 2009. The greatest annual variation was observed at 15C; relative total fines decreased in 2008 from roughly half to about 30%, and then increased to >80% in 2009.

TOC measurements in ENR area samples ranged from 0.28% to 1.3% in 2008 and from 0.63% to 1.7% in 2009 (Tables 8 and 9). Relative TOC was fairly consistent between 2007 and 2008 with the largest change of 0.5% at 15C (Figure 8). Relative TOC increased from 2008 to 2009 at all stations with the largest change of 0.7% at 5C. At all stations except for 4C and 6C, relative TOC was highest in 2009 over the three year period. At 4C and 6C, changes in TOC follow the same relationship from 2007 to 2009 as percent fines.

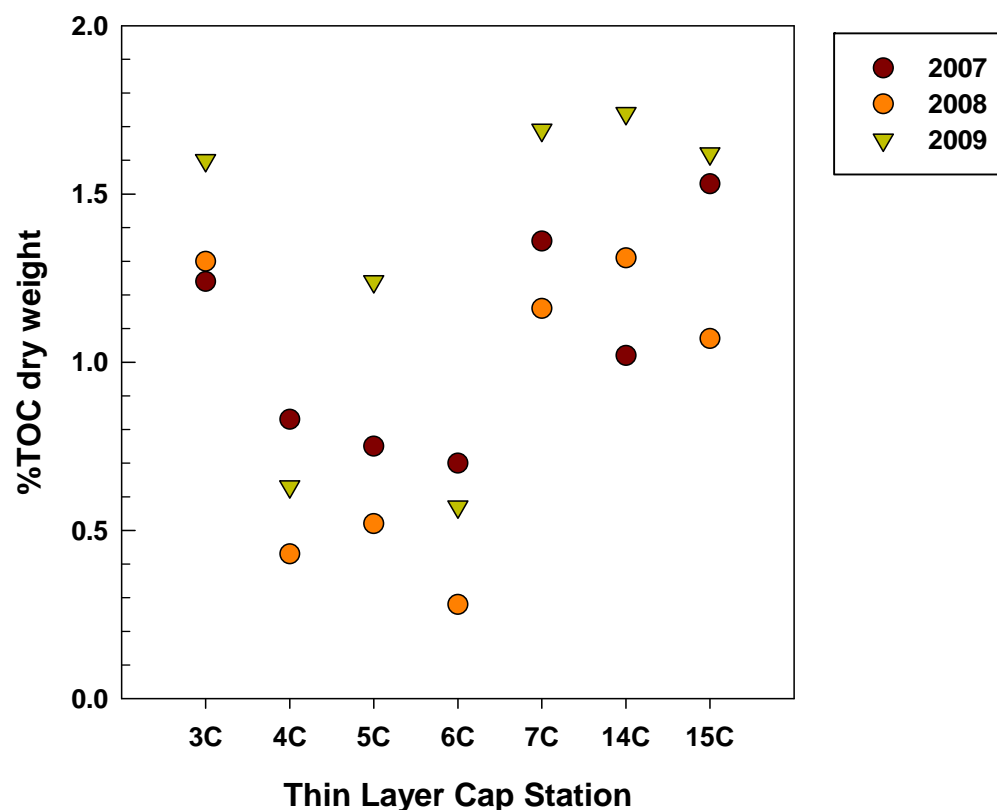


Figure 8. Percent TOC in ENR Area Samples, 2007-2009

Perimeter Area Monitoring Results for 2008 and 2009

The analytical chemistry results for the eight stations in the Perimeter Area sampled in 2008 and 2009 can be found in Tables 8 and 9, respectively. The results are normalized to dry weight (dw) or organic carbon (OC) for comparison to SMS. In 2008, TOC content of the sample from 8C was outside the range for comparison to OC-normalized values of the SMS and was compared to dw-normalized AETs. The concentrations of four chemicals exceeded the SMS in each of years 2008 and 2009 as discussed below.

Concentrations of total PCBs exceeded the SQS or LAET at five stations in 2008: 8C, 9C, 10C, 12C and 13C. In 2008, BEHP concentrations exceeded the CSL at 1C and 11C and the SQS at 2C, 9C, and 12C. BBP concentrations exceeded the SQS but not the CSL at stations 1C, 2C,

11C and 12C. At 11C, the CSL criterion for BBP was also exceeded. Benzoic acid concentrations at 1C and 2C exceeded the SQS and CSL (the criteria are the same values).

In 2009, mercury and total PCB concentrations exceeded the CSL at 8C. PCBs exceeded the SQS but not the CSL at 9C, 10C and 12C. At 11C, BEHP exceeded the CSL while BBP exceeded only the SQS.

Grain size distributions are shown for 2008 and 2009 in Figure 9. Changes in relative grain size distribution between years varied by station. At 1C and 2C, percent fines decreased between 2007 and 2008 by a small amount and then returned to proportions in 2009 similar to 2007. The same pattern was observed for 9C and 11C except the proportions of fines in 2009 were >10% higher than in 2007. Changes in the proportion of fines at 8C were more dramatic with a larger decrease in 2008 and slightly larger increase in 2009 than at 9C or 11C. The upstream station, 13C, compares most closely each year in overall composition to 1C and 2C, particularly in 2009. These three stations, in addition to 10C, are dominated by fines (i.e., >50%) and gravel is essentially absent. The only stations where relative fines noticeably increased from 2007 to 2008 were 10C and 12C. The proportion of total fines continued to decrease slightly in 2009 at 12C but not at 10C.

TOC composition ranged from 0.41% to 2.9% in 2008 and 1.0% to 2.2% in 2009 (Tables 8 and 9). Little interannual variability exists in TOC from 2007 to 2009 at perimeter stations except at 8C (Figure 10). Here, TOC fell to <0.5% in 2008 but reached 2.2% in 2009, the highest of any station that year. TOC has been distinctly higher each year at 1C and 2C compared to all other stations. The TOC at 13C, upstream, is slightly lower than that at 1C and 2C but higher than TOC at the other stations.

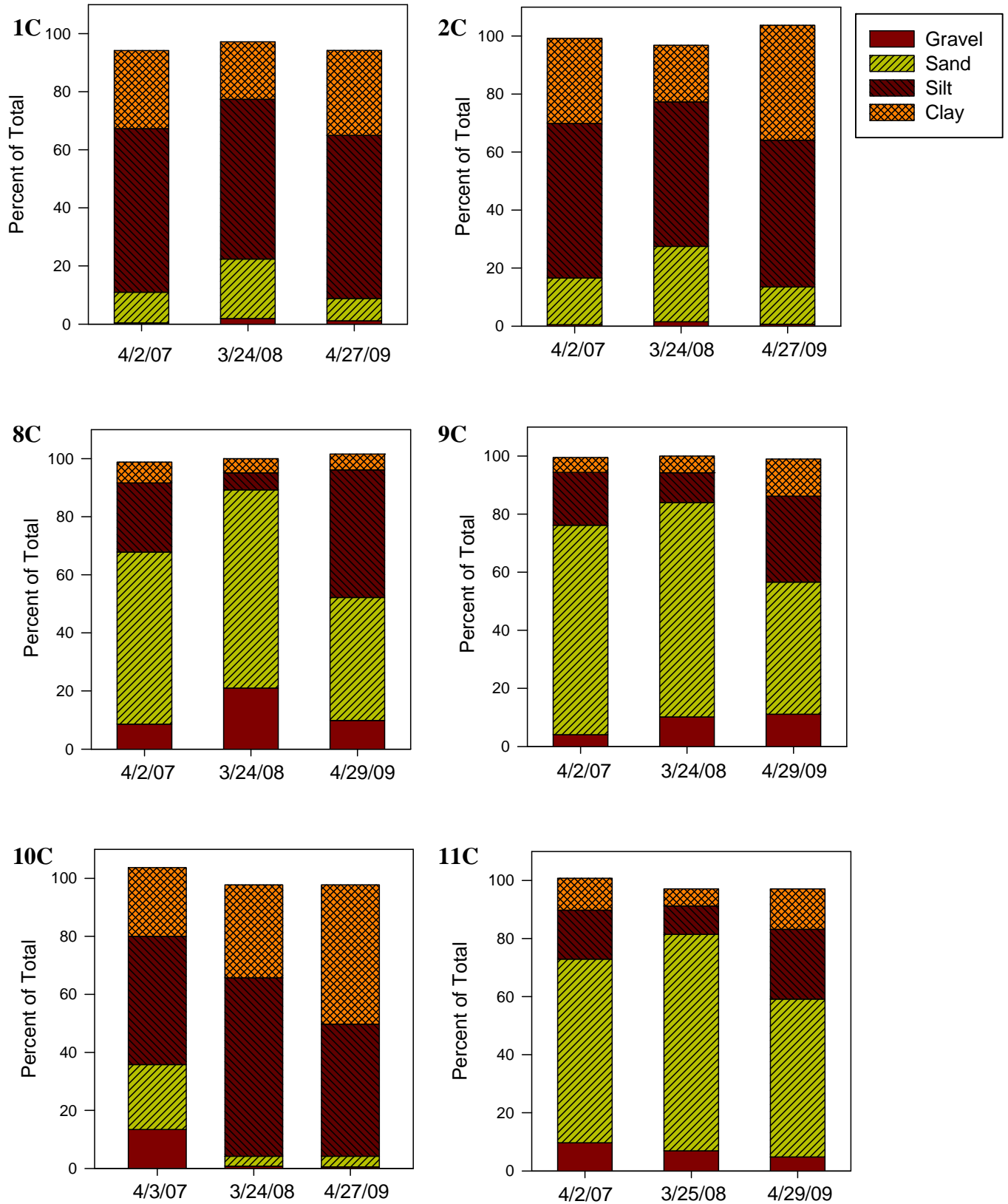


Figure 9. Changes in Grain Size Perimeter Only Stations (1C, 2C, 8C-13C)

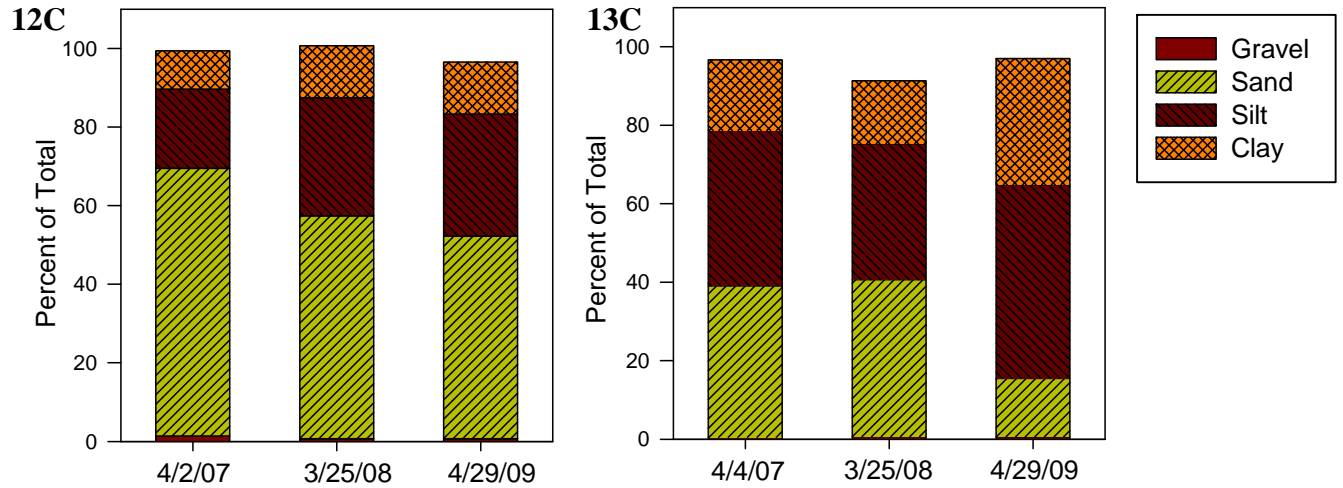


Figure 9. (continued). Changes in Grain Size Perimeter Only Stations (continued) (1C, 2C, 8C-13C)

Note: Station 13C was not added until 2005

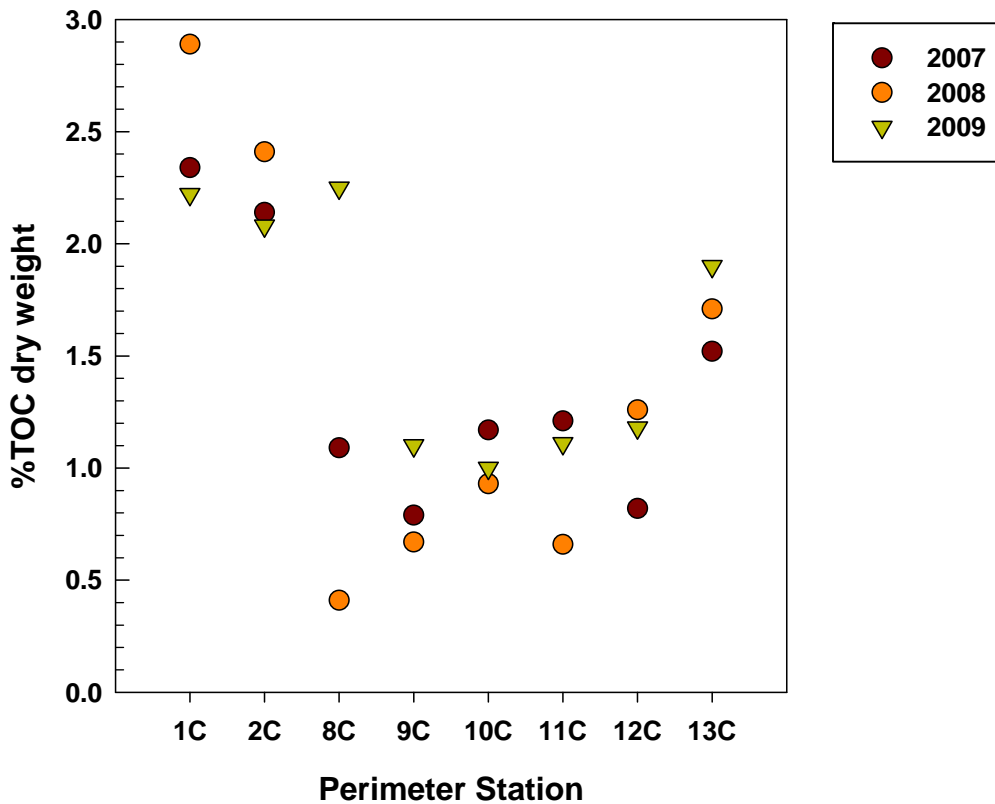


Figure 10. Percent TOC in Perimeter Area Samples, 2007-2009.

Table 8. 2008 Sediment Chemistry Results – Comparison to SMS

	SMS		Cap Area A					Cap Area B		
	SQS	CSL	DUD_1A	DUD_2A	DUD_3A	DUD_4A	DUD_5A Avg	DUD_1B	DUD_2B	DUD_3B
Conventionals (%)										
Total Solids			77.1	41.4	47.4	63.8	81.7	57.5	44.7	44.8
Total Organic Carbon			0.355	3.60	2.17	1.45	0.130	1.47	2.14	2.28
Metals (mg/kg dw)										
Arsenic	57	93	3.37 J	16.4	13.7	7.37 J	2.39 J	9.22 J	13.4 J	13.2 J
Cadmium	5.1	6.7	0.56 J	0.70 J	0.49 J	0.42 J	0.12 U	0.33 J	0.47 J	0.42 J
Chromium	260	270	22.4	36.0	31.2	30.72	23.9	29.2	31.5	31.3
Copper	390	390	31.8	98.3	77.8	55.96	47.7	63.8	85.2	75.7
Lead	450	530	37.2	66.9	43.2	36.05	5.38	33.0	45.4	40.8
Mercury	0.41	0.59	0.027 J,E	0.209 E	0.194 E	0.116 E	0.016 J,E	0.317 E	0.172 E	0.239 E
Silver	6.1	6.1	0.259 U	0.483 U	0.42 U	0.313 U	0.245	0.348 U	0.447 U	0.446 U
Zinc	410	960	153	211	153	135	40.2	106	152	146
PCBs (mg/kg-OC)										
Total PCBs	12	65	7.71	3.87 *	4.32	5.26	5.83	11.2	5.39	5.72
LPAH (mg/kg-OC)										
2-Methylnaphthalene	38	64	3.24	0.29	0.47	0.59	1.92 U	0.34 J	0.37 J	0.32 J
Acenaphthylene	66	66	0.750 U	0.35	0.41	0.36 J	1.92 U	0.62	0.27 J	0.55
Acenaphthene	16	57	1.98	0.45	0.71	1.43	1.96	0.75	0.46	0.54
Anthracene	220	1200	3.04	2.34	3.73	10.31	4.73	4.39	3.23	3.04
Fluorene	23	79	2.71	0.89	1.20	3.37	4.04	1.43	2.12	1.01
Naphthalene	99	170	0.88 J	0.52	0.41	3.44	1.92	0.52	0.38 J	0.36 J
Phenanthrene	100	480	18.3	5.40	7.16	26.00	17.13	8.67	5.60	5.87
Total LPAHs	370	780	27.6	10.0	13.6	44.9	31.7	16.4	12.1	11.4
HPAH (mg/kg-OC)										
Benzo(a)anthracene	110	270	10.5	7.25	7.89	21.4 E	12.2 E	9.30 E	7.28 E	8.16 E
Benzo(a)pyrene	99	210	12.5	7.32	8.54	19.6	15.1	10.6	7.80	8.38
Benzo(g,h,i)perylene	31	78	9.53	4.95	5.61	14.1	6.7	6.07	5.17	5.53
Chrysene	110	460	17.7	10.8	11.8	24.4	19.5	15.6	11.0	12.2
Dibenzo(a,h)anthracene	12	33	4.01	2.17	2.78	6.54	2.1	2.31	1.93	2.58
Fluoranthene	160	1200	29.3	14.6	14.7	38.5 E	26.3 E	16.6 E	12.5 E	13.4 E
Indeno(1,2,3-Cd)Pyrene	34	88	9.05	5.07	6.17	13.7	8.3	6.00	5.01	5.43
Total Benzofluoranthenes	1000	1400	23	17	20	42	30	26	21	22
Pyrene	230	450	30.5	17.2	15.6	41.4 E	29.5 E	17.6 E	13.2 E	13.7 E
Total HPAHs	960	5300	146	86.7	92.9	222	108	110	84.5	91.1
Chlorobenzenes (mg/kg-OC)										
1,2-Dichlorobenzene	2.3	2.3	0.075 U	0.015 U	0.019 U	0.022 U	0.192 U	0.16	0.02 U	0.02 U
1,2,4-Trichlorobenzene	0.81	1.8	0.036 U	0.007 U	0.010 U	0.011 U	0.096 U	0.01 U	0.01 U	0.01 U
1,4-Dichlorobenzene	3.1	9	179 **	0.077	0.32	0.69 E	0.95 E	0.14 E	0.11 E	0.12 E
Hexachlorobenzene	0.38	2.3	0.036 U	0.007 U	0.010 U	0.011 U	0.096 U	0.01 U	0.01 U	0.01 U
Phthalates (mg/kg-OC)										
Bis(2-Ethylhexyl)Phthalate	47	78	203 B	52.1 B*	50.8 B*	76.5 B*	56.8 B	28.3 B	33.0 B	43.5 B
Butylbenzylphthalate	4.9	64	34.5 B*	4.11 B*	2.96 B	10.4	10.4	3.28	3.63	2.70
Diethylphthalate	61	110	1.46 U	0.27 U	0.39 U	0.43 U	4.17	0.55 J	0.42 U	0.39 U
Dimethylphthalate	53	53	82.5 **	0.27 U	0.93	4.91	9.09	0.47 U	4.23	0.92
Di-N-Butylphthalate	220	1700	99.6 B	1.91 B	0.81 B	1.33	4.30	0.93 J	1.16	1.41
Di-N-Octylphthalate	58	4500	1.46 U	0.268 U	0.39 U	0.43 U	3.85 U	0.47 U	0.42 U	0.39 U
Ionic Organics (ug/kg dw)										
2-Methylphenol	63	63	2.59 U	4.83 U	4.22 U	3.13 U	2.45 U	3.48 U	4.47 U	4.46 U
4-Methylphenol	670	670	5.19 U	9.66 U	8.44 U	34.5	4.90 U	44.9	69.8	51.8
2,4-Dimethylphenol	29	29	1.30 U	2.42 U	2.11 U	1.57 U	1.22 U	1.74 U	2.24 U	2.23 U
Benzyl Alcohol	57	73	2.59 U	4.83 U	4.22 U	3.13 U	2.45 U	3.48 U	4.47 U	4.46 U
Benzoic Acid	650	650	171 B	365 B	338 B	318	120	289	331	299
Pentachlorophenol	360	690	13.0 U	24.2 U	21.1 U	15.7 U	12.2 U	17.4 U	22.4 U	22.3 U
Phenol	420	1200	5.19 U,E	9.66 U,E	8.44 U,E	190 U	68.1	400	436 *	413
Miscellaneous (mg/kg-OC)										
Dibenzofuran	15	58	1.24 J	0.42	0.70	0.91	1.92 U	0.66	0.58	0.50
Hexachlorobutadiene	3.9	6.2	0.18 U	0.03 U	0.05 U	0.05 U	0.48 U	0.06 U	0.05 U	0.05 U
N-Nitroso-di-phenylamine	11	11	1.46 U	0.27 U	0.39 U	0.43 U	3.85 U	0.47 U	0.42 U	0.39 U

Notes:

Comparison to AETs is presented in Appendix D

Heavy shading: Detected value exceeds one or both criterion

Light shading: TOC <0.5% or >3%, thus OC-normalized chemicals compared to LAET and 2LAET

Bold: Detected.

U: Special font denotes that TOC requires comparison to AET and 2LAET

* Exceeds SMS SQS or SQS-AET criteria.

** Exceeds SMS CSL or CSL-AET criteria.

dw: dry weight normalized

-OC: organic carbon normalized

SMS: Sediment Management Standards (Chapter 173-204 WAC)

SQS: Sediment Quality Standard (Table I, Chapter 173-204 WAC)

CSL: Cleanup Screening Level (Table III, Chapter 173-204 WAC)

LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons

HPAHs: High Molecular Weight Polynuclear Aromatic Hydrocarbons

PCBs: Polychlorinated Biphenyls

Qualifiers:

U: <MDL

J: <RDL

B: detected in method blank

G: low biased data

E: estimated

H: the sample holding time was exceeded

Table 8. (Cont'd) 2008 Sediment Chemistry Results – Comparison to SMS

	SMS		Enhanced Natural Recovery Area						
	SQS	CSL	DUD_3C	DUD_4C Avg	DUD_5C	DUD_6C	DUD_7C	DUD_14C	DUD_15C
Conventionals (%)									
Total Solids			63.2	80.7	74.5	82.7	60.9	62.3	65.1
Total Organic Carbon			1.30 H	0.43 H	0.522 H	0.280 H	1.16 H	1.31 H	1.07 H
Metals (mg/kg dw)									
Arsenic	57	93	9.02 J	4.53 J	4.70 J	3.14 J	8.37 J	9.15 J	9.06 J
Cadmium	5.1	6.7	0.301 J	0.193 J	0.161 J	0.120 U	0.279 J	0.337 J	0.230 J
Chromium	260	270	23.9	16.7	18.7	11.7	23.6	23.3	22.6
Copper	390	390	52.2	33.2	38.5	26.1	46.8	53.3	48.2
Lead	450	530	31.3	11.2	10.8	6.53	25.8	28.7	26.4
Mercury	0.41	0.59	0.119	0.048 J	0.05 J	0.144	0.104	0.116	0.118
Silver	6.1	6.1	0.316 U	0.248 U	0.268 U	0.242 U	0.33 U	0.321 U	0.307 U
Zinc	410	960	91.3	47.2	54.5	36.2	88.5	97.1	86.0
PCBs (mg/kg-OC)									
Total PCBs	12	65	10.8	8.00	7.46	5.0	4.93	9.78	6.49
LPAH (mg/kg-OC)									
2-Methylnaphthalene	38	64	0.24 U	0.58 U	0.51 U	0.86 U	0.28 U	0.25 U	0.29 U
Acenaphthylene	66	66	0.47 J	0.67 J	0.87 J	0.86 U	0.28 U	0.59	0.46 J
Acenaphthene	16	57	0.44 J	0.58 U	0.72 J	0.86 U	0.34 J	0.52	0.79
Anthracene	220	1200	2.87	3.91	4.83	2.78	1.58	3.96	3.42
Fluorene	23	79	0.97	1.62	1.91	1.94	0.736	1.22	1.38
Naphthalene	99	170	0.35 J	0.58 U	0.51 U	0.86 U	0.28 U	0.36 J	0.44 J
Phenanthrene	100	480	5.57	6.06	8.84	5.56	2.73	6.88	8.44
Total LPAHs	370	780	10.7	12.3	17.2	10.3	5.4	13.5	14.9
HPAH (mg/kg-OC)									
Benzo(a)anthracene	110	270	6.73	8.29	9.92	5.47	4.04	9.69	8.65
Benzo(a)pyrene	99	210	7.68	10.1	11.1	7.28	4.24	10.4	9.77
Benzo(g,h,i)perylene	31	78	3.58	4.40	4.76	2.96	1.61	4.45	3.87
Chrysene	110	460	10.9	13.7	15.7	11.9	6.50	15.0	13.8
Dibenzo(a,h)anthracene	12	33	1.72	1.34	1.45	0.862 U	0.297 J	2.52	2.29
Fluoranthene	160	1200	13.1	14.4	19.7	14.2	6.54	15.7	16.3
Indeno(1,2,3-Cd)Pyrene	34	88	4.17	5.27	5.66	3.95	2.09	5.41	5.09
Total Benzofluoranthenes	1000	1400	19	24	27	18	9.1	26	24
Pyrene	230	450	12.2	14.3	16.3	13.6	6.16	14.6	18.3
Total HPAHs	960	5300	79.0	96.0	112	76.9	40.6	104	102
Chlorobenzenes (mg/kg-OC)									
1,2-Dichlorobenzene	2.3	2.3	0.024 U	0.058 U	0.051 U	0.086 U	0.028 U	0.025 U	0.029 U
1,2,4-Trichlorobenzene	0.81	1.8	0.022 J	0.029 U	0.026 U	0.045 U	0.014 U	0.012 U	0.014 U
1,4-Dichlorobenzene	3.1	9	0.072	0.080 J	0.098 J	0.086 U	0.042 J	0.065	0.066
Hexachlorobenzene	0.38	2.3	0.012 U	0.029 U	0.026 U	0.045 U	0.014 U	0.012 U	0.014 U
Phthalates (mg/kg-OC)									
Bis(2-Ethylhexyl)Phthalate	47	78	15.7 B	27.8 B	24.8 B	23.4 B	8.95 B	17.0 B	22.1 B
Butylbenzylphthalate	4.9	64	2.29 B	3.43 B	3.01 B	4.96 B	1.77 B	2.32 B	2.09 B
Diethylphthalate	61	110	0.645 J	1.44 J	1.23 J	1.72 U	0.678 J	0.491 U	0.759 J
Dimethylphthalate	53	53	1.17	1.89	1.03 U	1.72 U	0.565 U	1.09	0.573 U
Di-N-Butylphthalate	220	1700	1.16	1.53 J,B	2.20 B	1.81 J,B	0.876 J,B	1.05 B	0.974 J,B
Di-N-Octylphthalate	58	4500	0.487 U	1.17 U	5.94	1.72 U	0.565 U	0.491 U	0.573 U
Ionic Organics (ug/kg dw)									
2-Methylphenol	63	63	3.16 U	2.48 U	2.68 U	2.42 U	3.28 U	3.21 U	3.07 U
4-Methylphenol	670	670	6.33 U	4.96 U	5.37 U	4.84 U	6.57 U	6.42 U	6.14 U
2,4-Dimethylphenol	29	29	1.58 U	1.24 U	1.34 U	1.21 U	1.64 U	1.61 U	1.54 U
Benzyl Alcohol	57	73	3.16 U	2.48 U	2.68 U	2.42 U	3.28 U	3.21 U	3.07 U
Benzoic Acid	650	650	275 B	50.5 B	200 B	145 B	192 B	238 B	192 B
Pentachlorophenol	360	690	15.8 U	12.4 U	13.4 U	12.1 U	16.4 U	16.1 U	15.4 U
Phenol	420	1200	69.8 E	10.1 E	33.8 E	28.7 E	14.1 E	62.3 E	29.0 E
Miscellaneous (mg/kg-OC)									
Dibenzofuran	15	58	0.40 J	0.58 U	1.09	0.862 U	0.35 J	0.47 J	0.57
Hexachlorobutadiene	3.9	6.2	0.06 U	0.15 U	0.13 U	0.216 U	0.07 U	0.06 U	0.072 U
N-Nitroso-di-phenylamine	11	11	0.49 U	1.17 U	1.03 U	1.724 U	0.56 U	0.49 U	0.573 U

Notes:

Comparison to AETs is presented in Appendix D
 Heavy shading: Detected value exceeds one or both criterion
 Light shading: TOC <0.5% or >3%, thus OC-normalized chemicals compared to LAET and 2LAET
 Bold: Detected.
 6.3 U : Special font denotes that TOC requires comparison to AET and 2LAET
 * Exceeds SMS SQS or SQS-AET criteria.
 ** Exceeds SMS CSL or CSL-AET criteria.
 dw: dry weight normalized
 -OC: organic carbon normalized
 SMS: Sediment Management Standards (Chapter 173-204 WAC)
 SQS: Sediment Quality Standard (Table I, Chapter 173-204 WAC)
 CSL: Cleanup Screening Level (Table III, Chapter 173-204 WAC)
 LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons
 HPAHs: High Molecular Weight Polynuclear Aromatic Hydrocarbons
 PCBs: Polychlorinated Biphenyls

Qualifiers:
 U: <MDL
 J: <RDL
 B: detected in method blank
 G: low biased data
 E: estimated
 H: the sample holding time was exceeded

Table 8. (Cont'd) 2008 Sediment Chemistry Results – Comparison to SMS

	SMS		Perimeter Area							
	SQS	CSL	DUD_1C	DUD_2C	DUD_8C AVG	DUD_9C	DUD_10C	DUD_11C	DUD_12C	DUD_13C
Conventionals (%)										
Total Solids			44.6	45.6	74.6	72.1	65.7	72.8	64.9	56.4
Total Organic Carbon			2.89	2.41	0.415	0.673	0.927	0.665	1.26	1.71
Metals (mg/kg dw)										
Arsenic	57	93	15.2	14.6	5.43 J	6.24 J	9.62	5.49 J	12.0	9.93 J
Cadmium	5.1	6.7	0.70 J	0.53 J	0.322 J	0.43 J	0.44 J	0.21 J	0.74 J	0.53 J
Chromium	260	270	35.9	34.2	22.9	21.6	25.6	21.2	32.7	30.9
Copper	390	390	91.3	82.5	52.8	52.1	49.3	49.7	71.3	71.8
Lead	450	530	60.1	50.7	22.2	39.1	43.5	19.8	94.9	47.2
Mercury	0.41	0.59	0.21	0.18	0.065	0.08	0.13	0.07	0.19	0.20
Silver	6.1	6.1	0.49 J	0.48 J	0.268	0.36 J	0.304 U	0.275 U	0.51 J	0.44 J
Zinc	410	960	199	168	62.5	74.8	107	74.0	147	129
PCBs (mg/kg-OC)										
Total PCBs	12	65	9.09	5.86	67.2 *	41.9 *	17.2 *	8.99	19.5 *	14.0 *
LPAH (mg/kg-OC)										
2-Methylnaphthalene	38	64	0.407	1.9	1.04	0.76 J	0.731	0.702 J	0.812	0.372 J
Acenaphthylene	66	66	0.412	0.82	0.673 J	0.62 J	0.411 J	0.579 J	0.592	0.425
Acenaphthene	16	57	0.609	4.39	1.53	0.74 J	0.575 J	0.517 J	0.814	0.525
Anthracene	220	1200	2.80	6.87	6.20	3.73	4.43	4.17	4.49	3.50
Fluorene	23	79	1.81	5.38	4.56	4.02	3.12	3.78	2.86	2.32
Naphthalene	99	170	0.34	0.54	0.74	0.60 J	0.33 U	0.41 U	0.78	0.28 J
Phenanthrene	100	480	8.14	27.5	14.5	6.76	7.19	9.88	11.87	5.99
Total LPAHs	370	780	14.1	45.5	28.2	16.5	15.7	18.9	21.4	13.0
HPAH (mg/kg-OC)										
Benzo(a)anthracene	110	270	11.2	29.0	12.6	7.75	9.16	13.7	12.9	9.01
Benzo(a)pyrene	99	210	9.15	15.9	13.6	10.6	11.7	13.8	15.4	9.65
Benzo(g,h,i)perylene	31	78	6.02	6.73	7.55	5.86	6.90	8.12	9.66	5.22
Chrysene	110	460	15.7	31.1	18.3	13.0	13.9	17.7	16.6	13.7
Dibenzo(a,h)anthracene	12	33	3.33	4.13	2.42	2.33	2.79	3.10	4.87	2.28
Fluoranthene	160	1200	18.5	65.4	23.4	11.6	14.4	22.5	20.2	12.3
Indeno(1,2,3-Cd)Pyrene	34	88	6.65	8.65	8.56	6.58	7.50	9.01	10.4	6.16
Total Benzofluoranthenes	1000	1400	22.9	42.0	32.2	23.6	26.8	32.4	34.0	22.4
Pyrene	230	450	31.5	88.5	36.9	24.3	24.3	31.0	45.2	18.9
Total HPAHs	960	5300	125	285	156	106	117	151	169	99.6
Chlorobenzenes (mg/kg-OC)										
1,2-Dichlorobenzene	2.3	2.3	0.0155 U	0.018 U	0.096	0.125	0.033 U	0.041 U	0.024 U	0.032 J
1,2,4-Trichlorobenzene	0.81	1.8	0.0078 U	0.009 U	0.055 U	0.021 U	0.016 U	0.021 U	0.012 U	0.010 U
1,4-Dichlorobenzene	3.1	9	0.084	0.071	0.15 U	0.48	0.39	0.22	0.46	0.078
Hexachlorobenzene	0.38	2.3	0.0078 U	0.009 U	0.055	0.0206 U	0.016 U	0.021 U	0.012 U	0.010 U
Phthalates (mg/kg-OC)										
Bis(2-Ethylhexyl)Phthalate	47	78	80.6 B**	65.6 B*	92.8 J	58.4 B*	35.5 B	84.1 B**	76.1 B*	28.2 B
Butylbenzylphthalate	4.9	64	6.04 B*	5.32 B*	6.07 J	3.73 B	4.76 B	11.1 B**	7.59 B*	3.37 B
Diethylphthalate	61	110	0.310 U	0.364 U	1.517 U	0.825 U	0.66 U	0.826 U	0.49 U	0.414 U
Dimethylphthalate	53	53	0.310 U	0.364 U	2.76	0.825 U	0.66 U	0.826 U	0.49 U	4.54
Di-N-Butylphthalate	220	1700	1.81 B	1.49 B	3.00	196 B	1.38 B	2.23 B	1.58 B	1.27 B
Di-N-Octylphthalate	58	4500	0.31 U	0.36 U	1.52 U	0.82 U	0.66 U	0.83 U	0.49 U	0.41 U
Ionic Organics (ug/kg dw)										
2-Methylphenol	63	63	4.48 U	4.39 U	2.68 U	2.77 U	3.04 U	2.75 U	3.08 U	3.55 U
4-Methylphenol	670	670	8.97 U	8.77 U	5.36 U	5.55 U	6.09 U	5.49 U	6.16 U	7.09 U
2,4-Dimethylphenol	29	29	2.24 U	2.19 U	1.34 U	1.39 U	1.52 U	1.37 U	1.54 U	1.77 U
Benzyl Alcohol	57	73	4.48 U	4.39 U	2.68 U	2.77 U	3.04 U	2.75 U	3.08 U	3.55 U
Benzoic Acid	650	650	661 B*	1287 B**	56.5 B	239 B	286 B	217 B	260 B	264 B
Pentachlorophenol	360	690	22.4 U	21.9 U	13.4 U	13.9 U	15.2 U	13.7 U	15.4 U	17.7 U
Phenol	420	1200	83.4 E	43.4 E	5.36 U,E	5.55 U,E	6.1 U,E	5.5 U,E	6.2 E	24.1 E
Miscellaneous (mg/kg-OC)										
Dibenzofuran	15	58	0.50	2.9	1.43	0.64	0.56 J	0.70 J	0.61	0.44
Hexachlorobutadiene	3.9	6.2	0.039 U	0.045 U	0.165 U	0.103 U	0.082 U	0.103 U	0.06 U	0.052 U
N-Nitroso-di-phenylamine	11	11	0.31 U	0.36 U	1.52 U	0.82 U	0.66 U	0.83 U	0.49 U	0.41 U

No Notes:

Comparison to AETs is presented in Appendix D

Heavy shading: Detected value exceeds one or both criterion

Light shading: TOC <0.5% or >3%, thus OC-normalized chemicals compared to LAET and 2LAET

Bold: Detected.

U: Special font denotes that TOC requires comparison to AET and 2LAET

* Exceeds SMS SQS or SQS-AET criteria.

** Exceeds SMS CSL or CSL-AET criteria.

dw: dry weight normalized

-OC: organic carbon normalized

SMS: Sediment Management Standards (Chapter 173-204 WAC)

SQS: Sediment Quality Standard (Table I, Chapter 173-204 WAC)

CSL: Cleanup Screening Level (Table III, Chapter 173-204 WAC)

LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons

HPAHs: High Molecular Weight Polynuclear Aromatic Hydrocarbons

PCBs: Polychlorinated Biphenyls

Qualifiers:

U: <MDL

J: <RDL

B: detected in method blank

G: low biased data

E: estimated

H: the sample holding time was exceeded

LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons

HPAHs: High Molecular Weight Polynuclear Aromatic Hydrocarbons

PCBs: Polychlorinated Biphenyls

Table 9. 2009 Sediment Chemistry Results – Comparison to SMS

	SMS		Cap Area A					Cap Area B		
	SQS	CSL	DUD_1A	DUD_2A	DUD_3A	DUD_4A	DUD_5A Avg	DUD_1B	DUD_2B	DUD_3B
Conventionals (%)										
Total Solids			76.1	41.9	48.6	60.3	82.2	46.4	40.9	40.9
Total Organic Carbon			1.63	2.84	1.94	1.57	0.19	1.81	1.81	1.77
Metals (mg/kg dw)										
Arsenic	57	93	6.57 J	14.1 J	11.9 J	7.63 J	3.05 J	11.4 J	12.5 J	12.0 J
Cadmium	5.1	6.7	0.68	0.69 J	0.47 J	0.36 J	0.14 U	0.45 J	0.44 J	0.42 J
Chromium	260	270	63.5 L	33.4	29.8	27.5	16.2	28.9	32.0	28.6
Copper	390	390	46.8	78.8	72.6	70.6	37.2	60.8	62.3	56.0
Lead	450	530	43.8 L	35.6	31.1	22.6	5.54 J	22.6	20.9	15.7
Mercury	0.41	0.59	0.056	0.19	0.21	0.11	0.02 J	0.16	0.16	0.13
Silver	6.1	6.1	0.250 U	0.477 U	0.412 U	0.531 J	0.27 U	0.431 U	0.513 U	0.465 U
Zinc	410	960	164	148	120	94.9	36.7	96.8	101	90.7
PCBs (mg/kg-OC)										
Total PCBs	12	65	3.49	3.62	4.39	3.37	5.52	3.19	2.47	1.23
LPAH (mg/kg-OC)										
2-Methylnaphthalene	38	64	1.02	0.30 J	0.44	0.37	1.64 J	0.29 J	0.32 J	0.68
Acenaphthylene	66	66	0.16 U	0.17 U	0.43	0.30	1.52 U	0.32 J	0.27 U	0.28 U
Acenaphthene	16	57	2.52	0.48	0.41	0.58	4.19	0.25 J	0.28 J	0.41 J
Anthracene	220	1200	5.78	1.75	3.29	4.50	11.3	1.91	1.84	1.13
Fluorene	23	79	2.38	0.62	0.93	0.98	4.24	0.64	0.68	0.74
Naphthalene	99	170	11.6	1.77	0.86	4.19	1.52 U	0.24 U	0.42 J	0.41 J
Phenanthrene	100	480	29.5 L	3.84	5.43	8.40	37.0	3.37	3.38	4.60
Total LPAHs	370	780	52.9	8.74	11.8	19.3	58.8	7.00	7.16	8.20
HPAH (mg/kg-OC)										
Benzo(a)anthracene	110	270	19.0	5.72	8.77	10.1	23.4	4.82	5.28	2.79
Benzo(a)pyrene	99	210	16.0	4.87	8.40	8.79	20.4	4.41	4.83	2.82
Benzo(g,h,i)perylene	31	78	12.8	3.41	5.68 J	6.33	11.2	2.91	3.17	1.75
Chrysene	110	460	19.3	7.11	10.5	12.1	25.1	6.73	7.04	3.96
Dibenzo(a,h)anthracene	12	33	5.74	1.45	2.21	2.39	4.91	1.14	1.28	0.71
Fluoranthene	160	1200	44.2 L	10.3	14.0	19.7	54.7	9.67	9.69	7.53
Indeno(1,2,3-Cd)Pyrene	34	88	11.6	2.93	5.49	5.49	11.3	2.71	2.95	1.69
Total Benzofluoranthenes	1000	1400	34.0	12.8	20.4	20	43.0	11.7	12.0	7.68
Pyrene	230	450	58.4 L	10.6	15.5	21.2	51.9	9.5	9.45	7.11
Total HPAHs	960	5300	221	59.2	91.0	106	246	53.6	55.6	36.0
Chlorobenzenes (mg/kg-OC)										
1,2-Dichlorobenzene	2.3	2.3	0.02 U	0.02 U	0.02 U	0.02 U	0.152 U	0.02 U	0.03 U	0.03 U
1,2,4-Trichlorobenzene	0.81	1.8	0.01 U	0.01 U	0.01 U	0.01 U	0.066 U	0.01 U	0.01 U	0.01 U
1,4-Dichlorobenzene	3.1	9	0.69	0.02 U	0.15	0.23	0.152 U	0.02 U	0.03 U	0.03 U
Hexachlorobenzene	0.38	2.3	0.01 U	0.01 U	0.01 U	0.01 U	0.066 U	0.01 U	0.01 U	0.01 U
Phthalates (mg/kg-OC)										
Bis(2-Ethylhexyl)Phthalate	47	78	53.8 L*	34.3	27.1	39.6	29.7 B	14.9	16.6	17.1
Butylbenzylphthalate	4.9	64	0.08 U	3.18 B2	1.94 B	2.71 B2	5.30 B	1.38 B	2.11 B	2.38 B
Diethylphthalate	61	110	0.32 U	0.34 U	0.42 U	0.42 U	2.64 U	0.48 U	0.54 U	0.55 U
Dimethylphthalate	53	53	0.32 U	0.34 U	0.42 U	3.27	2.64 U	0.48 U	0.54 U	0.55 U
Di-N-Butylphthalate	220	1700	1.93 B,L	1.19 B	2.22 B	1.65 B	7.02 B	1.56 B	1.71 B	2.00 B
Di-N-Octylphthalate	58	4500	50.4	0.34 U	0.42 U	0.42 U	2.64 U	0.48 U	0.54 U	0.55 U
Ionic Organics (ug/kg dw)										
2-Methylphenol	63	63	2.63 U	4.77 U	4.12 U	3.32 U	2.44 U	4.31 U	4.89 U	4.89 U
4-Methylphenol	670	670	5.26 U	9.55 U	8.23 U	6.63 U	4.87 U	8.62 U	9.78 U	9.78 U
2,4-Dimethylphenol	29	29	1.31 U	2.39 U	2.06 U	1.66 U	1.22 U	2.16 U	2.44 U	2.44 U
Benzyl Alcohol	57	73	2.63 U	4.77 U	4.12 U	3.32 U	2.44 U	4.31 U	4.89 U	4.89 U
Benzoic Acid	650	650	13.1 U	346	321	192	101	182	249	320
Pentachlorophenol	360	690	13.1 U	23.9 U	20.6 U	16.6 U	12.2 U	21.6 U	24.4 U	24.4 U
Phenol	420	1200	5.26 U	9.55 U	151	32.5	37.2	8.62 U	9.78 U	9.78 U
Miscellaneous (mg/kg-OC)										
Dibenzofuran	15	58	1.83	0.38	0.53	0.49	2.57	0.32 J	0.35 J	0.54 J
Hexachlorobutadiene	3.9	6.2	0.04 U	0.04 U	0.05 U	0.05 U	0.350 U	0.06 U	0.07 U	0.07 U
N-Nitroso-di-phenylamine	11	11	0.32 U	0.34 U	0.42 U	0.42 U	2.64 U	0.48 U	0.54 U	0.55 U

Notes:

Comparison to AETs is presented in Appendix D

Heavy shading: Detected value exceeds one or both criterion

Light shading: TOC <0.5% or >3%, thus OC-normalized chemicals compared to LAET and 2LAET

Bold: Detected.

6.3 U : Special font denotes that TOC requires comparison to AET and 2LAET

* Exceeds SMS SQS or SQS-AET criteria.

** Exceeds SMS CSL or CSL-AET criteria.

dw: dry weight normalized

-OC: organic carbon normalized

SMS: Sediment Management Standards (Chapter 173-204 WAC)

SQS: Sediment Quality Standard (Table I, Chapter 173-204 WAC)

CSL: Cleanup Screening Level (Table III, Chapter 173-204 WAC)

LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons

HPAHs: High Molecular Weight Polynuclear Aromatic Hydrocarbons

PCBs: Polychlorinated Biphenyls

Qualifiers:

U: <MDL

J: <RDL

B: A parameter in associated method blank was detected and sample result is within 5X of blank.

B2: A common lab contaminant in associated method blank was detected and the sample result is > 5 and ≤ 10X the blank.

L: the value is estimated or above the calibration range and could not be diluted and re-analyzed

SH: a sample handling criterion wasn't met

Table 9. (Cont'd) 2009 Sediment Chemistry Results – Comparison to SMS

	SMS		Enhanced Natural Recovery Area						
	SQS	CSL	DUD_3C	DUD_4C Avg	DUD_5C	DUD_6C	DUD_7C	DUD_14C	DUD_15C
Conventionals (%)									
Total Solids			55.4	76.6	57	77.4	47.4	50.8	46.6
Total Organic Carbon			1.60	0.63	1.24	0.57	1.69 SH	1.74 SH	1.62
Metals (mg/kg dw)									
Arsenic	57	93	9.57 J	4.18 J	7.19 J	4.39 J	10.5 J	10.6 J	10.1 J
Cadmium	5.1	6.7	0.42 J	0.16 J	0.25 J	0.16 J	0.32 J	0.39 J	0.30 J
Chromium	260	270	27.4	17.0	23.5	16.4	27.4	28.1	27.9
Copper	390	390	66.1	38.7	39.1	29.2	48.5	61.8	48.9
Lead	450	530	29.1	9.68	10.7	7.89	14.1	27.2	13.9
Mercury	0.41	0.59	0.17	0.07	0.10	0.066	0.13	0.20	0.13
Silver	6.1	6.1	0.361 U	0.25 U	0.368 U	0.21 U	0.44 U	0.394 U	0.43 U
Zinc	410	960	105	46.0	63.0	42.4	80.2	105	78.5
PCBs (mg/kg-OC)									
Total PCBs	12	65	6.82	7.86	2.77	5.17	2.77	8.25	1.91
LPAH (mg/kg-OC)									
2-Methylnaphthalene	38	64	0.23 U	0.42 U	0.28 U	0.46 U	0.25 U	0.23 U	0.26 U
Acenaphthylene	66	66	0.24 J	0.42 U	0.28 U	0.46 U	0.25 U	0.25 J	0.26 U
Acenaphthene	16	57	0.23 J	0.42 U	0.28 U	0.46 U	0.25 U	0.34 J	0.26 U
Anthracene	220	1200	2.09	2.82	0.94	1.67	0.60	2.57	0.74
Fluorene	23	79	0.54	0.80	0.51 J	0.80 J	0.37 J	0.65	0.42 J
Naphthalene	99	170	0.23 U	0.42 U	0.28 U	0.46 U	0.25 U	0.23 U	0.26 U
Phenanthrene	100	480	3.59	3.28	2.42	3.06	1.57	4.07	1.76
Total LPAHs	370	780	6.95	7.68	4.48	6.37	3.13	8.22	3.44
HPAH (mg/kg-OC)									
Benzo(a)anthracene	110	270	5.48	5.26	2.23	5.14	1.38	6.50	1.68
Benzo(a)pyrene	99	210	2.34	4.60	2.38	4.54	1.46	5.97	1.77
Benzo(g,h,i)perylene	31	78	0.86	2.33	1.25	2.37	0.87	2.88	0.90
Chrysene	110	460	7.74	8.46	3.06	6.44	1.91	8.61	2.29
Dibenzo(a,h)anthracene	12	33	0.35 J	1.0	0.62	0.91 J	0.44 J	1.04	0.44 J
Fluoranthene	160	1200	10.9	10.1	5.39	15.6	3.39	11.1	4.15
Indeno(1,2,3-Cd)Pyrene	34	88	0.81	2.28	1.30	2.17	0.88	2.97	0.90
Total Benzofluoranthenes	1000	1400	6.78	12.1	6.07	12.1	3.9	13.9	4.68
Pyrene	230	450	12.5	13.1	5.11	13.2	3.72	13.5	4.16
Total HPAHs	960	5300	47.7	59.2	27.4	62.3	17.9	66.4	20.9
Chlorobenzenes (mg/kg-OC)									
1,2-Dichlorobenzene	2.3	2.3	0.023 U	0.042 U	0.028 U	0.046 U	0.025 U	0.023 U	0.026 U
1,2,4-Trichlorobenzene	0.81	1.8	0.011 U	0.021 U	0.014 U	0.023 U	0.012 U	0.011 U	0.013 U
1,4-Dichlorobenzene	3.1	9	0.023 U	0.042 U	0.028 U	0.046 U	0.025 U	0.023 U	0.026 U
Hexachlorobenzene	0.38	2.3	0.011 U	0.02 U	0.014 U	0.023 U	0.012 U	0.011 U	0.013 U
Phthalates (mg/kg-OC)									
Bis(2-Ethylhexyl)Phthalate	47	78	16.4 B	52.9 *	30.7 B2	26.7 B	13.0 B	15.7 B	36.3 2
Butylbenzylphthalate	4.9	64	1.23 B	1.81 B	0.95 B	1.47 B	0.69 B	1.41 B	0.81 B
Diethylphthalate	61	110	0.45 U	0.84 U	0.57 U	0.91 U	0.50 U	0.45 U	0.53 U
Dimethylphthalate	53	53	0.45 U	0.84 U	0.57 U	0.91 U	0.50 U	0.45 U	0.53 U
Di-N-Butylphthalate	220	1700	0.83 J	1.1 J	0.68 J	0.96 J	0.83 J	0.91	0.53 U
Di-N-Octylphthalate	58	4500	0.45 U	0.8 U	0.57 U	0.91 U	0.50 U	0.45 U	0.53 U
Ionic Organics (ug/kg dw)									
2-Methylphenol	63	63	3.61 U	2.61 U	3.51 U	2.58 U	4.22 U	3.94 U	4.29 U
4-Methylphenol	670	670	7.22 U	5.22 U	7.02 U	5.17 U	8.44 U	7.87 U	8.58 U
2,4-Dimethylphenol	29	29	1.81 U	1.31 U	1.75 U	1.29 U	2.11 U	1.97 U	2.15 U
Benzyl Alcohol	57	73	3.61 U	2.61 U	3.51 U	2.58 U	4.22 U	3.94 U	4.29 U
Benzoic Acid	650	650	95.1	51.6	84.6	55.7	121	90.6	79.8
Pentachlorophenol	360	690	18.1 U	13.1 U	17.5 U	12.9 U	21.1 U	19.69 U	21.46 U
Phenol	420	1200	7.22 U	5.22 U	7.02 U	5.17 U	8.44 U	7.87 U	8.58 U
Miscellaneous (mg/kg-OC)									
Dibenzofuran	15	58	0.30 J	0.418 U	0.28 U	0.46 U	0.25 U	0.34 J	0.26 U
Hexachlorobutadiene	3.9	6.2	0.06 U	0.104 U	0.07 U	0.11 U	0.06 U	0.06 U	0.07 U
N-Nitroso-di-phenylamine	11	11	0.45 U	0.835 U	0.57 U	0.91 U	0.50 U	0.45 U	0.53 U

Notes:

Comparison to AETs is presented in Appendix D

Heavy shading: Detected value exceeds one or both criterion

Light shading: TOC <0.5% or >3%, thus OC-normalized chemicals compared to LAET and 2LAET

Bold: Detected.

6.3 U: Special font denotes that TOC requires comparison to AET and 2LAET

* Exceeds SMS SQS or SQS-AET criteria.

** Exceeds SMS CSL or CSL-AET criteria.

dw: dry weight normalized

-OC: organic carbon normalized

SMS: Sediment Management Standards (Chapter 173-204 WAC)

SQS: Sediment Quality Standard (Table I, Chapter 173-204 WAC)

CSL: Cleanup Screening Level (Table III, Chapter 173-204 WAC)

LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons

HPAHs: High Molecular Weight Polynuclear Aromatic Hydrocarbons

PCBs: Polychlorinated Biphenyls

Qualifiers:

U: <MDL

J: <RDL

B: A parameter in associated method blank was detected and sample result is within 5X of blank.

B2: A common lab contaminant in associated method blank was detected and the sample result is > 5 and ≤ 10X the blank.

L: the value is estimated or above the calibration range and could not be diluted and re-analyzed

SH: a sample handling criterion wasn't met

Table 9. (Cont'd) 2009 Sediment Chemistry Results – Comparison to SMS

	SMS		Perimeter Area							
	SQS	CSL	DUD_1C	DUD_2C	DUD_8C AVG	DUD_9C	DUD_10C	DUD_11C	DUD_12C	DUD_13C
Conventionals (%)										
Total Solids			42.1	43.0	61.4	62.3	63.9	62.3	63.9	46.7
Total Organic Carbon			2.22	2.08	2.25	1.10	1.00	1.11	1.18	1.90
Metals (mg/kg dw)										
Arsenic	57	93	13.8 J	12.3 J	15.5	7.38 J	8.920 J	7.38 J	9.08 J	11.35 J
Cadmium	5.1	6.7	0.57 J	0.47 J	3.47	0.63 J	0.36 J	0.32 J	0.50 J	0.41 J
Chromium	260	270	33.7	30.9	81.0	27.0	24.100	26.0	29.3	29.8
Copper	390	390	77.0	72.1	92.2	46.1	53.8	54.1	66.2	62.5
Lead	450	530	34.0	32.1	89.7	18.3	26.6	19.6	58.1	27.4
Mercury	0.41	0.59	0.18	0.17	0.61 **	0.12	0.13	0.11	0.16	0.19
Silver	6.1	6.1	0.451 U	0.465 U	3.74	0.321 U	0.313 U	0.305 U	0.36 J	0.428 U
Zinc	410	960	142	125	181	66.3	82.5	85.7	112	102
PCBs (mg/kg-OC)										
Total PCBs	12	65	4.27	4.47	131 **	15.1 *	14.2 *	6.05	20.3 *	4.8
LPAH (mg/kg-OC)										
2-Methylnaphthalene	38	64	0.39 J	1.74 L	0.94	0.29 U	0.31 U	0.31 U	0.26 U	0.35 J
Acenaphthylene	66	66	0.32 J	0.56 L	0.47	0.29 U	0.70	0.70 J	0.29 J	0.23 U
Acenaphthene	16	57	0.40 J	5.23 L	0.46	0.31 J	2.83	2.83 J	0.57	0.23 U
Anthracene	220	1200	2.15	4.75 L	2.37	1.36	7.34	7.34	3.01	1.50
Fluorene	23	79	0.70	3.61 L	0.77	0.63	3.06	3.06	0.84	0.49
Naphthalene	99	170	0.34 J	0.82 L	0.55	0.29 U	0.34 J	0.34 J	0.26 U	0.23 U
Phenanthrene	100	480	5.48	24.1 L	4.23	3.80	22.2	22.2	6.21	2.40
Total LPAHs	370	780	9.76	40.9 L	9.77	6.78	36.9	36.9	11.30	5.19
HPAH (mg/kg-OC)										
Benzo(a)anthracene	110	270	8.66	15.7 L	4.40	3.94	23.1	23.1	6.69	4.00
Benzo(a)pyrene	99	210	6.70	7.47 L	3.06	2.89	7.23	7.23	3.42	1.70
Benzo(g,h,i)perylene	31	78	2.95	2.17 L	1.41	1.24	2.28	2.28	1.34	0.52
Chrysene	110	460	11.0	15.9 L	5.27	4.83	21.6	21.6	10.1	5.78
Dibenzo(a,h)anthracene	12	33	1.54	1.11 L	0.62	0.61	0.97	0.97	0.62	0.27 J
Fluoranthene	160	1200	19.3	49.4 L	11.5	8.56	53.9	53.9	14.3	7.82
Indeno(1,2,3-Cd)Pyrene	34	88	2.83	2.21 L	1.14	1.12	2.34	2.34	1.28	0.55
Total Benzofluoranthenes	1000	1400	19.2	22.3 L	6.44	7.29	19.3	12.73	9.55	5.07
Pyrene	230	450	17.4	42.9 L	28.4	10.8	56.4	56.4	19.9	8.5
Total HPAHs	960	5300	89.5	159 L	62.3	41.3	187.5	187.5	67.2	34.2
Chlorobenzenes (mg/kg-OC)										
1,2-Dichlorobenzene	2.3	2.3	0.02 U	0.02 U	0.15	0.03 U	0.031 U	0.029 U	0.026 U	0.023 U
1,2,4-Trichlorobenzene	0.81	1.8	0.01 U	0.01 U	0.007 U	0.01 U	0.016 U	0.015 U	0.013 U	0.011 U
1,4-Dichlorobenzene	3.1	9	0.02 U	0.07	0.249	0.19	0.031 U	0.138	0.188	0.023 U
Hexachlorobenzene	0.38	2.3	0.01 U	0.01 U	0.007 U	0.01 U	0.016 U	0.015 U	0.013 U	0.011 U
Phthalates (mg/kg-OC)										
Bis(2-Ethylhexyl)Phthalate	47	78	26.6 B2	23.2 B2	42.1	42.1 B2	30.5 B2	104 **	39.3 B2	15.5 B
Butylbenzylphthalate	4.9	64	3.59 B2	2.16 B	0.072 U	1.14 B	2.31 B	11.2 *	1.87 B	1.87 B
Diethylphthalate	61	110	0.43 U	0.45 U	0.290 U	0.58 U	0.63 U	0.58 U	0.53 U	0.45 U
Dimethylphthalate	53	53	0.43 U	0.45 U	0.29 U	0.58 U	0.63 U	0.58 U	0.53 U	0.45 U
Di-N-Butylphthalate	220	1700	1.25	0.81 J,L	1.4	0.92 J	1.08 J	0.96 J	0.99 J	0.63 J
Di-N-Octylphthalate	58	4500	0.43 U	0.45 U	0.29 U	0.58 U	0.63 U	0.58 U	0.53 U	0.45 U
Ionic Organics (ug/kg dw)										
2-Methylphenol	63	63	4.75 U	4.65 U	3.26 U	3.21 U	3.13 U	3.21 U	3.13 U	4.28 U
4-Methylphenol	670	670	9.50 U	9.30 U	6.5 U	6.42 U	6.26 U	6.74 J	6.26 U	8.57 U
2,4-Dimethylphenol	29	29	2.38 U	2.33 U	1.63 U	1.61 U	1.56 U	1.61 U	1.56 U	2.14 U
Benzyl Alcohol	57	73	4.75 U	4.65 U	3.26 U	3.21 U	3.13 U	3.21 U	3.13 U	4.28 U
Benzoic Acid	650	650	425	256 L	171	104	117	142	78.9	87.4
Pentachlorophenol	360	690	23.8 U	23.3 U	16.3 U	16.1 U	15.6 U	16.1 U	15.6 U	21.4 U
Phenol	420	1200	9.50 U	26.7 L	6.52 U	6.42 U	6.26 U	6.42 U	6.26 U	8.57 U
Miscellaneous (mg/kg-OC)										
Dibenzofuran	15	58	0.37 J	3.20 L	0.525	0.35 J	1.29	0.450 J	0.450 J	0.225 U
Hexachlorobutadiene	3.9	6.2	0.05 U	0.06 U	0.036 U	0.07 U	0.08 U	0.073 U	0.066 U	0.056 U
N-Nitroso-di-phenylamine	11	11	0.43 U	0.45 U	0.290 U	0.58 U	0.63 U	0.581 U	0.530 U	0.450 U

No Notes:

Comparison to AETs is presented in Appendix D

Heavy shading: Detected value exceeds one or both criterion

Light shading: TOC <0.5% or >3%, thus OC-normalized chemicals compared to LAET and 2LAET

Bold: Detected.

6.3 U : Special font denotes that TOC requires comparison to AET and 2LAET

* Exceeds SMS SQS or SQS-AET criteria.

** Exceeds SMS CSL or CSL-AET criteria.

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-OC: organic carbon normalized

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LPAHs: Low Molecular Weight Polynuclear Aromatic Hydrocarbons

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Qualifiers:

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B: A parameter in associated method blank was detected and sample result is within 5X of blank.

B2: A common lab contaminant in associated method blank was detected and the sample result is > 5 and ≤ 10X the blank.

L: the value is estimated or above the calibration range and could not be diluted and re-analyzed

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SUMMARY

Samples were collected in 2008 and 2009 from stations in Cap Areas A and B, the ENR Area and the Perimeter Area as planned according to the SAP (King County 2003; King County 2004). Each year, a total of eight composite samples were collected from the cap areas, seven from the ENR area, and eight from the perimeter area. No results were rejected following QA review of the data. Bathymetry and diver surveys were also conducted in 2009. A summary of the overall findings are presented below.

Based on the bathymetric survey, the majority of the site has experienced net accretion after five years in the 0.5-1.5 foot range. In some areas, net accretion was up to 3+ feet. The largest of these areas is close to 1A and the Diagonal Way CSO/SD. Within approximately 100 feet inshore of this accretional area is a series of erosional spots located in front of the Diagonal Way CSO/SD and the Duwamish CSO Outfall. The net erosion in this area was 1+ feet after five years. This pattern would follow the expected scouring from active discharges directly in front of the outfalls, and accretion nearby and downstream, from immediate deposition of large-sized particles such as sand.

In Cap Area A five chemicals had SMS exceedances in 2008 and only one chemical in 2009. Chemical exceedances occurred at stations 1A, 2A, 3A and 4A in 2008 and at 1A in 2009. The chemicals with exceedances at one or more stations included total PCBs, 1,4-dichlorobenzene, dimethyl phthalate, BBP, and BEHP. In Cap Area B, only one chemical, phenol, exceeded SMS in 2008 at one station (2B). No chemicals exceeded SMS in Cap Area B in 2009. In the ENR area, no chemicals exceeded SMS in 2008. However, BEHP exceeded the SQS at 4C in 2009. In the Perimeter area, five chemicals exceeded the SMS between years 2008 and 2009. PCBs had exceedances at stations 8C, 9C, 10C, and 12C in both years and at 13C in 2008. BEHP and BBP had SMS exceedances at 11C in both years and at 1C, 2C, and 12C in 2008. BEHP also exceeded SMS at 9C in 2008. Benzoic acid exceeded SMS at 1C and 2C in 2008 while mercury exceeded SMS at station 8C in 2009. No concentrations exceeded SMS in either 2008 or 2009 in Cap Area B. In the ENR area, no concentrations exceeded SMS in 2008. However, the average concentration of BEHP in duplicates exceeded the SQS at 4C in 2009.

Overall, the number of chemicals with SMS exceedances declined from 2008 to 2009 especially in the Cap A area. The ENR Area only had one chemical exceedance at one location. This was for BEHP, a chemical that is expected to show recontamination in outfall areas. The perimeter stations continue to show decreases in the number of chemical exceedances. The number of stations with SMS exceedances for total PCBs declined in 2009 and only one station, 8C, continues to exceed the SQS and CSL. This station also showed increases in PCB concentrations whereas other stations showed declines or similar concentrations between 2008 and 2009. Overall, other chemical concentrations appear to have decreased. For example, the concentration of 1,4-dichlorobenzene that exceeded AETs at 1A in 2008 was below criteria in 2009. In addition, benzoic acid concentrations that exceeded SMS at 1A and 2A in 2008 were below criteria in 2009. Exceedance of the SMS for mercury at 8C in the Perimeter area was the only new chemical exceedance in 2009 not previously observed. Fewer SMS exceedances for phthalates were seen in 2009. In conclusion, improvement in both total PCB and phthalate concentrations continues across the perimeter and remediation areas. As specified in the

monitoring plan, King County will discuss with Ecology and EPA the need for future monitoring work at the current 5-year juncture.

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