Duwamish/Diagonal CSO/SD Sediment Remediation Project
Closure Report

Elliott Bay/Duwamish Restoration Program Panel

Prepared for:
King County Department of Natural Resources and Parks
Elliott Bay/Duwamish Restoration Program Panel

Prepared by:
The EcoChem Team

EcoChem, Inc.
Anchor Environmental, L.L.C.

Panel Publication 39

July 2005

Duwamish/Diagonal CSO/SD Sediment Remediation Project Closure Report

Elliott Bay/Duwamish Restoration Program Panel

Prepared for:
King County Department of Natural Resources and Parks
Elliott Bay/Duwamish Restoration Program Panel

Prepared by:
The EcoChem Team

EcoChem, Inc.
Anchor Environmental, L.L.C.

Panel Publication 39

Elliot Bay/Duwamish Restoration Program
NOAA Damage Assessment and Restoration Center Northwest
7600 Sand Point Way NE
Seattle, WA 89115-0070

(206) 526-6029
FAX (206) 526-6665

July 2005

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.

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

Duwamish/Diagonal CSO/SD Sediment Remediation Project Closure Report

TABLE OF CONTENTS

Tables

Figures

Appendices

Duwamish/Diagonal CSO/SD Sediment Remediation Project Closure Report

1.0 Introduction

This Closure Report documents the work performed during the sediment remediation project at the King County Duwamish Combined Sewer Overflow (CSO) outfall and the City of Seattle Diagonal Way CSO/Storm Drain (SD) outfall (Duwamish/Diagonal CSO/SD) site on the Duwamish River in Seattle, Washington (Figure 1). This Closure Report describes the dredging, transport, disposal, and capping methods which occurred between November 2003 and March 2004.

1.1. BACKGROUND

To implement the requirements of the 1991 Consent Decree (United States District Court 1991) defining the terms of a natural resources damage agreement, the Elliott Bay/Duwamish Restoration Program (EBDRP) was established. Program oversight is provided by the EBDRP Panel, which is composed of federal, state, and tribal natural resource trustees, the Municipality of Metropolitan Seattle (which subsequently became part of King County government and is now the King County Department of Natural Resources and Parks [KCDNRP]), and the City of Seattle (City). The goals of the EBDRP include remediation of contaminated sediments associated with KCDNRP and City CSOs and SDs, restoration of habitat in Elliott Bay and the Duwamish River, and control of potential sources of contaminants from the outfalls.

In 1992, a Sediment Remediation Technical Working Group (SRTWG) was established by the EBDRP Panel to address contaminated sediment issues. The SRTWG identified 24 potential sediment remediation sites associated with KCDNRP and City CSOs and SDs. These sites were evaluated against several criteria, which included extent of contamination, degree of source control near sites, and public input, as reported in the Final Concept Document (EBDRP 1994a). Ultimately, the SRTWG selected three sites (the Duwamish Pump Station CSO and Diagonal Way CSO/SD, the Norfolk CSO, and the Seattle Waterfront) for further investigation. This Closure Report addresses the construction activities at the Duwamish Pump Station CSO and the Diagonal Way CSO/SD outfalls, which were combined into one site due to their proximity (i.e., the Duwamish/Diagonal outfalls).

In 1994, the Duwamish/Diagonal Cleanup Study Plan was prepared by KCDNRP on behalf of the EBDRP Panel. The five documents that comprise the Plan are the *Cleanup Study Workplan* (EBDRP 1994b), the *Sampling and Analysis Plan* (EBDRP 1994c), the *Phase 2 Sampling and Analysis Plan* (EBDRP 1996a), the *Health and Safety Plan* (EBDRP 1994d), and the *Public Participation Plan* (EBDRP 1994e). These plans provide the framework for the Duwamish/Diagonal sediment cleanup study that was approved by Ecology under the Washington State Model Toxic Control Act (MTCA).

The *Cleanup Study Workplan* identified nine chemicals or classes of chemicals of potential concern, based on six preliminary sediment samples collected near the outfalls in 1992 (EBDRP 1994b; Appendix B, Pre-Phase 1 Data). The chemicals of concern (COCs) exceeding Sediment Management Standards (SMS) sediment quality criteria were mercury, silver, zinc, chlorinated benzenes, phthalate acid esters, polychlorinated biphenyls (PCBs), high molecular weight polycyclic aromatic hydrocarbons (HPAHs), benzoic acid, and tributyltin.

KCDNRP implemented field collection activities, described in the *Sampling and Analysis Plan* (EBDRP 1994c), between August 1994 and September 1996. The primary goal was to determine the extent of sediment contamination around the Duwamish/Diagonal outfalls based on comparison to SMS criteria. Sediment chemistry data collected by U.S. Environmental Protection Agency (EPA) in 1998 for a National Priority List evaluation were also used to define areas exceeding SMS for four specific chemicals, PCBs, mercury, and two phthalate compounds. The results of these efforts were presented in the *Draft Duwamish/Diagonal CSO/SD Cleanup Study Report* (EBDRP 2001). The preferred remedial action was to install an engineered sediment cap to isolate contaminated sediment, but maintain existing bottom elevations for navigation and fisheries in a 5-acre area in front of the outfalls. Based on public comment, the project site was expanded from 5 acres to 7 acres so the remedial action included mechanical dredging of approximately 70,000 cubic yards (cy) of contaminated sediment. All dredged material was to be placed on barges and the contaminated sediments were to be transported to either a nearshore confined disposal (NCD) site in Tacoma, Washington, or to an offloading facility in the East Waterway for transport and disposal at a permitted Subtitle D landfill. Capping the site with clean material to produce final bottom elevations that were approximately equal to pre-dredge bottom elevations required different layers of capping material for isolation and armoring to prevent erosion from tug boats using an adjacent mooring pier.

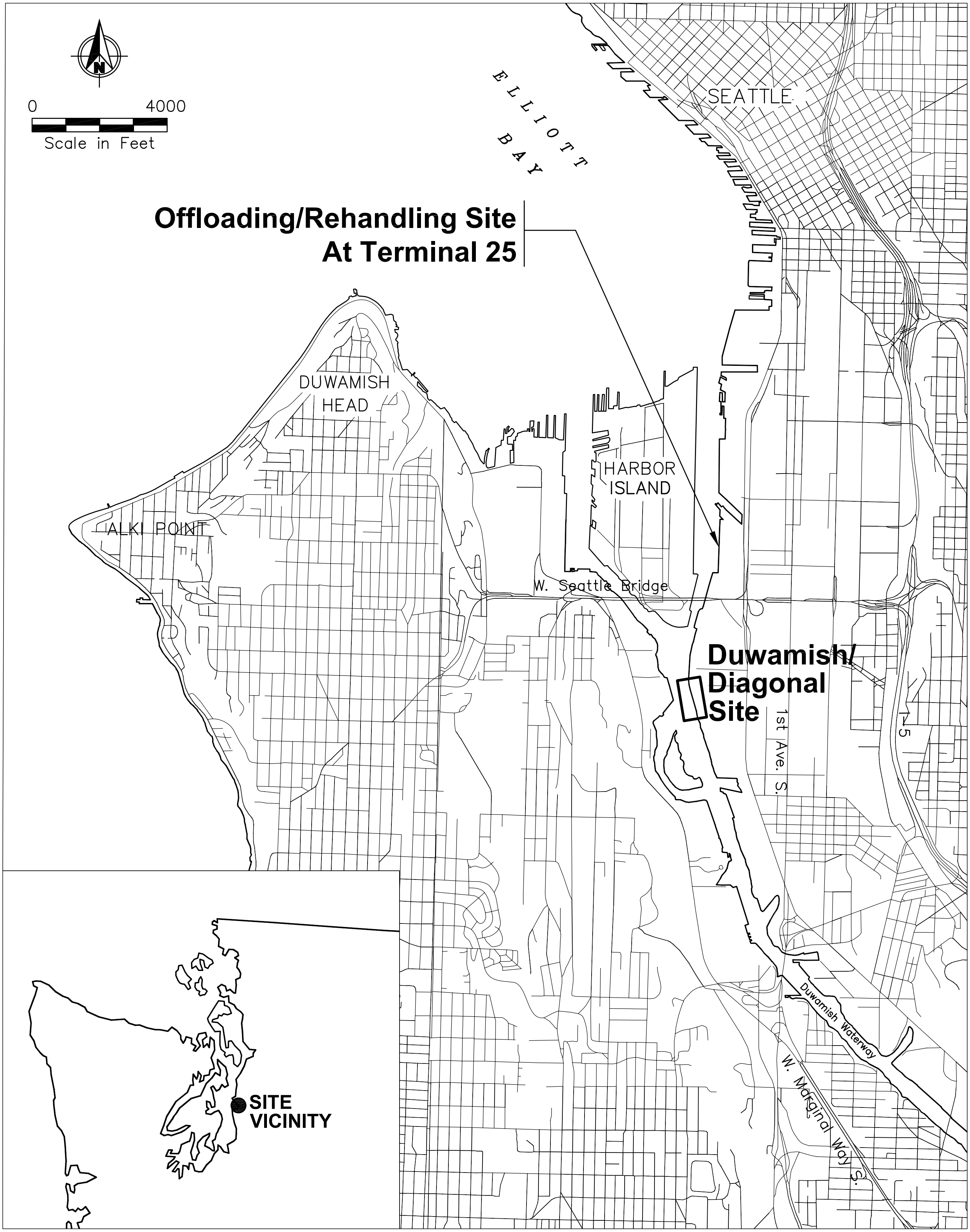
A public meeting was held by EPA in Tacoma, Washington, on August 19, 2003, regarding the use of the Blair Slip 1 NCD site for disposal of the Duwamish/Diagonal sediments. Parties testified both for and against the use of the NCD disposal site. In the end, King County withdrew its plan to dispose of the Duwamish/Diagonal sediments at Blair Slip 1 due to time constraints and opted for upland disposal to ensure that construction could move forward during the 2003-2004 dredging window, as approved in the project permits.

To approve the expanded 7-acre cleanup project, Washington Department of Ecology (Ecology) and EPA required more information than was contained in the *Draft Cleanup Study Report* (EBDRP 2001). To help expedite the approval process, King County provided the following three documents, which were to be included in a Finalized Cleanup Study Report:

1) Expanded Area Document For Duwamish/Diagonal Cleanup Project (33 pages)
2) Source Control Summary Document (70 pages)
3) Responsiveness Summary Document (55 pages)

Two monitoring plans (*Water Quality Monitoring Sampling and Analysis Plan and Sediment Monitoring Sampling and Analysis Plan*) were also required for the approval process, which King County submitted in October 2003 and are included in Appendices F and G.

This Closure Report discusses the construction activities performed to implement the cleanup.



Not to Scale

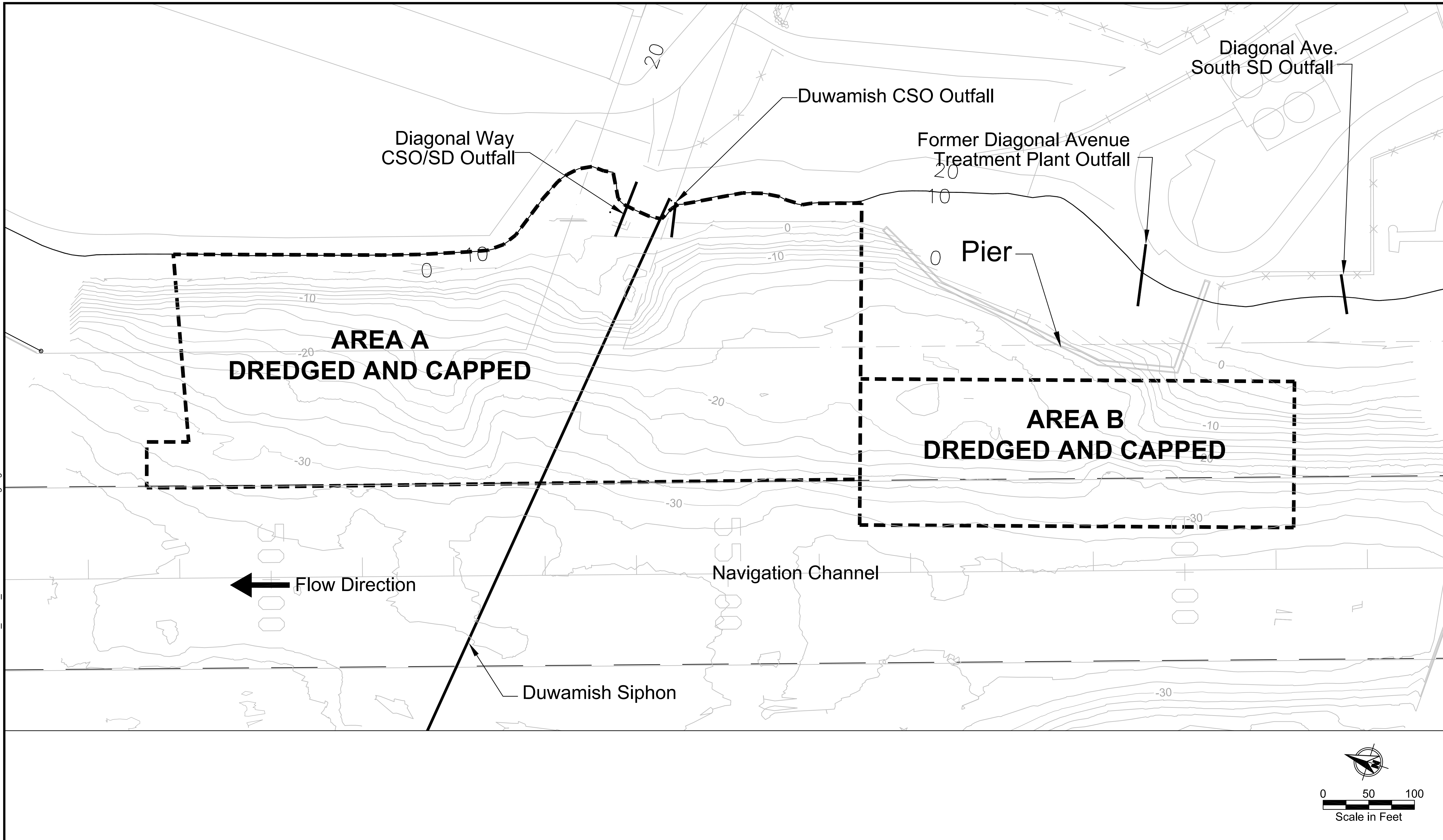
Jul 13, 2005 8:52am cdavidson K:\Jobs\00008601-Duwamish\CLSR_RPRT_2005\00008601-01CR.dwg Fig1

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project Duwamish/Diagonal Vicinity Map	Figure 1

1.2. OBJECTIVES

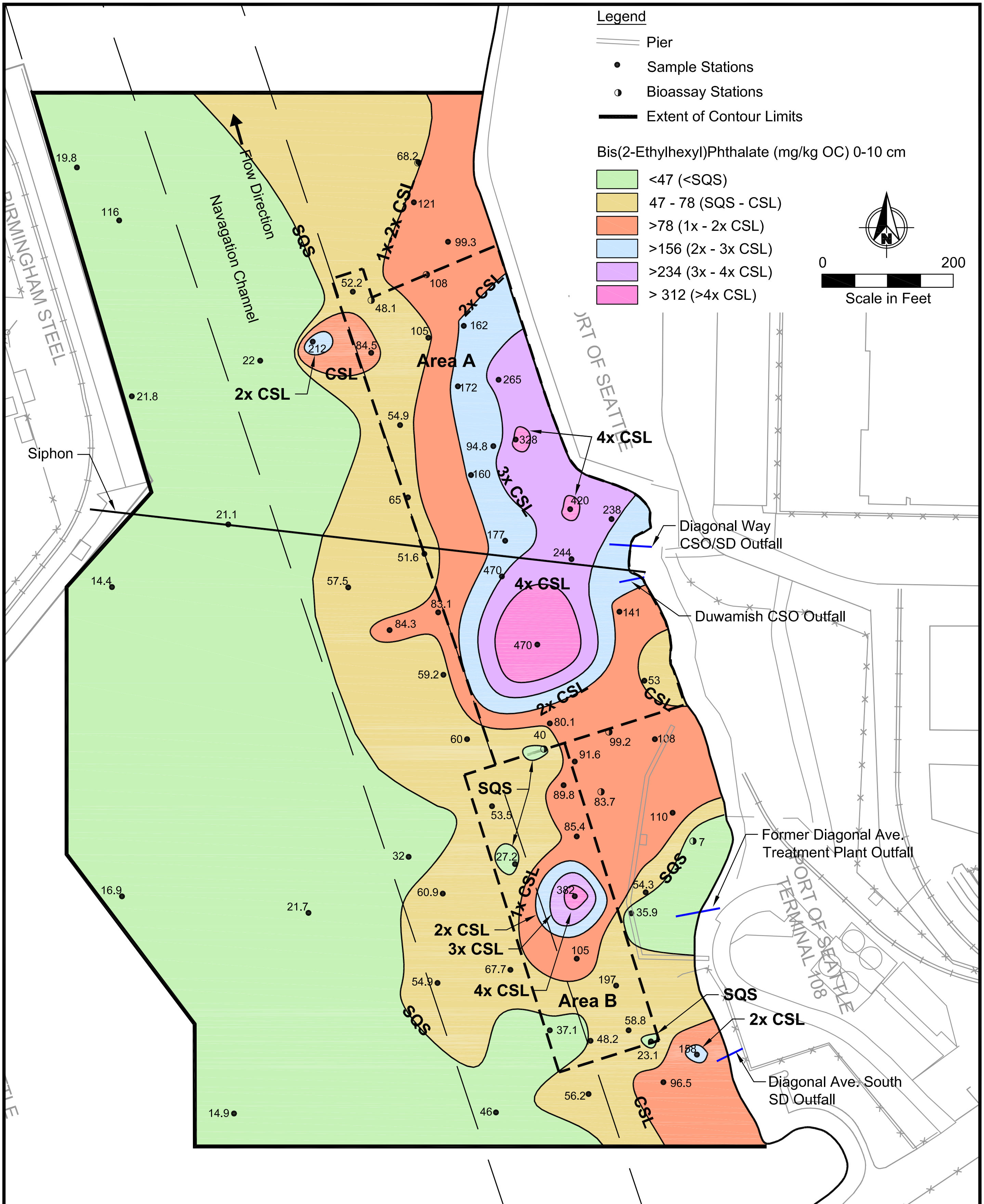
The objective of the project was to remediate contaminated sediment in a 5-acre rectangle (Area A) and a 2-acre rectangle (Area B), as shown in Figure 2. The extent of contaminated sediment removal for the two primary COCs, bis(2-ethylhexyl)phthalate (BEHP) and PCBs, is shown in Figures 3 and 4, respectively. Area A was the original proposed cleanup area designed to address chemicals associated with discharges from the Duwamish/Diagonal CSO/SD and remediates about 5 acres of the highest BEHP values in surface sediments. The upstream and downstream boundaries of Area A were set based on bioassay testing results, and the offshore boundary was set at the edge of the navigation channel. The 2-acre Area B addresses a historic chemical "hot spot" associated with discharges from a historic sewage treatment plant. High PCB values in these sediments represent a significant risk of recontamination to cleanup Area A if sediments in Area B were dredged at a later time. The offshore boundary of Area B extends 50 feet into the navigation channel in order to remove all of the chemical "hot spot" where PCB values exceed the Cleanup Screening Level (CSL). Areas A and B do not include all sediments above the Sediment Quality Standards (SQS) for PCBs, but all sediments that are near the Duwamish/Diagonal CSO/SD site and exceed the SQS for PCBs will be evaluated as part of the Lower Duwamish Superfund Study.

The cleanup action for Areas A and B involved first removing sufficient contaminated sediment from both cleanup areas to make room for an effective layer of cap material. Then the remaining contaminated sediments within each cleanup area were covered with a minimum of 3 feet of capping material to isolate the remaining chemicals from the environment and return the site to approximately the bottom elevations that existed prior to dredging.



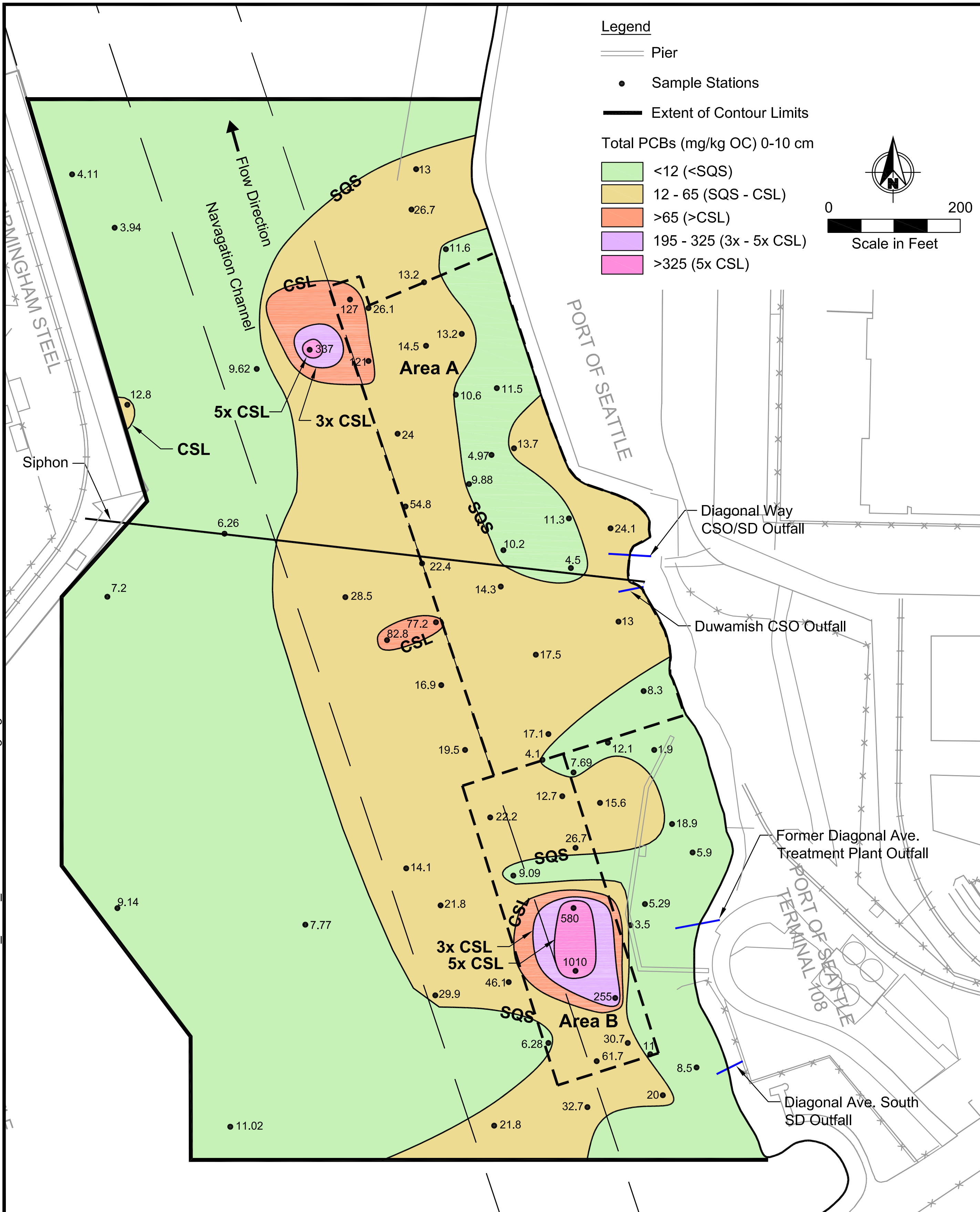
K:\Jobs\00008601-Duwamish\CLSR_RPRT_2005\00008601-05CR.dwg Fig 2
Jul 18, 2005 11:15am cdavidson

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project	Figure 2
	Cleanup Areas A and B Dredged and Capped	



Jul 28, 2005 10:23am dholmer K:\Jobs\000086-Duwamish\CLSR_RPRT_2005\00008601-76CR.dwg Fig 3

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project	Figure 3
	Bis(2-ethylhexyl)phthalate Distribution in Surface Sediment (0-10 cm)	



K:\Jobs\000086-Duwamish\CLSR_RPRT_2005\00008601-77CR.dwg Fig 4

Jul 28, 2005 10:25am dholmer

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project Total PCBs Distribution in Surface Sediment (0-10 cm)	Figure 4

2.0 Construction Activities

2.1. TIMELINE

The contractor began mobilizing their equipment to the site on November 13, 2003, and started dredging on November 14, 2003, at about 2:00 a.m. Dredging was conducted from November 14, 2003, to January 20, 2004. The contractor stopped dredging from December 20, 2003, through January 7, 2004, so they could perform dredging work at Blair Waterway in Tacoma, Washington, for a different client. Capping was conducted from January 23 to February 29, 2004 and on March 11, 2004. The contractor demobilized from the site on March 11, 2004.

Dredging was performed first in Area B due to the higher concentrations of PCBs in this area, and was generally complete on December 3, 2003. Confirmational surveys revealed some high spots remaining in Area B, which were dredged on December 13, 16, and 18, 2003, and January 11 and 20, 2004. Dredging in Area A commenced on December 3, 2003, and was completed on January 20, 2004, including any remaining high spots. Capping started in Area B on January 23, 2004 with placement of base capping sands, which were subsequently also placed in Area A. Placement of all armoring materials (including riprap, quarry spalls, and sandy-gravel [habitat mix]) was completed by February 29, 2004, and one adjustment occurred in March 2004. Confirmational surveys were conducted on March 3. The surveys showed that the surface elevations were too high in the 50-foot-wide part of Area B that extends into the navigation channel. On March 11, the contractor lowered the surface elevation in the 50-foot-wide part of Area B to be within the allowable 30-foot navigation channel depth. A final confirmation survey was conducted for King County on March 11, 2004.

2.2. CONTRACTOR SELECTION

The Request for Bids to construct the Duwamish/Diagonal CSO/SD Sediment Remediation Project was advertised in the Seattle Daily Journal of Commerce, Seattle Times, and the Chinese Post. A pre-bid conference was held on August 5, 2003, in the eighth floor conference room of the Exchange Building at 821 Second Avenue in Seattle. Sealed bids were required to be submitted to King County at the eighth floor Contracts Counter of the Exchange Building by 2:30 p.m. on August 12, 2003.

Three bids were received and were opened on August 21, 2003. The lowest responsive bid was submitted by Miller Contracting Inc. (Miller) of Bellingham, Washington, for $2,972,750 for upland disposal and $3,152,750 for disposal at Blair Slip 1. The engineer’s estimate for this project was $2,756,612.75 and $3,006,163.75, respectively. The contractor also included J.E. McAmis Industries of Chico, California, as a subcontractor responsible for the dredging portion of the project, to conform with maritime regulations that require dredging vessels to be from the United States. Miller was selected as the prime contractor and Notice to Proceed was issued on October 6, 2003.

A separate contract was advertised on August 1, 2003, for the disposal portion of the project. Sealed bids were required to be submitted to King County's Procurement and Contract Services Section Mailstop EXC-F1-0871 by 2:00 p.m. on August 12, 2003. Rabanco Regional Disposal Company (Rabanco) of Seattle, Washington, had the only responsive bid. Rabanco had a separate agreement with Wilder Construction Company of Everett, Washington, to operate an offloading facility at the Port of Seattle's Terminal 25. Sediment delivered to that facility would be offloaded from the barge, placed in lined railroad cars, and transported to Rabanco's Roosevelt Landfill in Klickitat County, Washington. The contract was awarded to Rabanco on September 10, 2003, as the alternate disposal option. Notice to proceed was issued on November 10, 2003, after the County dropped Blair Slip 1 as the preferred disposal option.

2.3. GENERAL CONSTRUCTION PROCEDURES

The contractor was required to dredge the southern portion of the site (Area B) first due to higher concentrations of PCBs located in this part of the site. Upon completion of the dredging in Area B, the contractor could dredge Area A. This allowed for residuals that may have been released during the Area B dredging and which settled downstream in Area A to be removed during that dredging operation. When all dredging was complete the contractor was allowed to begin capping operations. The cap consisted of several different layers. A base cap layer primarily composed of sand was placed first to contain all remaining sediment contamination. This was followed by an erosion control layer of gravel, quarry spall, or riprap, depending on the velocities anticipated from propeller wash, current, and waves at different locations. Finally, a layer of "habitat mix" (a rounded sand and gravel blend) was placed on exposed quarry spall or riprap surfaces. The placement of the base cap in Area B was required prior to placing base cap in Area A; however, the contractor was allowed to place various armor layers prior to the placement of all the base caps.

King County provided construction management and water quality monitoring services.

2.4. DREDGING OPERATIONS

2.4.1 Equipment

The contractor mobilized a derrick (*Crystal Gale*), tugs *(MV Norton Bay* and *MV Loren M),* split hull barges *(Sand Island and Swan Island),* and a hydrographic survey vessel to the site. The *Crystal Gale* is 142 feet long by 58 feet wide with a 12-foot draft. It is equipped with an American 12-210 crawler crane with a 10-cy clamshell bucket. The derrick is equipped with a differential global positioning system (DGPS) with an antenna on the tip of the boom over the bucket. WinOps® software was used to allow the operator to know where the horizontal position of the bucket was relative to the dredge plan at any given time. The vertical position of the dredge bucket was determined by 1-

foot markings on the cable and an electronic tide gauge that updated every 5 minutes. Two upstream and two downstream anchors were placed outside the dredge area, and winches on the corners of the dredge barge were used to change position upstream and downstream. The small tug (*MV Loren M)* periodically moved anchors inshore and offshore so the dredge barge could move inshore or offshore. Occasionally, the dredge had to be moved inshore to allow river traffic to pass.

Dredged sediment was placed in the two split hull barges (1,700 cy capacity each) and taken to the offloading facility for offloading, transport, and disposal. Water overflow pipes on the split hull barges were covered with three layers of filter fabric, which allowed some dewatering at the dredge site and no overflow at the offloading site. Some excess water was pumped from barges to holding tanks either on the barge or at the offloading facility.

Upland support equipment and facilities at the dredge site included a construction trailer and sanitary facilities. The contractor did not store any equipment on site. Personnel transferred on and off the derrick and tugs either at an offsite location, by boarding from the shore, or at the "E"-shaped pier located inshore of Area B. The King County inspector was set up in the construction trailer and continuously monitored dredging from the trailer or from the "E"-shaped pier.

King County personnel monitored water quality during dredging activities and collected confirmational sediment samples following completion of the dredging (see Section 3.0). Turbidity exceedances were observed periodically during the dredging operations and are discussed further in Section 3.1.1. Several actions were taken in an attempt to reduce turbidity, including slowing the rate of dredging, slowing the rate of movement through the water, not overfilling the bucket, and using a different bucket. An 18-cy rock bucket without digging teeth was used on November 25, 2003 to try to reduce turbidity exceedances. However, this 18-cy bucket resulted in higher than acceptable turbidity values because the top section of the bucket was open and its mouth did not seal well when closed; thus allowing sediment to escape. Consequently, the 10-cy digging bucket was used for the duration of the dredging.

While dredging near the outfalls on December 9, 2003, at approximately 10:00 a.m., an oil sheen was observed on the water surface by the contractor. It is believed to have been a pocket of oil that had been deposited from a past discharge and was disturbed by the dredging. Upon observation, the contractor halted dredging activities and deployed an oil absorbent boom. The contractor notified King County, the U.S. Coast Guard (Reference 707-574) and Ecology (Reference 03-3096). The U.S. Coast Guard stated that it was acceptable to resume dredging in the area with caution. King County instructed the contractor to move to another portion of the site and continue dredging there and to only partially fill the barge so that water levels in the barge would stay below the overflow drain pipes, and thus contain all oily water within the barge. When the contractor returned to this area no further sheens were observed.

The 10 cy digging bucket was effective for sediment conditions and debris present at the site, and required enforcement of BMPs to minimize turbidity and loss of material. The limitations identified for the other dredging equipment considered during the Alternatives Evaluation process are included in the *Cleanup Study Report* (EBDRP 2001) and are still valid. An environmental bucket was considered and rejected due to its inability to dig in firm sediments. Previous studies by the Port of Seattle showed that environmental buckets were ineffective in sediment hardness of greater than three blow counts. Most sediment along side slopes exceeded this number. Hydraulic dredging equipment was rejected as infeasible for the following reasons:

- There was no nearby location of sufficient size that was suitable to deal with the large amounts of water and sediment mix that would be generated.
- Large debris was expected to be encountered which could clog the dredge, resulting in high turbidity releases when the dredge was shut down to clear the pipeline. At least 39 logs were removed plus other debris, including barge tow cables.
- There would have been a very high cost of time and money for mobilization and set up of hydraulic dredging for a relatively small quantity of sediments to be removed, and hydraulic dredging could cause the project to take more than one winter dredging season to finish both dredging and capping.

2.4.2 Sequencing

The dredge cut plan is shown in Figure 5. At about 2 a.m. on November 14, 2003, the contractor began dredging in Area B at the inshore part of the dredge area. Because most of the dredge area was on the side slope created when the navigation channel was dredged, the contractor worked from the shallower inshore area to the deeper offshore area to maintain slope stability. After completing the 50-foot-wide strip of Area B located within the navigation channel, dredging in Area B was substantially complete. Dredging began in Area A on December 3, 2003, and the same general procedures of working from the top of the slope to the bottom were used in Area A. The confirmatory surveys by King County's surveyor showed some high spots in Area B, so the contractor moved equipment back to the location and made the required changes. The contractor's surveys identified high spots in Area A, so equipment was moved to those locations and the required changes were performed. All dredging in Areas A and B was completed on January 20, 2004.

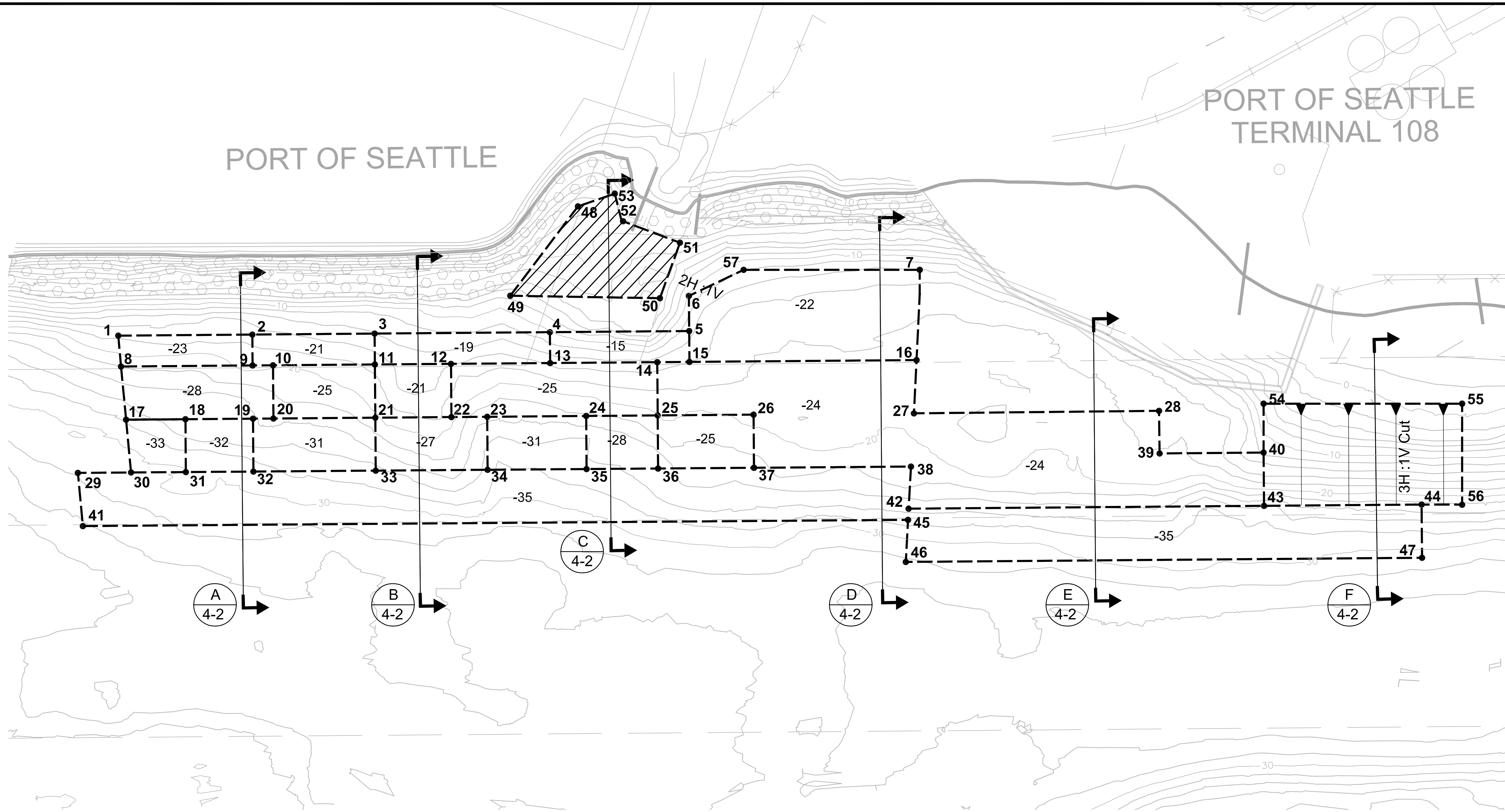
The contractor worked the first three days (November 14, 15, and 17) dredging two shifts per day. The shifts ran from 2 a.m. to 12 a.m. (first shift) and 12 a.m. to 10 p.m. (second shift) and produced about two barges of material per day. However, on November 18, the offloading facility stopped accepting barges for 2 days due to difficulty handling the sediment with high water content because it would not stack, which reduced their storage capacity. Rabanco resumed accepting barges on November 25, but limited the daily average to their contracted amount of 2,000 cy/day, which is about 1.3 barges per day. The dredging contractor switched to working one shift per day and delivered barges according to Rabanco's schedule. When dredging stopped from December 20 to January

7, Rabanco was able to completely empty the site, which provided maximum storage capacity for both the King County project and the Port of Seattle's East Waterway project. Dredging resumed on January 8, and on January 9 King County approved Miller's request to work two compressed shifts. The first shift ran from 5 a.m. to 2 p.m. and the second shift ran from 2 p.m. to 9 p.m. Double compressed shifts were worked 10 of the 12 days it took to complete dredging by January 20, 2004.

Dredging occurred over 49 days and removed approximately 68,250 cy of material (including debris and over dredge). The average production rate of all material dredged and delivered for offloading was approximately 1,393 cy per day.

DREDGE COORDINATES

POINT	EASTING	NORTHING
1	1266907	209510
2	1266947	209390
3	1266984	209281
4	1267036	209125
5	1267077	209001
6	1267108	209012
7	1267198	208813
8	1266881	209498
9	1266920	209381
10	1266926	209363
11	1266956	209272
12	1266979	209204
13	1267008	209116
14	1267040	209021
15	1267050	208992
16	1267117	208790
17	1266835	209478
18	1266852	209425
19	1266872	209365
20	1266878	209347
21	1266909	209256
22	1266931	209189
23	1266942	209157
24	1266971	209069
25	1266993	209005
26	1267021	208920
27	1267069	208777
28	1267142	208559
29	1266773	209506
30	1266789	209458
31	1266805	209410
32	1266825	209350
33	1266861	209241
34	1266895	209141
35	1266924	209053
36	1266945	208989
37	1266974	208904
38	1267020	208764
39	1267104	208546
40	1267135	208453
41	1266727	209486
42	1266982	208754
43	1267088	208438
44	1267134	208297
45	1266972	208751
46	1266934	208741
47	1267087	208281
48	1267156	209137
49	1267056	209171
50	1267097	209037
51	1267153	209035
52	1267156	209092
53	1267178	209108
54	1267179	208468
55	1267236	208290
56	1267146	208261
57	1267148	208971



Legend:

- Remove Minimum of 4 Feet below Grade in this Area
- Approximate Extent of Visible Rock Bulkhead
- Cross Section Location
- Existing Bathymetry Elevation Contours in Feet (2-Foot Interval)
- Dredge Coordinate
- Dredge Boundary
- Minimum Required Dredge Elevation (MLLW)

Notes:

1. Topography/Basemap provided by the Port of Seattle (1994). This data is to be used for visual reference only.
2. Bathymetric contours created by Anchor Environmental from BWE 2002 survey referenced to MLLW (NOS).
3. Horizontal Datum - Washington State Plane North Zone NAD 83
4. A side slope shall be cut on the inshore portion of the site that removes as much sediment as possible without undercutting or destablizing the rock bulkhead.

0 50 100
Scale in Feet

EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Dredge Cut Plan

Figure 5

K:\Jobs\00008601-Duwamish\CLSR_RPRT_2005\00008601-02CR.dwg Fig 5

Jul 18, 2005 11:24am cdavidson

2.5. DISPOSAL ACTIVITIES

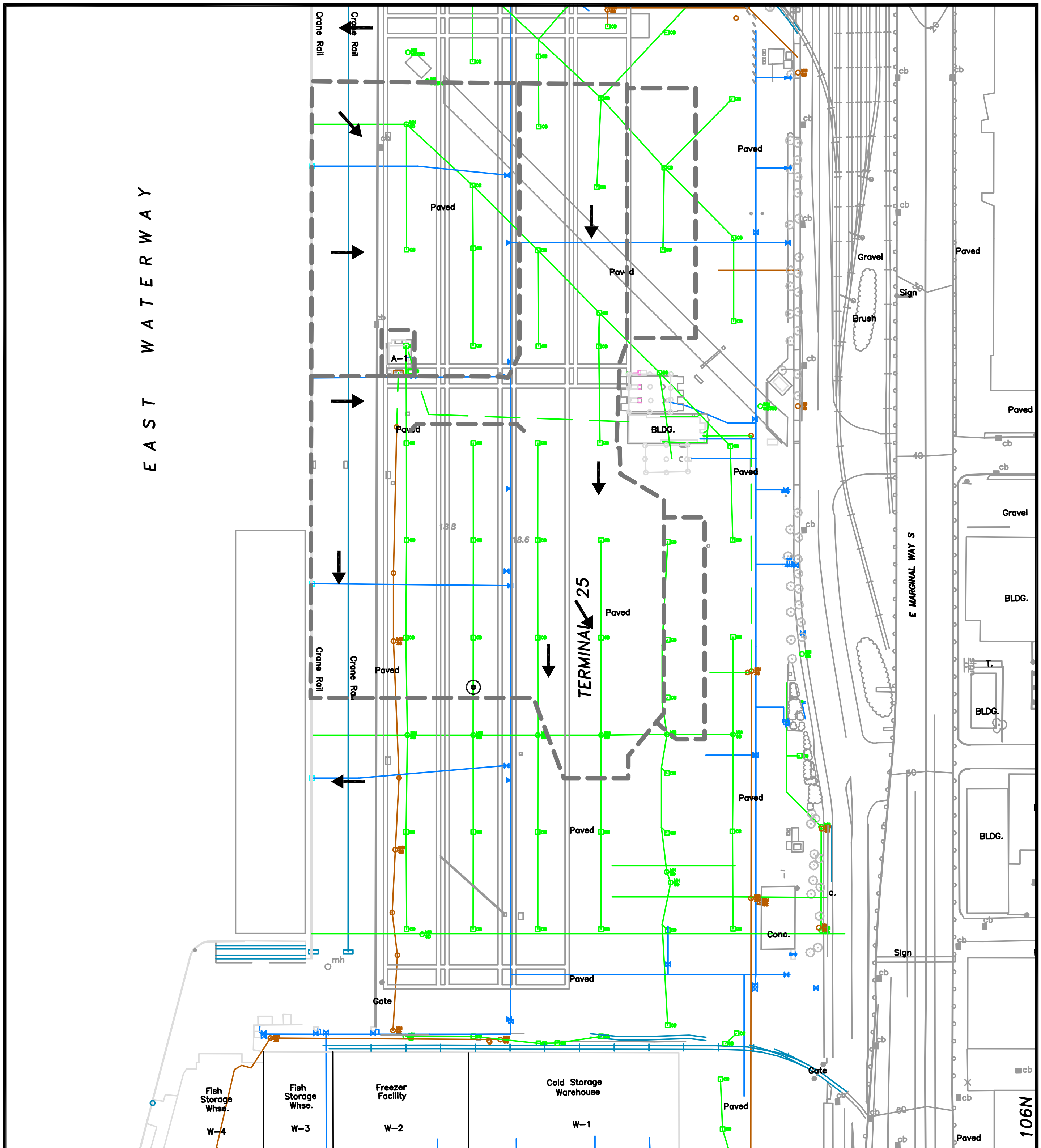
The offloading facility was the responsibility of Rabanco, the offloading contractor. By contract, the offloading contractor took ownership of the dredged sediment upon picking the sediment up with their off-loading bucket. Figure 6 shows the layout of the offloading facility. Once a barge was delivered to the offloading site, the offloading contractor was allowed 24 hours to offload the barge and return it to service for the dredging contractor. Dredged sediments were removed from each barge with a 5-cy clamshell bucket on a Bucyrus-Erie 88-B, Series 4 heavy duty crawler crane. Offloaded sediment was dropped onto the ground and then was transferred into staging areas or directly into lined 20-foot open-top shipping containers on railcars using front-end loaders. A steel-plate “batter board” that angles up from the pier deck and extends out past the barge’s sediment containment system was provided. When material dripped from the clamshell bucket, it hit the board and ran down into the sediment offloading area or fell directly back into the barge. The batter board assembly was relocated whenever the crane was repositioned, in order to be beneath the arc of the bucket. During the last week of dredging, the facility started to offload and dispose of dredged sediments from the Port of Seattle’s East Waterway dredging project.

Excess water was pumped out of each barge and into storage tanks for filtration treatment testing and proper disposal. Excess water was also collected from the stockpiled sediments along with rain water and stored in three 100,000 gallon tanks on site to allow filtration treatment, chemical testing, and proper disposal. Sampling is discussed further in Section 3.2.2. Ultimately, the water was discharged to the sanitary sewer at a manhole on the south side of the offloading site in compliance with the King Country Industrial Waste Authorization for discharge to the sewer. Approximately 2 million gallons of water was discharged from the tanks from the Duwamish/Diagonal project and from the one week overlap with the East Waterway project.

Railcars loaded with empty 20-foot open-top shipping containers were staged along the two loading tracks (Figure 6) for access by the front-end loaders. Two types of shipping containers were used. The first containers were 20-foot open-top ISO shipping containers, with dimensions of 20-feet long by 8-feet wide by 8-feet-6-inches high, and with side-hinged rear doors with manual latches. Prior to placement of the sediments in the containers, a 6 mil plastic liner was placed in the open top containers to prevent leakage and spillage out the top. Additional procedures to prevent spillage out the top were to limit the amount of sediment to about 34 tons, which resulted in adequate free board. The second type of container was a commercial 20-foot sealed-top container. A gasketed top was raised out of the way during loading and then secured on top after loading. Some loading was performed with a backhoe-type loader equipped with an articulating bucket.

Burlington Northern Santa Fe Railway Company (BNSF) then transported the loaded containers to Roosevelt, Washington, in Klickitat County for disposal at Roosevelt

Regional Landfill, a Resource Conversation and Recovery Act of 1976 (RCRA) Subtitle D landfill. Filled debris containers were shipped in a similar manner. No dewatering of dredged sediment was required because this landfill is conducting a moisture enhancement demonstration project approved by Ecology. A total of 91,555 tons of sediment were disposed of at Roosevelt Regional Landfill.



Sanitary Sewer Line
Stormwater
Water Line
Catch Basins
Proposed Rail Line
Curb (area within is paved and sealed)
Sampling Point
Stormwater Flow Direction

0 200
Scale in Feet

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project Offloading/Rehandling Facility Layout at Terminal 25	Figure 6

Jul 07, 2005 1:13pm cdavidson K:\Jobs\00008601-Duwamish\CLSR_RPRT_2005\00008601-78CR.dwg Fig 6

2.6. DECONTAMINATION

Upon completion of all the dredging operations, the clamshell bucket was rinsed off over a haul barge to remove sediments from the bucket. The haul barges were decontaminated by rinsing them with river water sprayed from fire hoses. This rinse water was collected inside of the barges and then pumped into the water tanks at the offloading facility for proper disposal.

2.7. CAPPING OPERATIONS

After all the dredging was complete and elevations were confirmed by the post-dredge survey, capping operations were allowed to begin. The capping plan showing armoring material is shown in Figure 7. Capping material was obtained from Canadian quarries and transported to the site by flat deck haul barges. Base cap and habitat mix materials were obtained from Lehigh Northwest – Producer's Pit in Victoria, British Columbia (BC) and the quarry spall and riprap were obtained from Pitt River Quarries in Coquitlam, BC.

The capping material was placed using a Hitachi 1800 excavator with a clamshell bucket. The contractor primarily worked two shifts during capping in an effort to complete the work by the end of February 2004. Base cap material was initially placed throughout Area B and approximately half of Area A. The logistics of ordering and obtaining the required quantities of the different capping materials from the two different quarries resulted in placement of materials at different locations in the site as the materials were available. For instance, base cap was placed throughout the area that would have quarry spall and riprap placed over it. While surveys of this portion of the base cap were conducted and reviewed, the contractor continued to place base cap in other portions of the site. If locations were discovered to have too little coverage, the contractor was required to place more material and then resurvey the area in question, prior to approval of a given layer in that portion of the site. Because it was unclear how much base cap material would be required for the whole site due to dispersion within the water column, only a portion of the base cap was initially ordered. This was followed by an order of quarry spall from the other quarry. Following the approval of a portion of the base cap layer's extent and thickness, the quarry spall was allowed to be placed in that portion. During the time that the surveys for the quarry spall were being reviewed, the contractor returned to placing base cap in other portions of the site. After low spots were corrected, the contractor placed habitat mix over the quarry spall and as a foundation layer under where the riprap would be placed. This procedure of placing cap materials, surveying, and reviewing continued until the entire site was capped.

Capping material placement occurred over 28.5 days with approximately 75,232 cy of material placed. The average production rate of all material placed was approximately 2,640 cy/day. The contractor encountered equipment problems. Initially, the WinOps system for determining horizontal positioning of the clamshell bucket relative to the dredge plan behaved sporadically. Anchor cables had to be replaced during capping operations. The hydraulic cylinder operating the clamshell burned out and had to be replaced. A rock skip-type bucket was used temporarily and had to be installed, and uninstalled once the clamshell was back in operation. Equipment maintenance and material handling also hampered the production rate. On several occasions, the contractor was faced with the unavailability of capping material, oftentimes due to delays at U. S. Customs as the materials originated in BC. The production rate was also restrained by the time required to review and approve confirmatory surveys. Operational controls (cycle time) to limit the effects of resuspension also limited the production rate.

Base cap placement occurred over 18 16-hour days with approximately 53,162 cy placed. This is an average production rate, including equipment and material problems, of approximately 2,953 cy/day (185 cy/hour). Neglecting the equipment and material problems, the base cap material placement rate is estimated to be 3,157 cy/day (395 cy/hour).

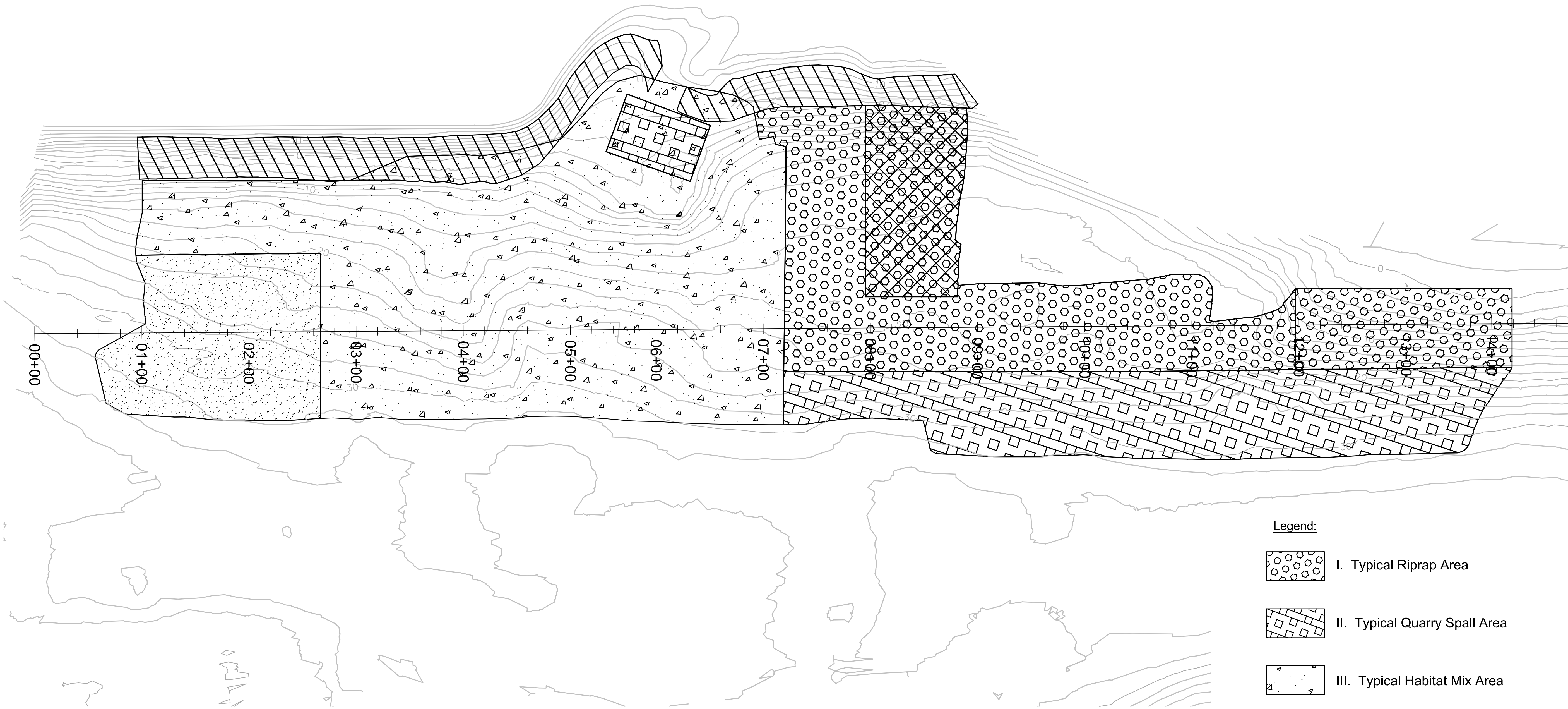
Habitat mix placement occurred over 6 16-hour days with approximately 12,043 cy placed. This is an average production rate, including equipment and material problems, of approximately 2,007 cy/day (125 cy/hour). Neglecting the equipment and material problems, the base cap material placement rate is estimated to be 2,143 cy/day (268 cy/hour).

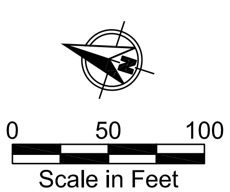
Quarry spall placement occurred over 2 16-hour days with approximately 3,686 cy placed. This is an average production rate, including equipment and material problems, of approximately 1,843 cy/day (115 cy/hour). Neglecting the equipment and material problems, the base cap material placement rate is estimated to be 2,071 cy/day (259 cy/hour).

Riprap placement occurred over 2.5 16-hour days with approximately 6,341 cy placed. This is an average production rate, including equipment and material problems, of approximately 2,536 cy/day (159 cy/hour). Neglecting the equipment and material problems, the base cap material placement rate is estimated to be 2,921 cy/day (365 cy/hour).

A construction survey taken during placement of the base cap material in Area A revealed that the original design, which mimicked the original slope of 7.5 horizontal to 1 vertical (7.5H:1V), would result in final elevations that would be significantly higher than the original grade in most locations. After consulting with the National Marine Fisheries Service (NMFS), the US Fish and Wildlife Service (USFWS), and the U.S. Army Corps of Engineers, the contractor was instructed to place less thickness of base cap material so as to approximate the original grade, which was the intent of the original design. Even with this change, a minimum thickness for base cap material of 2 to 3 feet was achieved. The original cap design projected that a minimum thickness of 2 to 3 feet of base cap material would be provided if Area A were filled with base cap material to a slope of 7.5H:1V. Because the contractor had detailed bottom surveys over small areas, they could adjust the amount of fill to approximate the original bottom elevations without putting too much or too little base cap material on it.

The March 3 confirmational surveys performed upon completion of capping activities showed that in Area B the portion in the navigation channel had some elevations shallower than the authorized channel depth of -30 feet Mean Lower Low Water (MLLW). The contractor was instructed to remove this material and performed the changes on March 11, 2004. A permit extension was issued to work from March 1 to March 15, but the contractor used only one in-water work day in March 2004.





— -10 — Existing Bathymetry Elevation Contours in Feet (2-Foot Interval)

Notes:
1. Topography/Basemap provided by the Port of Seattle (1994). This data is to be used for visual reference only.
2. Bathymetric contours created by Anchor Environmental from BWE 2002 survey referenced to MLLW (NOS).
3. Place 'Habitat Mix' over the existing riprap between elevations -5 feet MLLW and +12 feet MLLW.
4. Horizontal Datum - Washington State Plane North Zone NAD 83

Legend:
- I. Typical Riprap Area
- II. Typical Quarry Spall Area
- III. Typical Habitat Mix Area
- IV. Typical Base Cap Area
- V. Habitat Mix over Existing Structural Rock Bulkhead
- VI. Light Loose Riprap, Special Note Gradation Requirements

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project Required Grain Sizes for Cap Erosion Layer	Figure 7

3.0 Compliance Monitoring

The MTCA requires three types of compliance monitoring to be performed in order to confirm the adequacy of the remedial action (WAC 173-340-410). These include protection monitoring, performance monitoring, and confirmational monitoring. The compliance monitoring performed during the Duwamish/Diagonal Sediment Remediation project is discussed in this section. The KCDNRP produced two sampling and analysis plans in October 2003 which describe the water quality monitoring activities and the sediment monitoring activities. These two plans (KCDNRP 2003a and 2003b) are included in Appendices F and G and should be consulted for the details of the sampling design and procedures used to collect the compliance monitoring samples. Ecology approved the cleanup project in 2001 under MTCA, but when the lower Duwamish was listed as a Superfund site in September 2001, EPA began reviewing project plans and monitoring for consistency with Superfund requirements.

3.1 PROTECTION MONITORING

Protection monitoring is performed to confirm that human health and the environment are adequately protected during construction of the cleanup action as described in the project's specific safety and health plan (WAC 173-340-410(a)). No deviations from the contractor's health and safety plan were reported or observed.

Water quality monitoring of the Duwamish River was required in several permits, including the Hydraulic Project Approval permit, issued by the Washington Department of Fish and Wildlife to protect the environment. Details of the water quality monitoring were included in both EPA and Ecology comments on the Nationwide 38 permit issued by the U.S. Army Corps of Engineers. Additionally, water quality monitoring was required as part of the Biological Opinion issued jointly by NMFS and the USFWS.

3.1.1 Water Quality Monitoring During Dredging

Water quality monitoring was performed in accordance with the approved *Water Quality Monitoring Sampling and Analysis Plan* (KCDNRP 2003a). Sampling occurred twice daily when dredging operations occurred during both tidal events. One sampling event was during the flood tide and one during the ebb tide. If dredging operations only occurred during one tidal event, only one sample was collected. Three stations were monitored during each event. During the ebb tide, one station was located at the edge of the mixing zone, 300 feet downstream of the dredging operation; the second station was at the mid-point, 150 feet from the dredging operation; and the third station was the background or reference station located about 1600 feet upstream of the dredging operations so as to be outside of the influence of the operations. During the flood tide, the stations were reversed. An echo sounder (fish finder) was used to locate the center of the turbidity plume at the given sampling radius of 150 feet and 300 feet to ensure that the plume, if present, was sampled. Once the plume was located with the fish finder, a field instrument was lowered to identify the depth with the highest turbidity so that the grab sample would collect the water with the highest turbidity.

Field measurements taken at each sampling location either just prior to or just after grab samples were collected for chemical analysis. A Hydrolab MiniSonde® was used to collect field data, including surface water temperature, pH, turbidity, specific conductance, salinity, and dissolved oxygen. Water grab samples were collected using two 10 liter Niskin bottles hung on a hydro wire. The samples were collected 90 centimeters (cm) above the bottom and 60 cm below the surface at each location. The water samples were transferred from the Niskin bottles to sample bottles and stored in coolers until transferred to the laboratory for analysis. All water samples collected during the entire period of dredging were tested in the laboratory for turbidity.

As defined in the monitoring plan, the chemical testing of water samples focused on the first week of dredging and was stopped after 8 days of testing because all samples measured at the edge of the mixing zone (300 feet downstream) were well below the water quality standards (less than 1 to 2 percent of standard). The water samples selected for chemical analysis each day were the ones that were collected when the highest turbidity conditions were observed based on field turbidity measurements. These water samples were analyzed for total suspended solids (TSS), salinity, turbidity, mercury, PAHs, phthalates, and PCBs in accordance with the monitoring plan. A complete listing of all results of the field data and analytical data are provided in Appendix D, including water chemistry.

A summary of the field and laboratory turbidity data measured at the edge of the mixing zone (300 feet downstream) during dredging are listed in Table 1. These two different turbidity values did not agree for several reasons. Even though the field turbidity sensor was suspended below the Niskin bottle, the turbidity plumes are highly variable and even a small distance can result in a large variation of the data. Also, when water from the Niskin bottle was tested with the field turbidity instrument, the numeric value provided by the field instrument was different than the turbidity value determined in the lab for water in the Niskin bottle. Only the laboratory turbidity values were used for official comparison to water quality standards.

Table 1 provides a comparison to the water quality standard for the turbidity values measured at the edge of the mixing zone in nephelometric turbidity units (NTUs) to the maximum calculated turbidity standard (MCTS), which is the reference station turbidity background plus 10 NTUs. The MCTS is different for each measurement, because of the variation of the background measurement. For ease of evaluation, Table 1 contains a row of values that shows the total exceedance amount (in NTUs), if applicable. Approximately 20 percent (22 of 119) of all measurements were out of compliance and a significant number of these occurred in the first 2 weeks of operations and are primarily located at the bottom sampling location. All the turbidity data are presented in Appendix D. Samples with the greatest exceedance occurred in the first few days, on November 14 and 17, 2003 with exceedances of 22, 28.3, 18.7, and 15.7 NTUs, respectively. Also, when the trial bucket was used on November 25, 2003, the exceedance was 25.3 NTU above the MCTS value of 11.1 NTU.

Table 1
Water Sample Turbidity Results During Dredging

Date	Parameter	Flood Tide						Ebb Tide			
		Surface		Bottom		Surface 2		Surface		Bottom	
Friday, November 14, 2003	Lab/Field	6.5	15.1	9.6	3.1			11.6	38.3	32.6	29.5
	MCTS	16.4		10.9				15.6		10.6	
	Exceedance	None		None				None		22	
Monday, November 17, 2003	Lab/Field	3.7	12.1	39.1	35.6			31.3	66.7	27	72.5
	MCTS	12.5		10.8				12.6		11.3	
	Exceedance	None		28.3				18.7		15.7	
Thursday, November 20, 2003	Lab/Field	18	34.1	3.6	4.7						
	MCTS	28.3		11.5							
	Exceedance	None		None							
Friday, November 21, 2003	Lab/Field	9.7	17.5	5.2	27	9.2	15.6				
	MCTS	14.7		11.4		14.7					
	Exceedance	None		None		None					
Tuesday, November 25, 2003	Lab/Field	3.4	4	36.4	54.5	12.3	21.7	7.5	12.8	15.8	23.1
	MCTS	13.3		11.1		13.3		11.9		11.1	
	Exceedance	None		25.3		None		None		4.7	
Wednesday, November 26, 2003	Lab/Field	2.6	4.1	1	1.5	3.2	4.8				
	MCTS	12.5		10.8		12.5					
	Exceedance	None		None		None					
Tuesday, December 02, 2003	Lab/Field	12	24.4	14	12.5	12	25.6	9.2	17.3	10.4	20.5
	MCTS	21.5		11.6		21.5		18.5		12.7	
	Exceedance	None		2.4		None		None		None	
Wednesday, December 03, 2003	Lab/Field	6.6	15.6	4.5	6.1	7.8	17.1	5.5	11.7	2.4	5
	MCTS	17.2		12.9		17.2		15.1		12.4	
	Exceedance	None		None		None		None		None	
Thursday, December 04, 2003	Lab/Field	4.4	7.6	15.3	26.6						
	MCTS	14.9		11.3							
	Exceedance	None		4							
Friday, December 05, 2003	Lab/Field	4.2	7.7	9.1	14.5	16.8	26.1				
	MCTS	14.7		11.4		14.7					
	Exceedance	None		None		2.1					
Monday, December 08, 2003	Lab/Field	11.4	5.2	3.1	20.6	4.3	7.5	4.1	6.1	1.3	2.1
	MCTS	14.2		11.3		14.2		13.7		24.7	
	Exceedance	None		None		None		None		None	
Tuesday, December 09, 2003	Lab/Field							2.4	4	4.1	7.3
	MCTS							12.2		11.4	
	Exceedance							None		None	
Wednesday, December 10, 2003	Lab/Field							2.7	4	2.6	10.4
	MCTS							12.7		11.2	
	Exceedance							None		None	

Table 1
Water Sample Turbidity Results During Dredging

Date	Parameter	Flood Tide						Ebb Tide			
		Surface		Bottom		Surface 2		Surface		Bottom	
Thursday, December 11, 2003	Lab/Field	3.8	5.1	2.7	28.5	5.3	5.5	2.8	3.6	6.6	10
	MCTS	13.5		12.9		13.5		12.4		11.1	
	Exceedance	None		None		None		None		None	
Friday, December 12, 2003	Lab/Field	3.4	5.1	10	14.8	4.3	6.7				
	MCTS	14.4		11.5		14.4					
	Exceedance	None		None		None					
Saturday, December 13, 2003	Lab/Field							3.6	5.6	13.1	10.3
	MCTS							12.7		11.6	
	Exceedance							None		1.5	
Monday, December 15, 2003	Lab/Field	3.7	6.1	38	41.9	8	7.7	5.2	7.2	29.4	39
	MCTS	14		11.2		14		13.6		12	
	Exceedance	None		26.8		None		None		17.4	
Tuesday, December 16, 2003	Lab/Field	3.1	5.3	7.3	17	3.8	26.9	3.5	7.6	3.8	12.4
	MCTS	13.3		11.4		13.3		13.5		15.3	
	Exceedance	None		None		None		None		None	
Wednesday, December 17, 2003	Lab/Field	3.5	4.8	2.3	8.6	9.54	12.6	5.5	23.7	5.2	6.4
	MCTS	13.1		11.4		13.1		12.5		13.2	
	Exceedance	None		None		None		None		None	
Thursday, December 18, 2003	Lab/Field	2.3	4	10.8	18.9	8	14.4				
	MCTS	15.9		11.4		15.9					
	Exceedance	None		None		None					
Friday, December 19, 2003	Lab/Field	2	3.8	8.6	14.5	14.3	9.5				
	MCTS	15.5		11.5		15.5					
	Exceedance	None		None		None					
Thursday, January 08, 2004	Reference	5.5	10.9	1.9	2.4	5.5	10.9	6.2	8.4	1.8	6.4
	Lab/Field	6	8.6	29.7	37.6	8.66	13.3	7.6	10.1	6.3	3.4
	MCTS	15.5		11.9		15.5		16.2		11.8	
	Exceedance	None		17.8		None		None		None	
Friday, January 09, 2004	Lab/Field	3.9	7	34.9	46.8	5.3		3.7	6.5	3	7.6
	MCTS	16.9		11.3		16.9		14.2		12.3	
	Exceedance	None		23.6		None		None		None	
Saturday, January 10, 2004	Lab/Field	5.3	8.2	14	26.3	5.7		5.8	11.3	16.1	13.5
	MCTS	17.6		11.4		17.6		11.9		15.9	
	Exceedance	None		2.6		None		None		0.2	
Sunday, January 11, 2004	Lab/Field							3.9	9.6	9.4	15.1
	MCTS							13.7		11.3	
	Exceedance							None		None	
Monday, January 12, 2004	Lab/Field							3.5	8.6	24	20.2
	MCTS							12.5		12	
	Exceedance							None		12	

Table 1
Water Sample Turbidity Results During Dredging

Date	Parameter	Flood Tide						Ebb Tide			
		Surface		Bottom		Surface 2		Surface		Bottom	
Tuesday, January 13, 2004	Lab/Field							3.6	5.3	6.6	16.3
	MCTS							12.9		11.9	
	Exceedance							None		None	
Wednesday, January 14, 2004	Lab/Field	3.5	6.8	25.3	11.5	4.83	10.9	23	11.3	24.2	31.5
	MCTS	14.1		11.2		14.1		13.2		13.2	
	Exceedance	None		14.1		None		9.8		11	
Thursday, January 15, 2004	Lab/Field	12.3	27	2.5	3.1	8.9	29.5	12.8	25	2.6	4.5
	MCTS	16.1		10.8		16.1		14.9		12.5	
	Exceedance	None		None		None		None		None	
Saturday, January 17, 2004	Lab/Field							5.7	12.8	14.4	30.1
	MCTS							15.6		10.8	
	Exceedance							None		3.6	
Sunday, January 18, 2004	Lab/Field	5.1	11.5	10.1	48.7	6.22	18.6	4.6	9.4	2.6	8
	MCTS	16.1		10.7		16.1		14		12.2	
	Exceedance	None		None		None		None		None	
Monday, January 19, 2004	Lab/Field	4.5	7.9	16.2	25.5	4.7	11.4				
	MCTS	15.7		10.5		15.7					
	Exceedance	None		5.7		None					
Tuesday, January 20, 2004	Lab/Field							4.5	10.7	1.9	5.3
	MCTS							13.7		11.7	
	Exceedance							None		None	

Notes: Laboratory and field data reported in NTU.
Surface 2 is a sample collected downstream during the flood tide.
MCTS = Maximum Calculated Turbidity Standard, and is the background concentration plus 10 NTU.
Exceedance = Lab Value - MCTS

The first 5 days of dredge monitoring reports extend over a period of 3 work weeks from Friday, November 14 to Tuesday, November 25, 2003. During this time period, many complaints were logged about the poor dredging practices by various observers including the King County inspector. The most obvious problems were over-filling the dredge bucket and spilling material out of the bucket as it was moved to and from the barge. Initially, the King County inspector was not scheduled to stay permanently at the site, but after King County observed dredging problems on the second day (November 17, 2003), King County determined they needed to use a full time inspector to monitor the contractor. Also, King County directed the contractor to implement the BMPs outlined in their Dredging and Disposal Plan and subsequently specified the dredging rate be reduced to 8 hours to fill one barge instead of the 2.5 to 4 hours that had been the practice to date. Additionally, overfilling the dredge bucket was further discouraged by requiring the contractor to stop dredging for 5 minutes if multiple overfilled buckets occurred. During site visits and meetings with the dredging contractor on November 18 and November 25, 2003, EPA stressed the importance of implementing these BMP in order to address the exceedances of water quality criteria for turbidity. On November 25, 2003, the contractor tried using an 18-cy bucket, without digging teeth, but this produced high turbidity values.

A complete listing of all chemical results from water grab samples that were submitted for analysis is included in Appendix D. Compliance with water quality standards focused on the same four COCs that were identified in the *Draft Cleanup Study Report* (EBDRP 2001), mercury, PCBs, bis(2-ethylhexyl)phthalate, and butyl benzyl phthalate. Because numerical water quality standards exist only for mercury and PCBs, Table 2 includes a comparison with water quality values for only these two chemicals. For both mercury and PCBs, most of the measurements were less than the respective detection limits (0.005 µg/liter(l) for mercury and 0.47 µg/l for PCBs), and for both chemicals the detection limits were less then 1 percent of the respective water quality standard. In the two samples where mercury was detected, both values (0.007 and 0.0083 µg/l) were below the reliable limit for quantification and were less then 1 percent of the water quality standard value of 1.8 µg/l. The highest PCB value (0.216 µg/l on November 17, 2003) occurred along with one of the higher turbidity values on the second day, but the PCB value was only 2 percent of the water quality standard value of 10 µg/l. The chemistry data show that even when turbidity values were at their highest, the mercury and PCB concentrations in the water column were far below the water quality standard values, and this is also true for the other chemicals measured.

Table 2
Water Sample Chemistry Results During Dredging

Sample Date and Location	Turbidity NTU	Dissolved Mercury µg/l	Mercury % of Standard (1.8 µg/l)	Total PCB µg/l	PCB % of Standard (10 µg/l)
11/14 S	11.6	<.005	<1	<.048	<1
11/14 B	32.6	<.005	<1	.048*	<1
11/17 S	31.3	<.005	<1	.16	2
11/17 B	27.0	<.005	<1	.216	2
11/20 S	18.0	<.005	<1	<.047	<1
11/20 B	3.6	<.005	<1	<.047	<1
11/21 S	9.7	<.005	<1	<.047	<1
11/21 B	5.2	<.005	<1	<.047	<1
11/21 S-2	9.2	<.005	<1	<.047	<1
11/25 S	3.4	<.005	<1	<.048	<1
11/25 B	36.4	<.005	<1	<.047	<1
11/25 S-2	12.3	<.005	<1	.048	<1
11/26 S	2.6	<.005	<1	<.047	<1
11/26 B	1.0	<.005	<1	<.047	<1
11/26 S-2	3.2	<.005	<1	<.047	<1
12/2 S	9.2	<.005	<1	<.047	<1
12/2 B	10.4	.0083*	<1	.052*	<1
12/3 S	5.5	<.005	<1	<.047	<1
12/3 B	2.4	.007*	<1	<.047	<1

* = Value below reliable detection limit for quantification.
S = Surface
B = Bottom

Widespread concern about reported problems at the start of dredging resulted in increased inspection and monitoring throughout the project. NMFS trustees hired Ridolfi as an independent inspector to monitor dredging and provided verbal and written reports. Citizens also monitored activities on a regular basis and reported concerns to regulatory agencies and King County. EPA approved King County's request to conclude water quality monitoring for COCs after 1 week of monitoring, as outlined in the sampling and analysis plan (sampled for the first 8 days of dredging). Data from COC monitoring showed that mercury and PCB values were well below numeric water quality standards even at the highest turbidity values tested. However, King County had to abandon their plans to only monitor turbidity during the first week of dredging because no compliance was demonstrated for turbidity in 1 week. EPA told King County to continue monitoring turbidity on all days of dredging and report the results for timely review. King County tried to use field turbidity measurements to provide the contractor with directions on a real time basis, but found the field turbidity measurements were unreliable because they did not agree or correlate with the laboratory turbidity measurements.

3.1.2 Water Quality Monitoring During Capping

No water sample was collected on January 23 (first day of capping) because work stopped early due to problems with the WINOPS system. Turbidity values taken during the first 7 full days of capping are listed in Table 3 and extend over a period of 2 work weeks. Of the 23 samples collected, two exceeded the turbidity standard, but one value was only slightly above the standard. The one high value occurred the fifth day of capping (January 29) with an exceedance of 63 NTU at the bottom sample. The contractor was notified about the increased turbidity value and was directed to place material with minimum bottom disturbance or King County would need to continue monitoring turbidity during the entire capping process. The contractor and the King County inspector both noted that a large rainstorm occurred on January 29 resulting in a large volume of brown stormwater discharging out the 12-foot-diameter Diagonal CSO/SD outfall. Because this discharge was into the area that had been dredged and not capped, it could have caused some erosion of bottom sediment that partially contributed to the high turbidity value, even at the bottom sample. EPA notified King County that water quality monitoring could be stopped after the planned 7 days of sampling. However, King County inspectors still continued to monitor capping work until completion.

Table 3
Water Sample Turbidity Results During Capping

Date	Parameter	Flood Tide						Ebb Tide			
		Surface		Bottom		Surface 2		Surface		Bottom	
Saturday, January 24, 2004	Lab/Field	5.5	10.3	5.5	10.7	5.47	12.8				
	MCTS	25.0		11.9		25.00					
	Exceedance	None		None		None					
Sunday, January 25, 2004	Lab/Field	4.8		5.9		7.9					
	MCTS	18.0		13.7		18.0					
	Exceedance	None		None		None					
Monday, January 26, 2004	Lab/Field							9.7	21.3	14.3	28.8
	MCTS							15.3		13.6	
	Exceedance							None		0.7	
Wednesday, January 28, 2004	Lab/Field	3.7	12.2	1.6	4.0	8.58	17.5	4.0	14.1	5.6	13.6
	MCTS	16.9		14.5		16.90		12.9		12.7	
	Exceedance	None		None		None		None		None	
Thursday, January 29, 2004	Lab/Field	5.4	9.3	75.5	137.3	18.6	40.9				
	MCTS	19.8		12.5		19.8					
	Exceedance	None		63.0		None					
Tuesday, February 03, 2004	Lab/Field							10.2	20.9	0.9	1.8
	MCTS							18.6		11.4	
	Exceedance							None		None	
Thursday, February 05, 2004	Lab/Field	6.8	6.7	10.6	3.2	9.7		9.31	16.4	1.3	4.1
	MCTS	18.2		12.6		18.2		19.50		11.1	
	Exceedance	None		None		None		None		None	

Notes: Laboratory and Field data reported in NTU.
Surface 2 is a sample collected downstream during the flood tide.
MCTS = Maximum calculated Turbidity Standard, and is the background concentration plus 10 NTU.
Exceedance = Lab value – MCTS

3.2 PERFORMANCE MONITORING

Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards or other performance standards (WAC 173-340-410 (b)).

3.2.1 Post-Dredge and Post-Cap Surveys

Throughout the dredging and capping operation, bottom surveys performed by the contractor were submitted to King County's project engineer and reviewed for compliance with the Contract Drawings. When all high spots identified by the contractor's surveys had been removed, a post-dredge survey was conducted by Blue Water Engineering to independently confirm the dredging results. The post-dredge survey showed that the contractor removed sediments to the minimum required elevations shown in the Contract Drawings and as described in the Technical Specifications. Similarly, the contractor's surveys were used to determine compliance with the Contract Drawings for each given layer of the cap. Due to the rapid turn-around requirements for each layer and/or part of the site, and because the contractor's surveys were in agreement with the independent surveys, the contractor's surveys were used to confirm that each cap material thickness was sufficient. These surveys showed that the cap layers were placed in accordance with the Contract Drawings and Technical Specifications. When all capping was complete, Blue Water Engineering performed an independent post-cap survey to confirm the final elevations of the area. Surveys are discussed further in Section 4.0 and are included in Appendix E.

3.2.2 Sampling and Analysis of Water From Dewatering Process

Water collected during the sediment dewatering process at the offloading facility was collected and stored in three 100,000 gallon tanks on site. Prior to the discharge of the accumulated water to the sanitary sewer system, it was treated by filtration through multiple granulated activated carbon filters and then tested. Samples were collected and analyzed for chemical and physical constituents required by the King County Industrial Waste Discharge Authorization issued to the off loading facility (see document for details).

The samples were analyzed for TSS, total PCBs, bis (2-ethylhexyl) phthalate, benzo(a)pyrene, and the following metals: arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc. Results from these analyses are provided in Table 4. No exceedances of discharge permit standards were identified in any of the samples, so the water was allowed to be discharged to the sewer. A total of about 2 million gallons of water was treated, tested, and discharged from mid-November 2003 to the end of January 2004, which also included the first week of the East Waterway Project. During the entire Duwamish/Diagonal project, a batch treatment and discharge approach was used, but during this period the offload facility was performing testing of their continuous discharge treatment system. Approval for continuous discharge was issued by King County Industrial Waste on January 21, 2004.

Table 4
Treated Water Sample Results From Dewatered Sediments (gallons per day)

Sample Date	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	PCB's* (µg/L)	Benz(a)pyrene (µg/L)	Bis-2-ethylhexylpthalate (µg/L)	Flow (GPD)
November											
24	0.14	0.002	0.005	0.003	0.02	0.01	0.006	ND	ND	ND	
25	0.17	0.002	0.005	0.003	0.02	0.01	0.006	ND	ND	ND	
26											40,000
28	0.05	0.002	0.05	0.005	0.02	0.01	0.025	ND	ND	ND	
December											
1	0.05	0.002	0.005	0.017	0.02	0.01	0.017	ND	1.0	11.6	
1	0.05	0.002	0.005	0.012	0.02	0.01	0.022	ND	1.0	2.8	
1	0.004	0.005	0.005	0.044	0.01	0.01	0.05	ND	1.0	1.0	
2								ND			76,900
3								ND			69,100
4								ND			150,000
5								ND	1.0	1.0	38,400
8	0.05	0.002	0.005	0.004	0.02	0.01	0.006	ND	ND	ND	95,200
9								ND	1.0	1.8	95,200
11								ND			85,400
12								ND	1.0	1.0	130,000
13											3,800
14											80,400
15											96800
16	0.05	0.002	0.005	0.002	0.02	0.01	0.006	ND			91,900
19								ND	ND	ND	
22	0.05	0.002	0.005	0.013	0.002	0.01	0.068	ND			
January											
2								ND			100,700
8								ND	ND	3	
9											109,800
10	0.05	0.002	0.005	0.007	0.02	0.01	0.014	ND			
12								ND	ND	ND	
13								ND			89,800
14								ND			129,400
15								ND			109,020
16											87,500
17											99,400

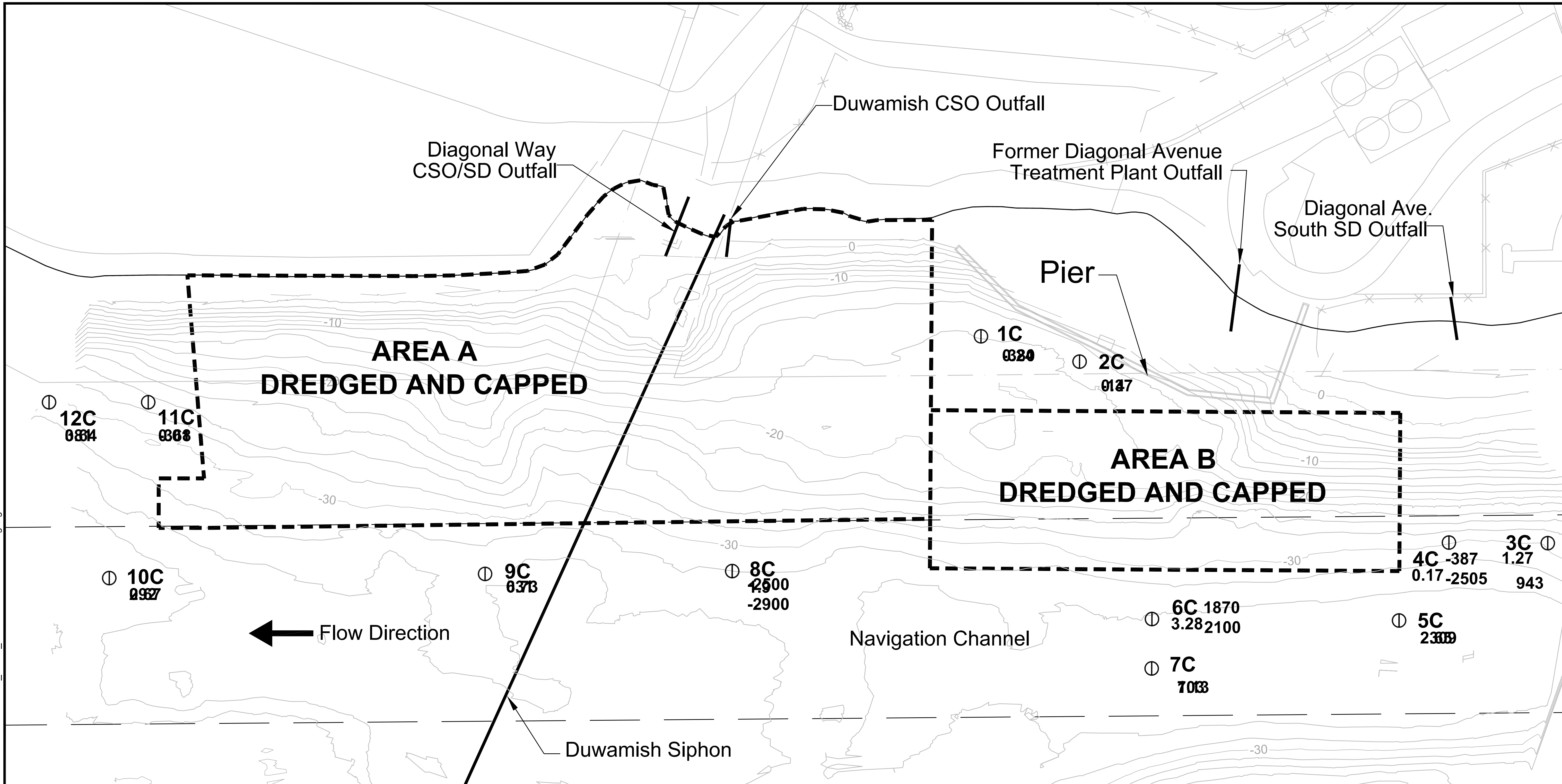
Table 4
Treated Water Sample Results From Dewatered Sediments (gallons per day)

Sample Date	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Lead (mg/L)	Nickel (mg/L)	Zinc (mg/L)	PCB's* (µg/L)	Benz(a)pyrene (µg/L)	Bis-2-ethylhexylpthalate (µg/L)	Flow (GPD)
18	0.05	0.002	0.005	0.007	0.02	0.01	0.0337	ND	ND	ND	93,200
23								ND			82,300
28								ND			95,800
29	0.05	0.002	0.009	0.019	0.02	0.0001	0.087	ND	ND	1.5	
29	0.05	0.002	0.006	0.004	0.02	0.0001	0.035	ND	ND	0.42	
30								0.094**			

ND = not detected
* Water Samples were analyzed for Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260.
**Aroclor 1254 was the only Aroclor detected.
See Appendix D for complete chemical results.

3.2.3 Sediment Sampling

When the *Sediment Monitoring Sampling and Analysis Plan* (KCDNRP 2003b; Appendix G) was prepared for the project, the regulatory agencies overseeing the monitoring activities (Ecology and EPA) required sediment sampling beyond the site boundary to document any changes in chemical concentrations of surface sediments due to dredge material moving beyond the site boundary. A total of 12 monitoring stations were established beyond the site boundary and sampled both before and after the project was implemented to document potential changes over time. Figure 8 shows that stations C1 through C12 were spaced upstream, downstream, inshore, and offshore of the dredge site and were generally either 50 feet or 150 feet from the boundary of the dredge prism, as requested by EPA. A discussion of the rationale for locating the 12 monitoring stations was included in the *Sediment Monitoring Sampling and Analysis Plan* (KCDNRP 2003b). In order to improve the reproducibility of chemical measurements at each monitoring station, 10 individual grab samples were collected at each monitoring station (instead of the usual 3). All 10 grabs were then combined into a single composite sediment sample for the station. To verify reproducibility of the 10 grab composite samples, field replicates were obtained at two stations before construction (4C and 8C) and three stations after construction (4C, 6C, and 8C).



Legend:

Sample Location

381 Difference between pre- and post-construction PCB surface sediment concentration (µg/kg dry weight)

0 50 100
Scale in Feet

K:\Jobs\008601-Duwamish\CLSR_RPRT_2005\00008601-80CR.dwg Fig 8

Jul 18, 2005 11:32am cdavidson

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project	Figure 8
	Post-Construction Changes in PCB Dry Weight Concentrations At Twelve Stations Beyond Site Boundary	

3.2.3.1 Sediment Analyses

All sediment samples collected beyond the site boundary for before and after comparisons were submitted to the King County Environmental Laboratory for analysis of standard sediment characterization parameters (PCBs, base/neutral/acid extractable semi-volatiles (BNAs), chlorinated pesticides, mercury, metals, and the sediment conventional parameters of total organic carbon (TOC), total solids, and particle size distribution (PSD). The analytical methods used for various parameters are listed in Appendix D. All analyses were performed under QA1 guidance (Ecology 1989) per the methods described in the *Sediment Monitoring Sampling and Analysis Plan* (KCDNRP 2003b), and the resulting data underwent QA1 review. Based on this review, it was determined that for the before samples a third PCB aroclor (1260) could be quantified so revisions were made that resulted in final PCB values that were 12 to 44 percent larger then PCB values initially reported in draft documents (see QA reports for discussion). During QA review of the after samples, it was determined that quantification should be based on second column results, which had a higher standards recovery, so the PCB values were revised, but only a few stations had minor reductions compared to values reported in draft documents (maximum of 4 percent at station 10C; see QA reports for discussion). Results of the analyses are presented in Tables 5 and 6, and are discussed in the next section.

Table 5
Chemicals That Exceed SMS At 12 Stations Beyond Site Boundary
Before and After Construction

	PCBs		BEHP		BBP		Mercury		Cadmium		Silver		1,4 DCB	
Stations	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
DUD_1C	SQS	SQS	CSL	CSL		SQS								
DUD_2C	SQS	SQS	CSL	CSL		SQS								
DUD_3C	SQS	CSL	SQS	CSL		SQS								
DUD_4C	SQS	SQS												
DUD_4C Rep	CSL	CSL	SQS	CSL										
DUD_5C	SQS	CSL		CSL										
DUD_6C	CSL	CSL		CSL		SQS	SQS						CSL	
DUD_6C Rep		CSL		CSL		SQS								
DUD_7C	SQS	CSL	SQS	SQS		SQS								
DUD_8C	CSL	CSL	CSL	CSL		SQS	CSL							
DUD_8C Rep	CSL	CSL	CSL	CSL		SQS	CSL		SQS					
DUD_9C	SQS	CSL	SQS	CSL		SQS								
DUD_10C	SQS	CSL		SQS				CSL						
DUD_11C	SQS		CSL		SQS									
DUD_12C	SQS	CSL	SQS	CSL		SQS	SQS				CSL			
Stations>SQS	9>SQS	2>SQS	5>SQS	2>SQS	1>SQS	8>SQS	2>SQS		1>SQS					
Stations>CSL	3>CSL	9>CSL	4>CSL	9>CSL			1>CSL	1>CSL			1>CSL		1>CSL	

Table 6
Changes in PCB Dry Weight and SMS Values at 12 Stations
Beyond Site Boundary After Construction

Stations	PCB Concentration (µg/kg dry weight) #				PCB Concentration (mg/kg OC)			
	Before	After	Increase	Decrease	Before	After	Increase	Decrease
DUD_5C	341	2,650	2310 ##		27 *	153 **	126	
DUD_6C Rep	1,290***	3,390	2100 ##			213 **	123	
DUD_6C	1,290	3,160	1870 ##		90 **	208 **	118	
DUD_3C	327	1270	943 ##		15 *	107 **	91	
DUD_7C	427	1,130	703 ##		28 *	75 **	47	
DUD_9C	103	733	631		13 *	95 **	82	
DUD_12C	263	644	381		20 *	80 **	60	
DUD_10C	373	666	292		37 *	65 **	28	
DUD_2C	382	368		14. ##	16 *	47 *	31	
DUD_11C	378	9.21		368	28 *	low TOC		
DUD_1C	621	240		380	18 *	35 *	17	
DUD_4C	492	105		387 ##	21 *	42 *	21	
DUD_4C Rep	2,740	235		2510 ##	129 **	101 **		28
DUD_8C	4,180	1,680		2,500	245 **	162 **		83
DUD_8C Rep	5,030	2,130		2,900	254 **	164 **		90

Stations	Total Solids (percent dry weight)				TOC (percent dry weight)			
	Before	After	Increase	Decrease	Before	After	Increase	Decrease
DUD_5C	60	57		3	1.27	1.73	0.46	
DUD_6C Rep	61 ###	59		2	1.43	1.59	0.16	
DUD_6C	61	61	0	0	1.43	1.52	0.09	
DUD_3C	50	63	13		2.16	1.19		0.97
DUD_7C	55	59	4		1.54	1.51		0.03
DUD_9C	69	70	1		0.78	0.77		0.01
DUD_12C	59	69	10		1.32	0.81		0.51
DUD_10C	66	65		1	1.02	1.03	0.01	
DUD_2C	50	67	17		2.36	0.78		1.58
DUD_11C	59	79	20		1.36	<.05		1.31
DUD_1C	46	72	26		3.36	0.68		2.68
DUD_4C	48	76	28		2.38	0.25		2.13
DUD_4C Rep	50	76	26		2.12	0.23		1.89
DUD_8C	56	67	11		1.70	1.04		0.66
DUD_8C Rep	55	65	10		1.98	1.30		0.68

= Values rounded to three significant figures
= Stations near Area B
- Value from DUD_6C used
* = Value Exceeds SQS
** = Value Exceeds CSL
*** = Original value from DUD_6C used

3.2.3.2 Discussion of Sampling Results

The complete listing of analytical results for sediment samples collected before and after construction are included in Appendix D for both dry weight and TOC normalized values. A summary of the SMS comparison for all chemicals is included in Table 5 and individual results for PCBs are included in Table 6. Corresponding TOC and total solids values are also include in Table 6.

Previous results from stations sampled beyond the site boundary by King County (1994 to 1996), NOAA (1997) and EPA (1998) showed SMS values were exceeded at most stations, which is why both Ecology and EPA considered the Duwamish/Diagonal project to be a partial cleanup action. The new sediment samples collected at the 12 stations in October 2003, before the Duwamish/Diagonal project, reflect these conditions and showed that all 12 stations beyond the site boundary exceeded the SQS or CSL values for one or more of 5 chemicals (PCBs, BEHP, benzyl butyl phthalate (BBP), 1,4 dichlorobenzene, mercury, cadmium and silver). The results listed in Table 5 show that the main focus for increases in SMS was limited to PCBs, BEHP, and BBP.

For PCBs, Table 5 shows that all 12 stations exceeded SMS before construction with 9 greater then SQS and 3 greater then CSL. After construction, 11 stations exceeded SMS with 2 greater then SQS and 9 greater then CSL, which is a net increase of 6 stations exceeding the CSL. The maximum increase occurred at stations 5C and 6C, which increased to over 2 times the CSL and 3 times the CSL, respectively.

For BEHP, Table 5 shows that 9 stations exceeded SMS before construction with 5 greater than SQS and 4 greater than CSL. After construction, 11 stations exceeded SMS with 2 greater than the SQS and 9 greater than the CSL for a net increase of 5 in stations greater than the CSL and 2 stations greater than the SMS. For BBP, one station exceeded the SQS before construction and this increased to 8 stations after construction, but no stations exceeded the CSL. For mercury, 4 stations initially exceeded SMS (2 greater than the SQS and 2 greater than the CSL), but in the after samples these all dropped below SMS and one different station exceeded the CSL. For cadmium, silver, and 1,4 dichlorobenzene, only one station initially exceeded SMS for each chemical (1 greater than the SQS for first compound and 1 greater than the CSL for the last two compounds), but in the after samples this dropped to no stations above the SMS.

To accurately evaluate changes in chemical concentration over time and space, it is important to use chemical quantification measurements that contain the least variability. Based on comparisons of PCB data in Table 6, TOC normalized values have more variability then dry weight values because the change in TOC does not change uniformly with the change in the chemistry value. A clear example can be seen in one of the replicate samples from stations 4C and 8C (sample 4C rep and 8C) , which both underwent a decrease of 2,500 parts per billion (ppb) in PCB dry weight values, but the corresponding change in TOC normalized values differ by more than a factor of two (minus 28 vs. minus 83 mg/kg TOC, respectively). Another example occurs at stations 7C and 9C, where the increase in dry weight was greater at station 7C (703 ppb vs. 631

ppb), but station 9C showed a much larger increase in the SMS value than station 7C (82 vs. 47 mg/kg TOC respectively). In a few cases the TOC normalized values can show an increase even though the dry weight chemistry values show a decrease, and this occurs with PCBs in three samples (1C, 2C, and 4C). Table 6 shows that SMS values increased at 11 stations (1C, 2C, 3C, 4C rep, 5C, 6C, 7C, 9C, 10C, 11C, 12C), but PCB dry weight values increased at only 7 stations (3C, 5C, 6C, 7C, 9C, 10C, 12C).

The most accurate way to identify changes produced by the two transport processes that effect chemical concentrations beyond the site boundary (i.e., dredge sediment transport and capping sand transport) is to look for spatial differences in the change in dry weight concentrations at each station. To assist in this analysis, the stations in Table 6 were arranged in progressive order starting with the greatest increase and progressing to the largest decrease in PCB dry weight. In Figure 8, the observed changes in PCB dry weight values were plotted next to the station numbers to show the spatial differences. Dry weight concentrations increased at 7 stations, but there was a greater increase in the four stations located near Area B (3C, 5C, 7C, and the replicate samples 6C and 6C rep) compared to the three stations located near Area A (9C, 10C, 12C). The highest increase (2,309 ppb) occurred at station 5C, which is located in the channel 50 feet west of the upstream end of Area B. The second and third highest increases (2,100 ppb and 1,870 ppb) occurred in the two replicate samples at station 6C (samples 6C and 6C rep), which is also located in the channel 50 feet from the edge of Area B, approximately midway along the length of Area B. The next highest increase (943 ppb) occurred at station 3C, which is located 150 feet upstream of Area B, upstream of station 4C, near the edge of the channel. The increase at station 3C shows upriver transport of suspended dredge material with incoming tide. The fourth and lowest level of increase at Area B was 702 ppb at station 7C, which is located in the channel 100 feet from the edge of Area B, offshore from station 6C. The lower increase at station 7C compared to station 6C shows a reducing concentration gradient going away from Area B in the cross-current direction. The four stations with the greatest increase in PCB values all border Area B, which correlates with where the contractor was observed spilling the most material when they started dredging.

For the three stations that increased around Area A, the largest increases (631 ppb) occurred at station 9C, which is located in the channel 50 feet west of Area A, slightly downstream of the middle of Area A. The next level of increase was 381 ppb that occurred at station 12C, which is located 150 feet downstream of Area A, downstream of station 11C, inshore of the east channel line. The lowest amount of increase was 292 ppb at station 10C, which is located in the channel about 65 feet from the downstream corner of Area A.

Five stations showed a reduction in PCB dry weight values (1C, 2C, 4C, 8C, and 11C), but the reduction at station 2C (-14 ppb) is so small that it could be considered as no change. A reduction in PCB values can occur when some of the clean capping sand is transported onto the station, which either buries all the underlying contaminated sediment (station 11C) or partially dilutes the 10 cm deep sample (samples 1C, 2C, 4C, 4C rep, 8C, and 8C rep). The amount of reduction that is produced depends both on the amount of sand added and the size of the beginning PCB value. Stations with the highest starting PCB values can produce the largest reduction values, and this is shown in the results. One of the replicate samples from station 8C (8C rep) had the highest beginning concentration value of 5,030 ppb, which was reduced to 2,130 ppb and yielded the largest reduction value (2,900 ppb). The seconded largest reduction in PCBs was 2,500 ppb for the second replicate sample at station 8C (sample 8C) and one of the replicate samples at station 4C (4C rep). Sample 8C had a much higher beginning total PCB value then sample 4C rep (4,180 ppb vs. 2,740 ppb). The addition of capping sand at the five stations (1C, 2C, 4C, 8C, and 11C) not only reduced the PCB concentration at these five stations, but also produced a corresponding reduction in the TOC values plus an increase in the percent total solids values, as seen in Table 6 for samples from these 5 stations (samples 1C, 2C, 4C, 4Crep, 8C, 8C rep, and 11C).

The transport of capping sand beyond the site boundary appears to have the greatest effect on the area of the river bottom located within 50 feet of the site boundary, because only the stations in this area have lower PCB values after construction. Five of the eight stations located within 50 feet of the site boundary show a reduction in PCB dry weight values. The five stations, which exhibit a decrease in PCB values (1C, 2C, 4C, 8C, and 11C), are fairly evenly distributed around the perimeter of both cleanup Areas A and B (Figure 5), except there are no PCB reductions at stations on the offshore side of Area B. Stations 1C (minus 380 ppb) and 2C (minus 14 ppb) are both located upstream of Area A and inshore of Area B. Station 4C (replicates of minus 387 ppb and minus 2,505 ppb) is located upstream of Area B and near the shore side of the channel. Neither of the two perimeter stations in the channel offshore of Area B shows a reduction; however, one of the two perimeter stations in the channel offshore of Area A is station 8C, which shows the maximum reduction of all stations (replicates of minus 2,500 ppb and minus 2,900 ppb). The fifth station to show a reduction was station 11C (minus 368 ppb) located downstream of Area A and inshore of the channel. It is reasonable to expect some transport of capping sand beyond the site boundary because there are substantial tidal currents in the river and each bucket of capping sand is intentionally spread across the surface of the water to increase dispersion and minimize impact on the bottom.

A second approach was used to help interpret the changes in PCB dry weight values that were observed at stations beyond the site boundary. This approach involved using a simple mathematical model to estimate the amount of dredge material that would accumulate at each of the 12 stations under a given set of conditions. A simple three-dimensional dispersion model had been used during the Cleanup Study (EBDRP 2001) to predict PCB recontamination; this model included conservative assumptions regarding river hydrodynamics, sedimentation/settling rates, contaminant concentrations and potential dredging actions. For consistency, this same model was used to generate an estimated deposition curve for increasing distance from the center of the dredge area. The deposition curve was derived by assuming that 2 percent of the dredge prism was dispersed (Anchor 2003) and that dispersion occurred from the center of the dredge prism. This curve was used to estimate the deposition thickness of dredge material (in centimeters) at each of the 12 stations, as shown in Table 7. The predicted PCB concentration produced by this deposition at each station was calculated by assuming the average PCB concentration for the newly deposited dredge material was equal to the average PCB concentration for the entire dredge prism (4.45 mg/kg dry weight). For simplicity, replicate samples were averages for this analysis.

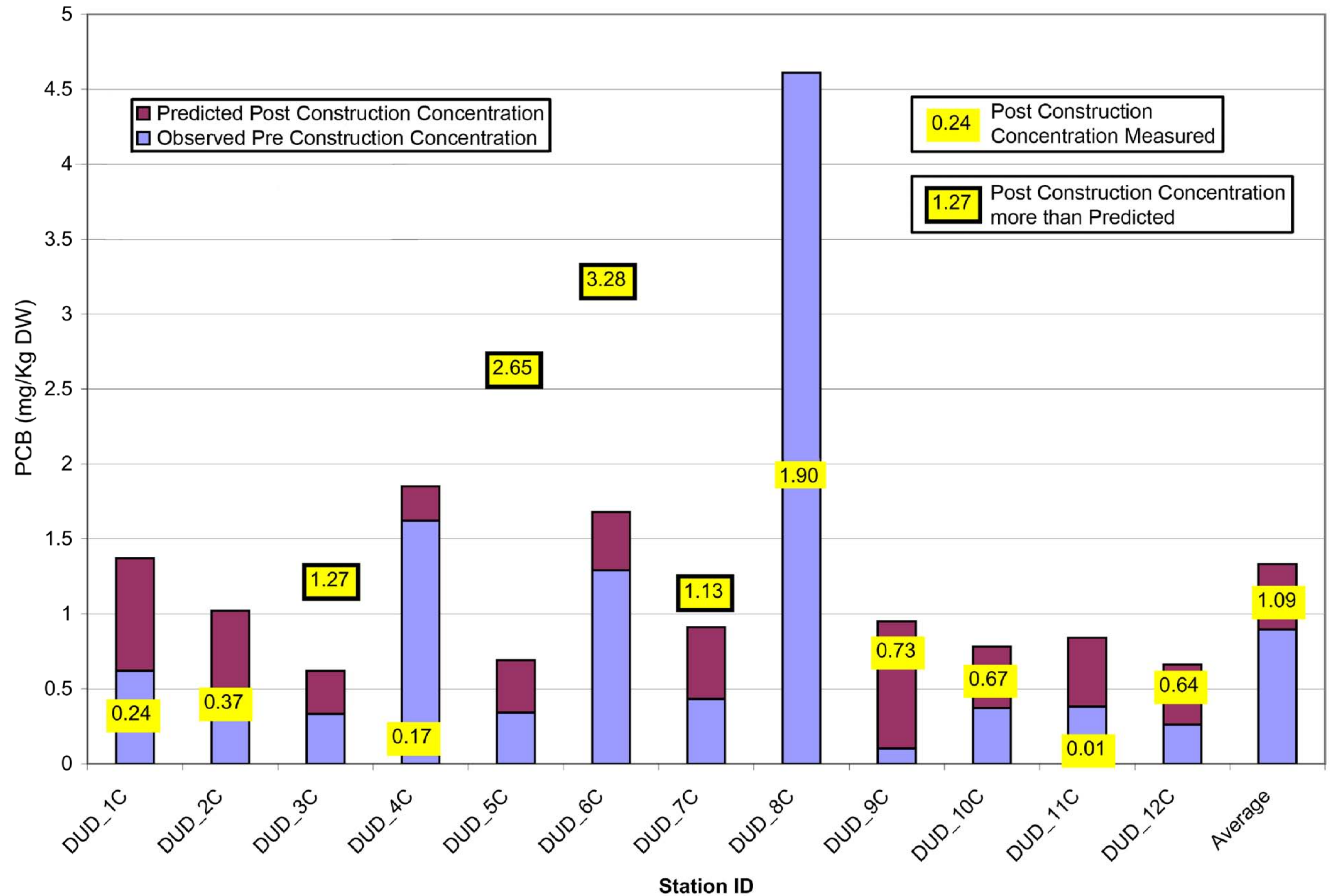
Table 7 lists the comparison between the predicted PCB values that were calculated using a 2 percent release and the actual dry weight PCB values measured after construction. The vertical bars in Figure 9 show the predicted increase in PCB dry weight values at each of the 12 stations and how the measured PCB values after construction compare with the predicted values. Figure 10 shows the spatial distribution of the PCB dry weight values measured after construction and whether the values are lower or higher than the values predicted by the model. Of the seven stations that had higher PCB dry weight values after construction, only the four stations around Area B (stations 3C, 5C, 6C, and 7C) had values that were higher than the predicted values (Figures 9 and 10). These four locations are adjacent to Area B, which is where the contractor started dredging and encountered the greatest problems with spillage. All six stations adjacent to Area A (1C, 8C, 9C, 10C, 11C and 12C) had PCB concentrations that were less than those predicted by the model, which could be interpreted to suggest that loss rates at these sites were less then the 2 percent value used for the model estimates or that the stations were influenced by transport of capping sand beyond the site boundary. The five stations that underwent a reduction in PCB values (stations 1C, 2C, 4C, 8C, and 11C) were significantly different than the model predictions; however, the difference between predicted and observed values can be explained by the transport of capping sand onto the station during cap placement.

Regulatory agencies and environmental groups expressed concern that excess amounts of PCB sediment were released due to sloppy dredging practices at the start of the project when the dredging contractor failed to use best management practices to minimize loss of dredge material. Ecology and EPA stated that they did not approve a 2 percent loss rate for the Duwamish/Diagonal project and that they could not accept the modeling results as an accurate prediction. Ecology ultimately informed King County that the data showed that an excessively high amount of PCBs were released around Area B and that the elevated PCB levels should be addressed by further cleanup actions as soon as possible. A new alternatives evaluation was performed in November 2004 to remediate the highest PCB values, which recommended installing a thin layer of sand to reduce elevated PCB values around Area B. In order to work during the early 2005 dredge window, King County moved quickly to obtain Ecology approval and the required permits to place a minimum 6-inch-thick layer of sand over about 4 acres of river bottom adjacent to Area B. The thin layer placement work was completed in February 2005 and will be described in a separate Closure Report for that cleanup action. Additional monitoring work required specifically for the thin layer placement action will also be described in a future report.

Table 7
PCB Distribution and Model Prediction
(mg PCB/kg dry weight)

Station	Measured Values Before	Model* Predicted Values	After Measured Values Lower than Predicted Values	After Measured Values Higher than Predicted Values	Distance to Station (meters)	Deposition** Thickness at Station (cm)
DUD_1C	0.62	1.37	0.24		92	1.97
DUD_2C	0.38	1.02	0.37		123	1.58
DUD_3C	0.33	0.62		1.27 ***	278	0.72
DUD_4C	1.62	1.85	0.17		245	0.8
DUD_5C	0.34	0.69		2.65 ***	237	0.9
DUD_6C	1.29	1.68		3.28 ***	163	1.23
DUD_7C	0.43	0.91		1.13 ***	169	1.19
DUD_8C	4.61	4.57	1.9		61	2.62
DUD_9C	0.1	0.95	0.73		92	1.97
DUD_10C	0.37	0.78	0.67		204	1.00
DUD_11C	0.38	0.84	0.01		180	1.13
DUD_12C	0.26	0.66	0.64		214	0.95

* = Based on Average PCB concentration of 4.45 ppm dry weight for all dredged sediment that settles onto bottom
** = Based on an assumed loss rate of 2 percent for dredged sediment dispersed from center of dredge area
*** = Stations exceeding predicted PCB increase all boarder cleanup Area B



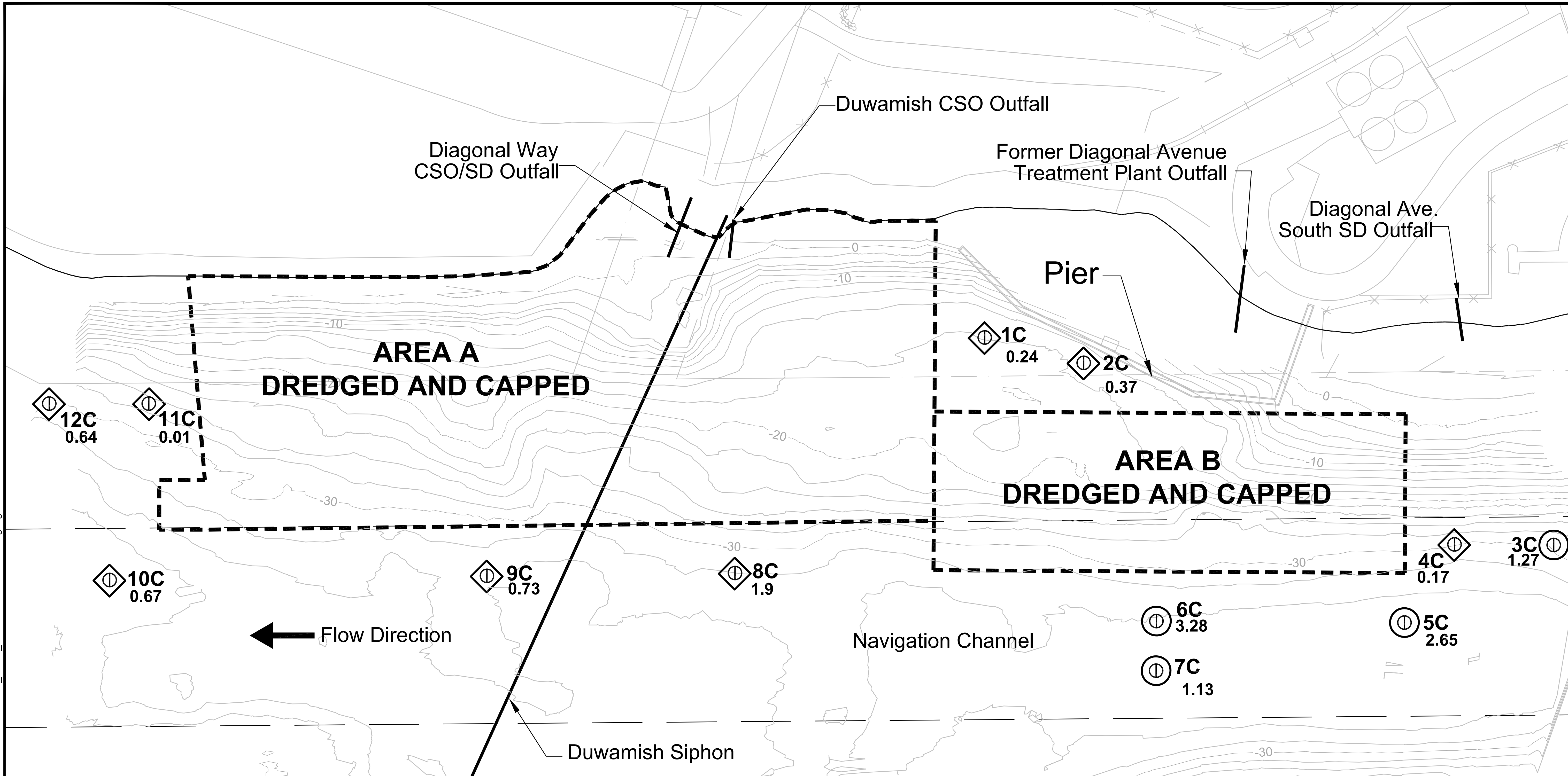
EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Predicted vs. Observed Post Construction PCB Concentrations At Twelve Stations Beyond Site Boundary

Figure 9

Jul 18, 2005 11:31am cdavidson K:\Jobs\00008601-Duwamish\CLSR_RPRT_2005\00008601-80CR.dwg Fig 9



Post cleanup surface sediment PCB concentration less than cleanup study model predictions.

Post cleanup surface sediment PCB concentration greater than cleanup study model predictions.

0.64 Post dredge surface sediment PCB concentration (mg/kg DW)

EcoChem Team	Duwamish/Diagonal Sediment Remediation Project	Figure 10
	Post Construction PCB Concentrations in PPM at Stations Beyond Site Boundary Compared to Predicted Values	

Jul 18, 2005 11:33am cdavidson K:\Jobs\00008601-Duwamish\CLSR_RPRT_2005\00008601-80CR.dwg Fig 10

3.3 CONFIRMATIONAL MONITORING

Cleanup regulations require confirmation monitoring to be performed to confirm the long-term effectiveness of the cleanup action, once cleanup standards and other performance standards have been attained (WAC 173-340-410 (c)). Long term confirmation testing of the chemical levels on surfaces of cleanup up Areas A and B began in the summer of 2004 and will continue for 10 years until 2014. Sampling during the first 5-year period will occur each year, but during the second 5-year period there is the potential that the sampling frequency could be reduced. A separate report will be issued with the sediment chemistry results for each year sampled; however, Section 6 of this report (Post Construction Monitoring) includes results of 2004 baseline chemistry for stations on the cap. Appendix G details the Sediment Monitoring Sampling and Analysis Plan for cleanup Areas A and B.

4.0 Surveys

4.1 PRE-CONSTRUCTION, POST-DREDGE, AND POST-CAP SURVEYS

King County hired an independent hydrographic surveyor (Blue Water Engineering) to perform site surveys at key times during the project. Surveys were performed before construction began at the site, after the dredging was complete, and after capping was complete. These surveys were used to verify that the depths of dredging and elevations for capping were achieved as required in the Contract Documents. These surveys were also used as the basis for dredge quantities for contractor payment. Each survey was performed using a survey grade fathometer with survey lines approximately every 25 feet across the site. Tidal corrections were made based on periodic reading of tide staffs installed at the site. Horizontal location control was provided by using a DGPS that utilized the Coast Guard corrector station and locally surveyed monuments. The horizontal datum used in the surveys was North American Datum of 1983 with the 1991 update (NAD83 [91]) and the vertical datum was the U.S. Army Corps of Engineers' MLLW. Copies of the surveys are included in Appendix E; these surveys function as the as-builts required by MTCA (WAC 173-340-400(b)).

A reconnaissance survey was performed on August 2, 2003. This survey was used to develop the final plans included in the Technical Specifications. A confirmational pre-dredge survey was performed on October 23, 2003. The post-dredge survey was performed for Area B on January 14, 2004, and for Area A on January 21, 2004. The post-cap survey was performed on March 3, 2004. A final confirmation survey was conducted on March 11, 2004.

4.2 CONTRACTOR DAILY PROGESS SURVEYS

The contractor was required to perform daily progress surveys over the entire area dredged to date during dredging operations. Typically, only the area dredged on the given day was surveyed. The contractor used an Ashtek 24 channel dual frequency DGPS receiver for horizontal positioning and a Knudsen 320M survey grade fathometer. Laptop computers with Hypack® software processed the data. Soundings were corrected for the tides based on an on site electronic tide gauge. The contractor performed a pre-dredge survey on the same date that Blue Water Engineering performed King County's pre-dredge survey. The two surveys were in substantial agreement. The contractor's final post-dredge survey was also in substantial agreement with Blue Water Engineering's post-dredge survey.

During capping operations, the contractor's daily surveys were used to determine whether each cap layer had adequate thickness. This was allowed because their history of surveys and their methods were acceptable. This allowed for confirmation of their placement much quicker and resulted in fewer delays than they would have incurred if an independent surveyor had to be called in and the survey processed over an allowable 5-day period. The contractor's final post-cap survey agreed with the Blue Water Engineering post-cap survey.

4.3 QUANTITIES

A comparison between the pre-dredge survey and the post-dredge survey shows that 68,250 cy were removed during the entire project (including the debris and overdredge quantities). The capping quantities were measured by material type and paid by the ton. The contractor delivered and placed 79,743 tons of base cap, 18,064 tons of habitat mix, 5,529 tons of quarry spall, 7,141 tons of light loose riprap, and 2,371 tons of light loose riprap special (Table 8). These quantities were measured at the quarry based on barge displacement and using certified displacement curves.

Table 8
Quantities of Capping Materials (in tons)

Material Type	Original Bid	Revised Estimate	Final Construction
Base Cap	78,000	80,000	79,743
Habitat Mix	5,400	17,200	18,064
Quarry Spalls	5,600	5,100	5,529
Riprap	7,350	6,600	7,141
Riprap Special	1,875	1,800	2,371

5.0 Deviations From Plans

The following deviations were noted from the Engineering Design Report (EBDRP 2003), Contract Drawings, and Technical Specifications:

- The cap surface in the northern portion of Area A was changed from being a 7.5H:1V slope to a final elevation that more closely matched original grade.
- The Capping Plan sheet (Sheet C-4) of the Contract Drawings did not define how the transition from the 7.5H:1V slope to the capped surfaces to the south would be made. The contractor was instructed to construct the toe of the slope at the transition in the 7.5H:1V area.
- Plan Sheet C-5 (which defined the required grain sizes for the cap erosion layer) was modified to allow the changes in the materials to occur either at the toe or crest of a slope instead of halfway up a slope. This change was made to improve constructability.
- The original bid quantity for habitat mix was underestimated. This was corrected to 17,200 tons by change order (see previous section regarding quantities).
- The water quality monitoring for turbidity was anticipated to be discontinued after 1 week of compliance, but EPA requested that King County continue the turbidity monitoring for the entire dredging period due to lack of consistent compliance.

6.0 Post Construction Monitoring

6.1 SEDIMENT CHEMISTRY STATIONS ON CAP SURFACE IN CLEANUP AREAS A AND B

The *Sediment Monitoring Sampling And Analysis Plan* is included in Appendix G and contains long-term monitoring requirements for changes in the surface sediment chemistry over a period of 10 years in cleanup Areas A and B. Figure 11 shows the five surface sediment monitoring stations in Area A (1A to 5A) and three stations in cleanup Area B (1B to 3B), which are intended to provide information about any recontamination on the cap surface over time. The first year baseline samples were collected in cleanup Areas A and B on June 1, 2004 (Year 0 sampling event). Complete chemical results are reported in Appendix D. Table 9 contains summarized results of detected SMS chemicals. All values are reported only in dry weight because this is the most useful value to show changes in chemical concentrations over time. The TOC values at most stations are too low to accurately TOC normalize the data.

Six of the surface grab stations are located in areas covered with habitat mix (stations 1A to 3A and 1B to 3B), which contains a large amount of gravel and makes it difficult to collect a representative sample with the standard grab sampler. At Station 3A, no sediment sample could be collected because only larger gravel was present. At three other stations (2A, 1B, and 2B) it was necessary to field sieve the samples through a 1-cm mesh stainless steel screen to remove large gravel. All sediment passing through the screen was retained as the sample (small gravel and finer). At each of the three stations this represented about 80 percent of the total volume collected by the grab sampler.

The dry weight baseline chemical concentrations for BEHP and PCBs are plotted in Figure 11 next to each of the stations on the cap surface, because these two chemicals were the most significant in determining sediment cleanup boundaries. Station 5A had the lowest concentrations for both chemicals and these values were less then the detection limits of 34 ppb for BEHP and 1.7 for PCB. Station 5A is located in the offshore downstream corner of Area A where there is capping sand without any habitat mix. There was no blank contamination, so all BEHP values are usable as reported. The highest baseline BEHP values occur in Area A at stations 1A and 2A, which have values of 442 and 324 ppb, respectively. These two stations are located closest to the Diagonal Way CSO/SD outfall pipe, which is where the highest BEHP concentrations occurred prior to remediation. The concentration at 4A was 120 ppb, which falls within the range of values in Area B. The lowest value on Area B is 89 ppb at station 3B. Both stations 1B and 2B have similar higher values of 158 and 168 ppb.

For PCBs, the highest baseline concentrations occur in Area B with station 1B at 120 ppb and station 2B at 82 ppb. At both of these stations, the samples were sieved to remove large gravel that was about 20 percent of the volume. The highest PCB value in Area A was 46.7 ppb at station 2A; this sample was also sieved to remove large gravel. The lowest PCB value in Area B was 30.8 ppb at station 3B; this value is fairly similar to the value at station 1A (46.7 ppb), which is located closest to station 3B. The two lowest detected PCB values were at stations 1A and 4A with values of 18.5 and 20 ppb, respectively.

Baseline samples for the cap were collected June 1, 2004, which was about 2 months after the Duwamish/Diagonal project was completed. There is no way to know whether the presence of higher baseline BEHP values in Area A and higher PCB values in Area B reflect the conditions immediately after the cap was placed or whether these values were influenced by potential input sources during the 2 months before the baseline samples were collected. The highest baseline BEHP values were at stations 1A and 2A located closest to the Diagonal CSO/SD outfall, which is suspected to be the primary input source for BEHP to the cap. The highest baseline PCB value occurred at station 1B (120 ppb), which is located approximately 100 feet inshore from where the highest post-construction PCB values were found beyond the site boundary (3,160 and 3,390 ppb in replicate samples at station 6C). Potential recontamination during the two months before collecting the baseline samples should be easier to determine when the results for the 1-year post-construction cap samples are available.[1]

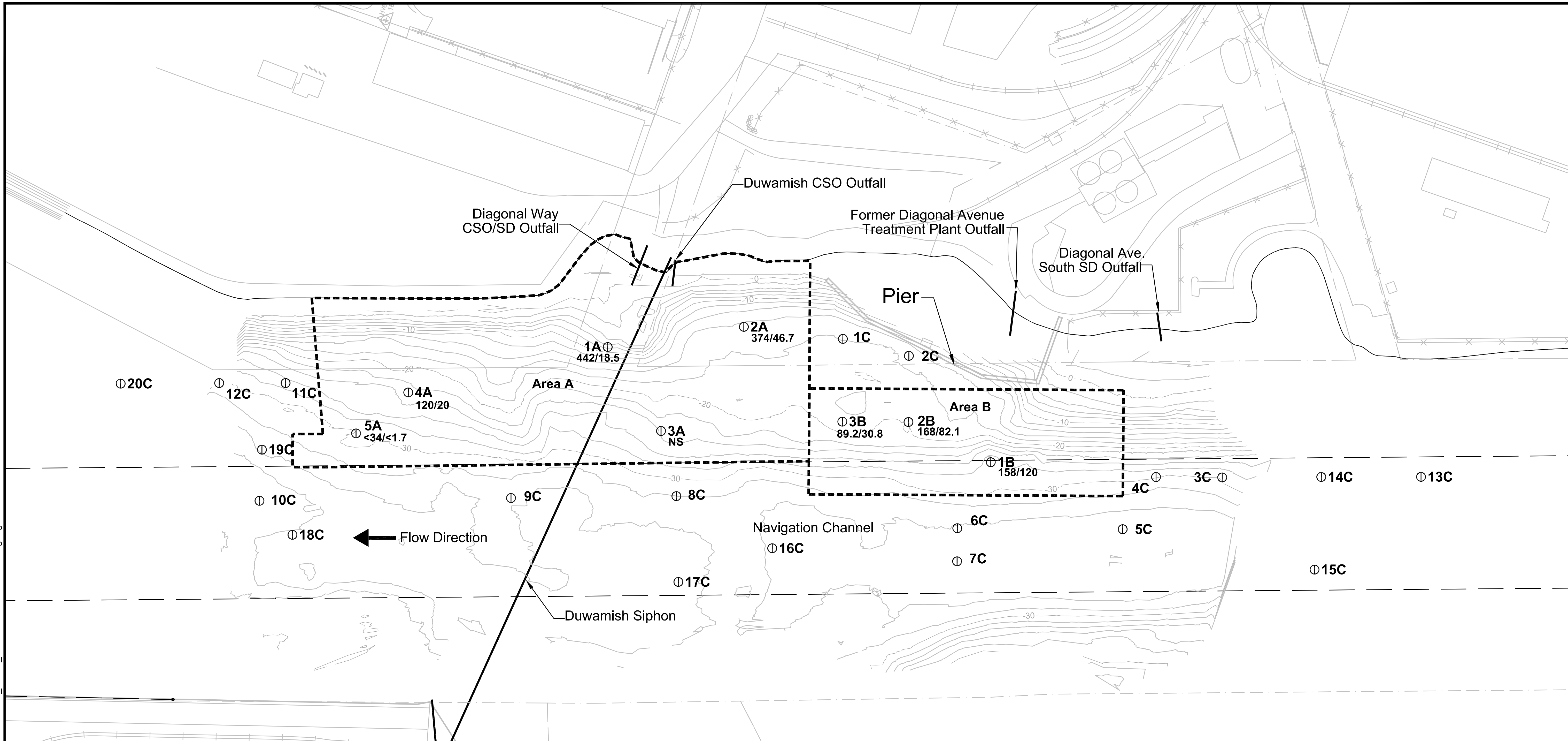
---

[1] These one-year cap samples were collected April 27, 2005, and were submitted to the King County Environmental Lab for analysis. Results for the 1-year post-capping samples will be presented to regulatory agencies in a future data report.

Table 9
2004 Baseline Chemistry at Cap Stations

Station Locator	DUD_1A			DUD_2A			DUD_4A			DUD_5A			DUD_5A rep			DUD_1B			DUD_2B			DUD_3B		
Date Sampled	1-Jun-04			1-Jun-04			1-Jun-04			1-Jun-04			1-Jun-04			1-Jun-04			1-Jun-04			1-Jun-04		
Sample Number	L32085-1			L32085-2			L32085-4			L32085-5			L32085-6			L32085-7			L32085-8			L32085-9		
% Solids	83.7			81.2			79.1			78.9			78.7			85.5			83.4			93.5		
% TOC	0.34			0.57			0.11			<0.05			<0.05			0.21			0.29			0.17		
	Value	Qual	Qual #	Value	Qual	Qual #	Value	Qual	Qual #	Value	Qual	Qual #	Value	Qual	Qual #	Value	Qual	Qual #	Value	Qual	Qual #	Value	Qual	Qual #
BNA Organics																								
(ug/kg dry weight)																								
LPAHs																								
Phenanthrene	45.5	G		47.8	G		27	RDL,G	40.5		<MDL,G	20		<MDL,G	20	30	<RDL,G	37.4	35	<RDL,G	38.4		<MDL,G	17
HPAHs																								
Benzo(a)anthracene	36.8	G		52.3	G		27.2	G		12	<RDL,G	20.5		<MDL,G	10	42	G		49	G		20.1	G	
Benzo(a)pyrene	42.3	G		57.5	G		37.3	G			<MDL,G	15		<MDL,G	15	61.2	G		54.9	G		27.2	G	
Benzo(b)fluoranthene	53.3			64.8			36.9				<MDL	15	15	<RDL	15	61.5			66.5			28.3		
Benzo(k)fluoranthene	40	L		62.2	L		34.8	L			<MDL,L	15		<MDL,L	15	56.7	L		57.9	L		27.1	L	
Benzo(g,h,i)perylene		<MDL	38	44	<RDL	78.8		<MDL	40		<MDL	41		<MDL	41		<MDL	37		<MDL	38		<MDL	34
Chrysene	59.7			112			43.1				<MDL	20		<MDL	20	61.6			77.3			34.2	RDL	34.2
Fluoranthene	88.4			114			57	<RDL	80.9		<MDL	41		<MDL	41	75.1			92.2			36	<RDL	68.4
Pyrene	82.1	G		85	G		49.3				<MDL	20		<MDL,G	20	65.7	G		75.4	G		34.2	RDL	34.2
Total HPAH	415.9			591.8			285.6			12			15			423.8			473.2			207.1		
Other BNAs																								
Benzoic Acid	270	<RDL	319	270	<RDL	329		<MDL	67		<MDL	67		<MDL	67		<MDL	62	260	<RDL	320	210	<RDL	57
Bis(2-Ethylhexyl)Phthalate	442			374			140				<MDL	34		<MDL	34	158			168			89.2		
PCBs																								
Aroclor 1248	4.25			11.3			4.31				<MDL	1.6		<MDL	1.7	37.8			21.3			8		
Aroclor 1254	10.5			25.2			10.5				<MDL	1.6		<MDL	1.7	65.5			40.8			16.9		
Aroclor 1260	3.79			10.2			5.16				<MDL	1.6		<MDL	1.7	17			20			5.9		
Total PCBs	18.5			46.7			20				<MDL	1.6		<MDL	1.7	120.3			82.1			30.8		
Metals																								
(mg/kg dry weight)																								
Arsenic, Total, ICP		<MDL	3		<MDL	3		<MDL	3		<MDL	3.2		<MDL	3	3.5	<RDL	14.5	5.9	<RDL	14.5		<MDL	2.6
Cadmium, Total, ICP		<MDL	0.18	0.2	<RDL	0.9		<MDL	0.18		<MDL	0.19		<MDL	0.18	0.18	<RDL	0.87	0.25	<RDL	0.87		<MDL	0.15
Chromium, Total, ICP	16.6			18.7			18.7			22.8			21.9			19.4			21.3			18.1		
Copper, Total, ICP	54.7			68.2			57.4			41.8			39.1			68.7			70.5			122		
Lead, Total, ICP	5.9	<RDL	9	11.3			4.8	<RDL	9.1		<MDL	1.9	2	<RDL	9.2	14.4			27.7			4.2	<RDL	7.7
Mercury, Total, CVAA		<MDL	0.024	0.037	<RDL	0.254		<MDL	0.025		<MDL	0.025		<MDL	0.025	0.025	<RDL	0.235	0.032	<RDL	0.24	0.022	<RDL	0.218
Silver, Total, ICP	0.84	<RDL,L	1.19	0.76	<RDL,L	1.2	0.97	<RDL,L	1.21	0.84	<RDL,L	1.29	0.91	<RDL,L	1.22	1	<RDL,L	1.16	0.96	<RDL,L	1.16	0.65	<RDL,L	1.03
Zinc, Total, ICP	43.8			48.3			37.8			26.5			32.9			48.1			67.5			38.4		

<MDL - Undetected at the method detection limit
<RDL - Detected below reporting detection limit
B - Blank contamination
G - Low standard reference material recovery
L- High standard reference material recovery



Station	Easting	Northing
1A	1267047	209089
2A	1267139	208902
3A	1266951	208973
4A	1266888	209354
5A	1266805	209410
1B	1267060	208484
2B	1267079	208621
3B	1267049	208716

Station	Easting	Northing
1C	1267168	208754
2C	1267175	208651
3C	1267146	208144
4C	1267116	208239
5C	1267025	208263
6C	1266950	208501
7C	1266902	208486
8C	1266864	208920

Station	Easting	Northing
9C	1266784	209157
10C	1266663	209517
11C	1266844	209535
12C	1266813	209630
13C	1267240	207858
14C	1267193	208002
15C	1267057	207968
16C	1266834	208758

Station	Easting	Northing
17C	1266742	208877
18C	1266629	209454
19C	1266738	209538
20C	1266766	209772

Legend:

Ⓘ Sample Location

442/18.5 Baseline Chemistry Values for Bis(2ethylhexyl)phthalate and PCBs in ppb DW

NS No Sample Possible

0 75 150
Scale in Feet

K:\Jobs\000086-Duwamish\CLSR_RPRT_2005\00008601-80CR.dwg Fig 11
Jul 28, 2005 10:14am dholmer

EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Cap Monitoring Stations In Area A and B Plus Baseline Chemistry Values for Bis(2-ethylhexyl)phthalate and PCBs

Figure 11

6.2 EIGHT ADDITIONAL SEDIMENT CHEMISTRY STATIONS BEYOND THE CAP SITE BOUNDARY

The sediment monitoring plan includes a requirement to collect sediment chemistry data at eight additional stations beyond the site boundary, for a total of 20 stations (original 12 stations plus 8 new stations). A summary of the sediment monitoring program is contained in Table 10, which shows that 10 additional stations will be sampled plus the original 12 stations. Eight additional stations (DUD_15C to DUD_20C) are positioned within the river to provide more information about distribution of chemicals in this part of the river and fill data gaps. The specific locations for these eight stations were established within the river in consultation with Ecology and EPA through the use of a summary map that showed all the existing surface sediment chemistry stations in this part of the river and whether each station exceeded SMS for any chemical. To investigate river bank erosion as a potential source of recontamination to Area A, the two river bank stations (DUD_30C and DUD_31C) are positioned upstream of the Duwamish/Diagonal outfalls. The locations of all 22 stations beyond the site boundary are shown in Figure 11 (12 original stations plus 10 additional stations), although these stations are not part of the annual long-term monitoring program for the project. Sediment samples were collected at the eight new stations in the river in February 2005, and bank sampling stations were identified during a field survey; however, King County has not yet received permission from the Port of Seattle to collect the bank samples.

It is important to remember that 15 of the 22 stations beyond the boundary are included in the 5-year sediment monitoring program for the 4-acre thin layer placement project (stations DUD_1C to DUD_15C), and the chemical results for those stations will be contained in future reports.

Table 10
Sumary of Surface Monitoring Stations and Schedule

Chemistry Stations	Station Position	Sampling Years													
		2003 Before	2004 After	2005 Once	2004 Baseline	2005 Annual	2006 Annual	2007 Annual	2008 Annual	2009 Annual	2010	2011	2012	2013	2014 Last
DUD_1A	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_2A	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_3A	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_4A	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_5A	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_1B	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_2B	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_3B	On Cap				CH	CH	CH	CH	CH	CH	?	?	?	?	CH
DUD_1C	Off Cap	CH	CH												
DUD_2C	Off Cap	CH	CH												
DUD_3C	Off Cap	CH	CH												
DUD_4C	Off Cap	CH	CH												
DUD_5C	Off Cap	CH	CH												
DUD_6C	Off Cap	CH	CH												
DUD_7C	Off Cap	CH	CH												
DUD_8C	Off Cap	CH	CH												
DUD_9C	Off Cap	CH	CH												
DUD_10C	Off Cap	CH	CH												
DUD_11C	Off Cap	CH	CH												
DUD_12C	Off Cap	CH	CH												
DUD_13C	Off Cap			CH											
DUD_14C	Off Cap			CH											
DUD_15C	Off Cap			CH											
DUD_16C	Off Cap			CH											
DUD_17C	Off Cap			CH											
DUD_18C	Off Cap			CH											
DUD_19C	Off Cap			CH											
DUD_20C	Off Cap			CH											
DUD_30C	Bank			CH											
DUD_31C	Bank			CH											

CH = chemistry sample

? = either annual sampling or less then annual sampling if the rate of changes in chemical concentrations on the cap are slow

2003 Before = 12 stations collected October 20 and 21, 2003

2004 After = 12 stations collected March 19 and 20, 2004

2005 Once = 8 off cap stations collected February 1 and 2, 2005

2004 Baseline = 8 cap stations collected June 1, 2004

2005 Annual = 8 cap stations collected April 27, 2005

2005 Once = bank stations identified and requested to sample

7.0 Affidavit

The remedial action for the contaminated sediments at the Duwamish/Diagonal CSO/SD site on the Duwamish River has been completed in substantial compliance with the Engineering Design Report dated June 2003 and the Technical Specifications dated July 2003.

Bruce McDonald, P.E.
Project Manager
Anchor Environmental, L.L.C.

BRUCE G. McDONALD
STATE OF WASHINGTON
32805
REGISTERED PROFESSIONAL ENGINEER
7/27/05
EXPIRES: 10 / 30 / 06

8.0 References

Anchor Environmental, L.L.C. (Anchor). 2003. Literature Review of Effects of Resuspended Sediments due to Dredging Operations. Prepared for the Los Angeles Contaminated Sediments Task Force. June 2003

United States District Court. 1991. Consent Decree, *United States of America, Et al., v. the City of Seattle , and Municipality of Metropolitan Seattle*, Western District of Washington at Seattle, Consent Decree No. C90-395WD, December 23, 1991.

Elliott Bay/Duwamish Restoration Program (EBDRP). 2003. *Duwamish/Diagonal CSO/SD Engineering Design Report.* Prepared for the Elliott Bay/Duwamish Restoration Panel. Prepared by the EcoChem Team. June 2003.

EBDRP. 2001. *Draft Duwamish/Diagonal CSO/SD Cleanup Study Report*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Natural Resources, Anchor Environmental, LLC, and EcoChem, Inc. Seattle, Washington.

EBDRP. 1996a. *Duwamish/Diagonal Phase II Sampling and Analysis Plan*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services. Seattle, Washington. April 1996.

EBDRP. 1994a. *Concept Document, Panel Publication 7*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services (KCDMS). Seattle, Washington. June 1994.

EBDRP. 1994b. *Duwamish/Diagonal Cleanup Study Workplan*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services (KCDMS). Seattle, Washington. June 1994.

EBDRP. 1994c. *Duwamish/Diagonal Sampling and Analysis Plan*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services (KCDMS). Seattle, Washington. September 1994.

EBDRP. 1994d. *Duwamish/Diagonal and Norfolk Health and Safety Plan*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services (KCDMS).

EBDRP. 1994e. *Public Participation Plan*. Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services (KCDMS).

Ecology. 1989. *Puget Sound Dredged Disposal Analysis Guidance Manual, Data Quality Evaluation for Proposed Dredged Material Disposal Projects.* Prepared for the Washington State Department of Ecology, Olympia, Washington by PTI Environmental Services, Bellevue, Washington.

KCDNRP (King County Department of Natural Resources and Parks). 2003a. *Duwamish/Diagonal Sediment Remediation Dredging and Capping Operations Water Quality Monitoring Sampling and Analysis Plan.* Prepared by King County Department of Natural Resources and Parks, Water and Land Resources Division, Seattle, Washington. October 28, 2003.

KCDNRP. 2003b. *Duwamish/Diagonal Sediment Remediation Dredging and Capping Operations Sediment Monitoring Sampling and Analysis Plan.* Prepared by King County Department of Natural Resources and Parks, Water and Land Resources Division, Seattle, Washington. October 28, 2003.