# Expanded Area for the Duwamish Diagonal Cleanup Project Addendum

## Elliott Bay/Duwamish Restoration Program

Prepared for the
Elliott Bay/Duwamish Restoration Program Panel
by the
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# PREPARED APRIL 2002

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# EXPANDED AREA FOR DUWAMISH/DIAGONAL CLEANUP PROJECT
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## 1. INTRODUCTION

The draft Duwamish/Diagonal Cleanup Study Report (December 2001) proposed a cleanup area of about 5-acres in size (actual size is 4.8 acres); however, during the public review process in February 2002, comments were received that recommended the site be expanded to remove an upstream area of high sediment chemistry called a chemical hot spot. The primary concern was that the 5-acre cleanup area would be completely recontaminated with PCBs exceeding the SQS when the chemical hot spot was dredged in the future. The Elliott Bay Duwamish Restoration Program (EBDRP) Panel had previously discussed the potential recontamination problem created by the upstream hot, but it appeared that the cost to address the upstream hot spot was beyond the available sediment remediation budget. In response to the concerns expressed about PCB recontamination and because lower contaminated sediment disposal costs freed up substantial project budget, the EBDRP Panel requested that an evaluation be conducted to determine if the upstream hot spot could be cleaned up using the remaining EBDRP sediment remediation funds. An expanded project was designed that removes the upstream hot spot and the cost of this expanded project was within the remaining EBDRP sediment remediation funds. Based on this new information, the EBDRP Panel now proposes an expanded Duwamish/Diagonal cleanup project.

When King County staff discussed the expanded project proposal with Ecology and EPA staff, it was agreed that a stand-alone document would be created that describes the revised cleanup project and this document would be provided to these regulatory agencies in advance of when King County releases the finalized Cleanup Study Report. This document would provide Ecology the information they require to proceed with preparing the Cleanup Action Decision (CAD) document Ecology issues as part of the State Sediment Management Standards (SMS) process. At some point in the future, the stand-alone document describing the expanded area will be included in the responsiveness summary that will be attached to the finalized Cleanup Study Report. The following write up is the stand-alone document that describes the expanded cleanup area.

In addition to the expanded project document, a second stand-alone document will be prepared for the regulatory agencies. That document will contain a complete summary of source control activities related to discharge pipes and other potential sources near the cleanup area, because this information is also needed by Ecology for preparing the CAD. The Duwamish/Diagonal project schedule is very tight in an effort to begin construction of the cleanup action by November 2003 when the dredging window opens. Numerous permits are required before the project goes to construction and King County cannot officially start the permitting activities until the project is approved by Ecology in the CAD.

## 2. PREDICTED PCB RECONTAMINATION IN THE 5-ACREA AREA

Because PCB recontamination modeling factored into the decision to expand the cleanup site, a short discussion of these predictions is included in this document. PCB recontamination is not expected to occur from the discharge pipes tributary to the cleanup area because the input of PCBs from discharge pipes is very low. However, there is an area of high PCB sediment chemistry (PCB hot spot) located a short distance upstream, which was recognized as a likely source of PCB recontamination to any nearby cleanup project. A complete description of the PCB recontamination modeling was included in Appendix P of the Cleanup Study Report (KCDNR 2001) and a short discussion was included in Chapter 7 of that report. The highest rate of recontamination will occur if the upstream hot spot is dredged during a future cleanup action. Even without a cleanup project being conducted at the hot spot, it is predicted that propeller wash or river currents will resuspend some of the high PCB sediment, which creates an opportunity for this contaminated sediment to settle onto the nearby cleanup project. The Duwamish/Diagonal cleanup project has been expanded to include the upstream PCB hot spot, which eliminates both of these primary sources of potential PCB recontamination.

A screening-level, semi-qualitative analysis utilizing existing models, site data, and conservative assumptions regarding river hydrodynamics, sedimentation/settling rates, contaminant concentrations, and potential dredging actions was performed to determine the degree to which natural recovery and/or recontamination by adjacent sites could occur. Two separate figures (7-5 and 7-6) were used to summarize the modeling results because different factors affect the inshore and offshore parts of the 5-acre cleanup site. The inshore one-half of the 5-acre cleanup area is illustrated in Figure 7-6 (this was omitted from the 2001 Cleanup Study Report). In the inshore area, the input of low concentration PCB sediments from the Diagonal CSO/SD pipe appear to dilute the input of any higher PCB sediment and would produce a faster rate of natural recovery. The inshore area, down stream of the outfall, has an average surface sediment concentration of about 11 mg/kg OC. In this area, some sediment core samples show that a 2 - 3 foot thick layer of the lower PCB sediments (3 to 45 mg/kg OC) were covering over higher PCB sediments at depth (100 to 240 mg/kg OC). Figure 7-5 illustrates conditions in the offshore half of the 5-site where the dilution effect of the sediment from the Diagonal CSO/SD diminishes and the calculated average PCB concentration is about 30 mg/kg OC.

In Figures 7-5 and 7-6, the PCB recontamination predicted to occur at the cleanup area due to propeller wash and river currents was shown by curves that starts with no PCBs present at year zero (conditions immediately following the cleanup action) and then increased over a 10 year period. These curves (represented by "X's") showed a faster rate of increase in PCB recontamination during the first 5 years (Years 0 to 5) compared to the second 5 years (Years 6 to 10). Also, the predicted recontamination rate is slower in the inshore area (Figure 7-6) compared to the offshore area (Figure 7-5) because the added sediments from the Diagonal CSO/SD discharge will dilute the input of higher PCB sediment from the hot spot. After 10 years has passed, the surface concentration predicted for the inshore area is about 7 mg/kg OC, which is similar to the value of 11

mg/kg OC that was calculated as the average inshore surface concentration based on sampling data. The offshore area is predicted to reach a concentration of about 24 mg/kg OC after 10 years, which is similar to the value of 30 mg/kg OC that was calculated as the average offshore surface concentration based on offshore samples. At the predicted rate of recontamination, the offshore area would reach the SQS value of 12 mg/kg OC (represented by dotted line) at the end of 2 years. However, in the inshore area, surface PCB concentrations are predicted to reach a steady state value of about 7 mg/kg OC, which is about one-half the SQS value.

During any dredging operation (mechanical and hydraulic dredging), there will be some loss of sediment into the water column. This is frequently due to debris encountered during dredging operations that can either prevent a clamshell dredge bucket from closing completely (mechanical dredging), or can plug the pump (hydraulic dredging). In Figures 7-5 and 7-6, the rapid increase in PCB concentration caused by dredging the upstream hot spot was illustrated by the vertical line that occurs after 2 years (upper graph) and after 5 years (lower graph) from the date the first cleanup project was completed. The upper and lower graphs represent two different time scenarios for when cleanup dredging will occur at the hot spot (within 2 years or 5 years).

For both cleanup scenarios the predicted spike in surface concentration due to dredging the hot spot would increase surface concentrations by about 21 mg/kg. The same size spike is shown in both the inshore and offshore areas and for both the 2-year and 5-year scenario. The maximum predicted surface values occur in the offshore part of the cleanup area as shown in Figure 7-5. The 5-year scenario (lower graph) for the offshore area is predicted to produce the highest value, which was about 40 mg/kg OC. The 2-year scenario for the offshore area predicted the second highest value, which was about 33 mg/kg OC (upper graph). The 5-year scenario predicted the highest surface concentration because the spike caused by dredging the hotspot starts at a higher value than predicted for the 2-year scenario. For both time scenarios, the natural recovery curve (represented by black squares) predicts the offshore area will approach the SQS value of 12 mg/kg OC (represented by dotted line) in 8 to 10 years.

For the inshore area (Figure 7-6), the maximum values for both time scenarios are lower because the spike caused by hot spot dredging starts at a lower concentration. The highest values predicted for the inshore area occurred for the 5-year scenario (lower graph), which was about 28 mg/kg OC. The 2-year scenario (upper graph) for the offshore area predicted a slightly lower value, which was about 26 mg/kg OC. The natural recovery curve (represented by black squares) predicts that the inshore area will decrease to the SQS value of 12 mg/kg OC (represented by dotted line) after about 3 years.

One reviewer commented that the recontamination model greatly over-estimated the recontamination due to prop-wash and river current. The reviewer may be correct because conservative assumptions were used in this model. The model predictions were intended to represent the worst-case condition, which means that the actual recontamination levels may be less than shown in the figures. It is not necessary to refine

the predicted PCB recontamination due to propeller wash and river current because the decision to expand the cleanup area can easily be justified based on the predicted PCB recontamination due to dredging the hot spot in the future.

## 3. SUMMARY DESCRIPTION OF EXPANDED PROJECT

The revised Duwamish/Diagonal project proposes to achieve the State Sediment Management Standards (SMS) throughout two rectangular cleanup areas (Area A and Area B) by removing a layer of contaminated sediment and installing in each area and engineered isolating sediment cap that maintains existing water depths and river bottom elevations. The two rectangular cleanup areas are adjacent to each other and are located on the east side of the Duwamish River as shown in Figure EX-1. Cleanup Area A is the larger of the two areas at about 4.8 acres and is located adjacent to two discharge pipes (Duwamish CSO and Diagonal CSO/SD). Cleanup Area B is smaller in size at about 2.1 acres and is located offshore from an abandoned sewage treatment plant that closed in 1969. Sediments at both cleanup areas have concentrations that exceed the SQS values for PCBs, mercury, bis(2-ethylhexyl)phthalate, and butyl benzyl phthalate. Even though cleanup Area B is smaller in size, this area has the highest PCBs and represents a potential source of PCB recontamination to Area A unless Area B is cleaned up prior to cleaning up Area A.

The EBDRP Panel recommended applying the same preferred cleanup method in both Area A and B since the areas are similar and adjacent. Chapters 8 and 9 of the Cleanup Study Report provided the detailed alternatives evaluation for Area A. The preferred alternative recommended in the report was Alternative 3 (CAPPING WITH NO CHANGE IS ELEVATIONS) based on the eight criteria set forth in the SMS regulation. The EBDRP Panel approved this alternative as environmentally protective and cost effective. Alternative 2 (MAXIMUM PRACTABLE CONTAINMENT BY CAPPING) was rejected because this alternative reduced the bottom depths by about 3 feet, which is considered undesirable for navigation, tribal fishing activities, and impacts to habitat. Alternative 4 (MAXIMIM PRACTICABLE REMOVAL OF CONTAMINANTS) was rejected because the volume of contaminated material to be dredged and the associated costs were about twice as much as Alternative 3 without providing significant environmental benefit. Alternative 4 included 82,000 cubic yards of dredged material at a cost of $10.6 million compared to Alternative 3, which had a dredged volume of 42,500 cubic yards and a cost of $5.89 million. Alternative 1 (NO ACTION) was rejected because natural recovery at the site would not cleanup the area within the 10-year time frame required by the SMS.

## 4. SPECIFIC DETAILS FOR CLEANUP AREA A AND ADDED AREA B

The boundaries for cleanup Areas A and B were established based on the chemistry data that King County collected for the project in 1994 through 1996 plus EPA data collected in 1998. Surface contour plots showing SQS and CSL exceedances for the four chemicals of concern (COCs) are shown in Figures 5-1, 5-3, 5-5, and 5-7 of the Cleanup Study Report (KCDNR 2001), which contains 65 stations. Sediment core data are shown

in Figures 5-2, 5-4, 5-6, and 5-8, which contain 18 stations with most cores extending down to a depth of 9 feet. A composite plot of SQS and CSL exceedances is shown in Figure 5-9, which also provides station numbers for surface samples. During project review it was requested that the boundaries of the cleanup area be included on the chemistry figures, so these boundaries were added to all contour and core figures. These figures are attached to this document, which will be included in the revised finalized Cleanup Study Report.

Cleanup Area A has a generally rectangular shape about 750 feet long (upstream/downstream) with an average width of about 260 feet (inshore/offshore) and covers an area of about 4.8 acres so it is often referred to as the 5-acre site. The inshore boundary is the rip rap shoreline, but the first row of dredge cuts is set back from the shore to avoid collapsing the bank. The upstream and downstream boundaries were established based on bioassay stations that showed no toxicity (Station DUD201, DUD202 and DUD203) or only low level toxicity (Station DUD 204). The offshore boundary is the east channel line where the bottom elevation is minus 30 feet (MLLW).

The offshore boundary of Area A does not extend into the channel because the chemical levels at the east channel line are equal to or lower than the chemical levels present at the bioassay stations used to define the upstream and downstream boundary. There are two single stations located in the channel (DUD044 and DR081) that exceed the CSL value for PCBs and bis(2-ethylhexyl)phthalate; however, the EBDRP Panel determined that the offshore boundary for Area A should not extend into the channel because these two stations are far removed from the CSO and SD outfalls and the high chemistry values observed are not consistent with a decreasing concentration gradient from the outfalls.

The volume of sediment that must be removed from Area A to provide room for the isolating cap is estimated at about 42,500 cubic yards based on preliminary plans. During the design phase of the project, the dredge cuts for Area A will be finalized and a revised volume of dredge material calculated that can be used in the bid documents for the dredging contract. Sediment will be removed from the cleanup area using a mechanical clamshell dredge (bucket size 8 to 12 cubic yards) and derrick mounted on a barge.

Rectangular dredge cuts are used, and the dredge contractor produces a uniform bottom depth within each dredge cut area (a flat bottom). Because the cleanup area is on a slope, the flat bottom dredge cut will remove more sediment on the inshore side (up slope side) than the offshore side (down slope side). Each dredge cut removes a minimum of 3 feet of material at the offshore side of the dredge cut; however, on the inshore side of the dredge cut, the depth of material removed could be more than double the 3 foot of material removed on the offshore side. Additional dredging due to the slope is part of the reason that average dredge depth equals about 5.5 feet when the total volume of sediment to be removed is divided by the surface area of the Area A. The second reason the average dredge depth equals about 5.5 feet is because excess dredging is performed in the dredge cut along the navigation channel line to provide a 2-foot over-dredge. This over-dredge will insure future maintenance dredging in the channel that is performed by the

U.S. Army Corps of Engineers will not affect the integrity of the containment cap nor expose contaminated sediments.

Cleanup Area B has a generally rectangular shape of about 500 feet long (upstream/downstream) with an average width of about 160 feet (inshore/offshore) and covers an area of about 2.1 acres (may be called the 2-acre site). The boundary for Area B was established to remove all sediments above the CSL value for PCBs (Stations DUD012, DUD026, DUD027, DUD260, DUD261, and DUD262) plus a large amount of surrounding sediment that exceeds the SQS for PCBs. The inshore boundary does not extend to the shoreline because there were surface sediments with PCB values below the SQS (stations DUD009, DUD010, DUD011, and DR010) that were located on the inshore side of the existing loading pier constructed of cluster pilings. The inshore boundary of Area B was set at the offshore side of the loading pier where the bottom elevation is about minus 15 feet (MLLW). The upstream boundary was set at a point past core Station DUD261 because this station exceeded the CSL for PCBs to a depth of 6 feet. Dredge cuts in the upstream part of Area B intersect the steepest part of the dredged river channel, which causes a wide side slope to extend inshore and this creates the inshore boundary of the cleanup project.

The downstream boundary of Area B was extended to meet the upstream boundary of Area A. The downstream part of Area B contains some sediments that are not above the CSL but these sediment are above the SQS. These stations above the SQS (DUD 024, DUD025, DUD35) were included in the downstream part of Area B because these station locations would likely be subject to future cleanup actions. It is also likely that PCB levels at these stations above the SQS will increase when the PCB hotspot sediments are dredged at the upstream end of Area B, as discussed above. Dredging these stations at a later date (not as part of Duwamish/Diagonal project) would also cause recontamination problems for the finished cleanup projects at Area A and the upstream part of Area B. Therefore, it will be advantageous to remove PCBs at all of the stations identified in Area B, now, to minimize the PCB residual that is left on the site.

The offshore boundary of the cleanup Area B extends about 50 feet into the navigation channel. The cleanup boundary extends into the channel because high PCB values are found at Stations DUD027 and DUD261, which are near the east channel line and exceed the CSL. In 1984, the U.S. Army Corps of Engineers dredged one barge load of contaminated sediment to remove a shoal from an area of the channel near Station DUD027. A 1997 bottom depth survey shows that presently there is a shoal up to about 3 feet thick extending about 50 into the channel from the east channel line. The offshore boundary of Area B was positioned 50 into the channel for four reasons:

- It appears that some high PCBs may already extend into the channel as an extension of the inshore area that has the highest PCB values in Area B.
- After dredging Area B some elevated PCB sediments may migrate onto the edge of the channel.
- Some elevated PCB sediments may already extend along the east channel line due to the previous dredging action in 1984.

- The cleanup project will remove the existing shoal from the navigation channel because the shoal probably already contains high PCBs (or will after dredging inshore Area B) and future dredging of this shoal by the US Army Corps of Engineers would recontaminate the completed cleanup projects in Area A and Area B.

The volume of sediment that must be removed from Area B to make room for the sediment cap is estimated at about 19,500 cubic yards. During design the dredge cuts will be finalized and a revised volume calculated for use in the construction bid document. The upstream part of cleanup Area B is the most complicated to design because the inshore area is located on a side slope extending down to the navigation channel. The rest of the area extends relatively level into the navigation channel at about elevation minus 30 feet MLLW.

The expanded Duwamish/Diagonal cleanup project now includes Area A at 4.8 acres and Area B at 2.1 acres for a combined area of 6.9 acres (may be referred to as a 7-acre site). When the dredge volume of about 42,500 cubic yards for Area A is added to the dredge volume of about 19,500 cubic yards for Area B, the total combined dredge volume equals 62,000 cubic yards. The cubic yards of capping material needed to return the site to pre-dredging elevations was determined to be 42,500 cubic yards (63,750 tons) for Area A and 19,500 cubic yards (29,250 tons) for Area B, for a total volume of cap material of 62,000 cubic yards (93,000 tons). It is important to point out that even though these volumes are the same number, the volume of cap material is about 10 percent less that the volume of material to be dredged. This difference occurs because the dredged material value of 62,000 cubic yards is the in-place sediment, which will expand (bulk) about 10 percent when the material is dredged yielding a volume of 68,200 cubic yards of bulked dredged material. The difference between these two numbers is 6,200 cubic yards (62,000 cubic yards capping material vs 68,200 cubic of yards of bulked dredged material), which is the volume difference needed to allow the over-dredged areas near the channel to remain 2 feet below the pre-dredge elevation.

## 5. CHEMICAL LEVELS REMAINING ON SITE AFTER CAPPING

During project review, regulatory agencies requested information regarding the chemical levels in sediments that will remain behind in this part of the river after the capping project would be completed. One part of this question deals with the sediment quality beyond the cap boundaries and the second part of this question deals with the sediment quality beyond the cap boundary. In order to answer the question about sediment quality beyond the cap area, each of the colored surface contour plots (5-1, 5-3, 5-5, 5-7, and 5-9) was revised to show the boundary lines for cleanup Areas A and B. The slope of the dredge cut may extend a short distance beyond these boundaries and a limited amount of capping material will extend beyond the boundary to back-fill these dredged side slopes.

In order to answer the question about the chemistry levels in the sediment that will remain under cap (sediment that will not be removed) four new figures were created

(Figures EX-3, EX-4, EX-5, and EX-6) using the core data collected in 1996 for each chemical of concern. Each core extended 9 feet deep and was divided into three 3-foot sections. Because a minimum of 3 feet of sediment will be removed to make room for the capping material, the sediment that will be capped can be represented by the 3 - 6 foot section or the 6 - 9 foot sections.

A table of data is included in each figure, and the term "REM" has been included in the table to show that all of the 0-3 foot deep core sections will be removed. This actually understates the amount of material that will be dredged because in most areas, more than 3 feet of sediment will be dredged due to the sloping project site. Across the entire site an average of 5.5 feet will be removed, with 12 to 15 feet removed in some locations. When core stations occur in areas that will be dredged much deeper then 3 feet the term "REM" is included for all three core sections to indicate that each core section would be removed. Station DUD255 is located in a deeper dredge cut along the channel and the term "REM" is included for all three core sections to indicate all 9 feet will be removed.

To allow the four figures to illustrate the spatial distribution of the sediment that would remain after dredging, the data for each of the three core sections is displayed next to the coring station location. At station DUD251, for example, the PCB values for each of the core sections 0-3/3-6/6-9 appear next to the station as REM/138/16U (see Figure EX-4). This indicates that the 0-3 foot section will be removed by dredging and the remaining 3-6 and 6-9 foot sections had values of 138 mg/kg OC and 16U mg/kg OC, respectively. By contrast, station DUD255 has REM/REM/REM listed next to the station because all 9 feet of sediment will be dredged. In some cases core sections were not analyzed and this situation was identified in the data tables and figures by the term "NA".

## 6. COST FOR COMBINED CLEANUP AREA A AND AREA B

Chapter 9 of the Cleanup Study Report provided cost estimates for three potential cleanup alternatives for Area A and this information was used to select a preferred alternative. Detailed cost information for the preferred alternative was provided in Table 9-2 titled Cost Estimate for Alternative 3: Capping with No change in Existing Elevations and this same table is included here as Table EX-1 with a more refined cost estimate. As stated above, the original cleanup area (Area A) was about 4.8 acres and required the removal of approximately 42,500 cubic yards of in-place sediment material (68,200 cubic yards bulked dredge material) and the placement of 42,500 cubic yards of clean material to cap any remaining contamination and restore the site to nominally original elevations. The estimated cost to implement the preferred alternative at Area A was $5.84 million as shown in Table EX-1 ($5.89 million minus $50,000 for reduced bottom survey costs). This cost estimate reflects the cost to proceed from this point in time and does not include about $ 1 million of planning funds spent to complete the site characterization and alternatives evaluation.

A detailed cost estimate for the expanded cleanup project including Area A and B, was prepared in the same format to allow for comparison and was included as Table EX-2.

The expanded cleanup project has a combined area of about 6.9 acres (Areas A at 4.8 acres and Area B at 2.1 acres). A similar cleanup remedy was used for the expanded project and the total volume of sediment to be removed by dredging was about 62,000 cubic yards of in-place material, which is an increase of approximately 19,500 cubic yards (46 percent). The expanded volume for disposal is 68,200 cubic yards (102,300 tons). The total volume of capping material needed to restore the site to nominally original elevations was 62,000 cubic yards (93,000 tons). The estimated cost for the expanded cleanup project was $8.17 million as shown in Table EX-2. The addition of Area B increased project costs by $2.33 million, which is a 40 percent increase in cost and was directly related to the increased area and volume of sediment to be removed and replaced. The estimated cost of $8.11 million for the expanded 6.9-acre project reflects only the cost to proceed forward from this point in time. About $ 1 million of planning funds have already been spent to perform the site assessment and alternatives evaluation described in the Cleanup Study Report.

## 7. SEQUENCE OF WORK TO CLEANUP AREA A AND AREA B

Because the two rectangular cleanup areas are adjacent to each other, the cleanup activities for each site will be coordinated in a manner that minimizes the potential for dredging work at one area to cause recontamination to the other area. It is anticipated that one contractor will complete all the dredging activities for both areas before proceeding with the sediment capping activities.

The proposed project will occur in the following sequence:

- Contaminated sediments will be dredged using a clamshell bucket dredge, beginning with the most contaminated sediment first (the upstream hotspot). Generally, the inshore, higher elevation, material will be removed first while moving toward the lower elevation channel. The dredged material will be placed on haul barges for transport to the off loading facility.

- River water that is deposited on the barge with the dredge material would be allowed to drain back to the river after passing through three layers of filter fabric.

- Dredge material would be transported to an off loading facility, likely located on Harbor Island, where it would be loaded into sealed, lined railcars. The rail cars would then be taken to an upland disposal site.

- An alternate disposal option would be for the dredge material to be hauled by barge to an approved off-site near-shore confined-disposal site, where it would be offloaded.

- Cap material would be obtained (either from commercial sources or from maintenance dredging activities such as the bi-annual Duwamish River turning

basin dredging) and transported to the site, where it would be spread using the crane and clamshell dredge bucket.

- Long-term monitoring (ten years) will be conducted to document cap stability and evaluate potential recontamination.

Dredging activities for the project will start in cleanup Area B to remove the highest PCB concentrations first. The advantage of this dredging sequence is that any sediment from dredging Area B that might fall onto Area A will be removed when Area A is dredged second. Dredging will either proceed from inshore to offshore or from offshore to inshore using the rectangular dredge cuts shown in Figure EX-1. In Area B the sloped area from the inshore boundary down to the east navigation channel line contains the highest PCBs so this area will be dredged first.

Adjacent to and within the navigation channel, the dredge cut will be deep enough to provide a 2-foot over-dredge. This means that when the 3-foot thick cap is installed, the finished bottom elevation will be minus 32 feet (MLLW). Since the navigation channel has a required depth of minus 30 feet (MLLW), the finished cap depth will be 2 feet deeper then the required channel depth. This over-dredging removes potential encumbrances for the future U.S. Army Corps of Engineers channel dredging and in some area removes material in advance of when the material would need to be removed as part of normal maintenance dredging activities. The over-dredging will also provide some storage capacity to limit the potential need for dredging of deposited sediments in this area of the river.

The longest dredge cut in Area B extends about 50 feet into the navigation channel and will remove the shoal that extends about 50 feet into the channel. The dredge cut in the navigation channel will run the entire 500-foot length of cleanup Area B (upstream/downstream), which will remove a 500-foot long section of the downstream end of the shoal. Besides removing the existing shoal, there will be an additional two feet of storage capacity created in this part of the channel due to the 2-foot over-dredging. Bottom depth surveys will be conducted in both Areas A and B to confirm that the required dredge depths were met. The dredging contractor will be required to correct any dredge cuts that are not deep enough per the dredge plan and another bottom survey will be performed that will verify the corrective action.

Capping activities will not be allowed to proceed until all dredging work is completed in both cleanup Areas A and B. This will allow any contaminated material that may have been resuspended and deposited on the site during dredging operations to be capped in-place when capping material is placed throughout the site. The sequencing of capping (inshore/offshore and upstream/downstream) will be left to the discretion of the contractor. The preferred source of cap material is clean sand from the U.S. Army Corps of Engineers bi-annual maintenance dredging at turning basing #3 located up stream of the Duwamish/Diagonal sediment cleanup project. If for some reason this dredged sand is not available, then clean sand will be purchased and barged to the area. The minimum cap depth would be 3 feet to correspond with the minimum dredge depth of 3 feet.

However, in many parts of Areas A and B the dredge depth is greater than 3 feet, which means that more than 3 feet of cap material will be added to restore the area to pre-dredge bottom elevations and slopes.

King County will obtain all necessary permits (including an U.S. Army Corps of Engineers section 404 permit) prior to work initiation. All in-water work is scheduled for completion between November 2003 and March 2004. To insure the sediment caps installed in Areas A and B are not compromised, property restriction agreements (institutional controls) are needed with the Port of Seattle to avoid dredging activities and to insure both Ecology and EPA are notified if construction activities will involve the sediment caps. A long-term (ten-year) monitoring program will be conducted by King County to document the cap stability and recontamination as described in Appendix Q of the Cleanup Study Report. The two main activities of the monitoring are to verify the cap stability and document recontamination of the cap surface.

## 8. SOURCE CONTROL ISSUES RELATED TO DISCHARGE PIPES

Because source control issues effect sediment cleanup decisions, it seems appropriate to include the key finding of the source control summary document as the last section of this expanded project document. In the future, the source control summary document will be included in the responsiveness summary that will be attached to the final Cleanup Study Report. In discussions with Ecology and EPA, it was agreed that this source control summary document would be provided to the regulatory agencies prior to release of the finalized Cleanup Study Report. The general conclusion of the source control summary document was that many source control activities have occurred to reduce chemical inputs, which has eliminated concern about recontamination for most chemicals. The main source control activities regarding discharge pipes are provided below.

There are two discharge pipes located along the east side of cleanup Area A. The Duwamish CSO is a submerged pipe that has not overflowed since 1989 and is not considered a significant recontamination source. This CSO is the emergency overflow for the Siphon and the Duwamish Pump station and is not expected to overflow unless there is an emergency situation that shuts down the pump station (i.e. power loss due to an earthquake).

The Diagonal CSO/SD discharge consists of a large concrete structure located in the intertidal area and attached to a buried 12-foot diameter pipe. A large amount of CSO control has occurred at Diagonal CSO/SD with the City of Seattle reducing CSOs to less than one event per year. King County has achieved about 80 percent reduction in CSO volume at Diagonal CSO/SD with about 65 MGY remaining. In addition, the separated storm water from the Diagonal and Hanford basins discharge out the Diagonal CSO/SD pipe and represents the largest flow volume at an estimated 1,230 MGY. The City of Seattle will clean contaminated sediment from the Diagonal CSO/SD pipe before the Duwamish/Diagonal sediment cleanup project is implemented.

There are three programs that are applied to the entire Seattle area and reduce chemical inputs to CSO and SD discharges. The City of Seattle runs a storm water protection program that involves business inspections and catch basin maintenance. King County runs an industrial pretreatment program that is designed to limit chemical discharges to the sewer system in order to protect the sewage treatment plants from chemical upsets and to limit the amount of chemicals in biosolids. A multi-agency hazardous waste program also inspects businesses to reduce chemical input. In the future, some additional work may be focussed on the Diagonal CSO/SD drainage basin.

All of the CSO control and BMP activities performed to date as well as ongoing activities reduce the chemical loading that will discharge out the Diagonal CSO/SD. Past experience monitoring sediments off CSO and SD discharges indicate that the only chemicals that produce sediment concentration above the SMS standards are the phthalates. The phthalates have wide spread usage in products and do not appear to be coming from localized point sources that could be controlled by industrial source control actions. Resource agencies seem to be in agreement that it is difficult to remove phthalates from large storm water discharges and that it is important to proceed with cleanup projects that remove high priority chemicals like PCBs even if there is potential for some level of phthalate recontamination.

At cleanup Area B, there is one historic outfall pipe in the intertidal area from the old treatment plant that closed in 1969. Upstream of Area B there is a small (12-inch) storm drainpipe located in the upper intertidal area. This small pipe is Diagonal Ave. South storm drain with a drainage basin of about 12 acres. Three sediment samples were collected offshore from this small SD pipe; however, the only chemicals that showed increased values near the storm drain were the two phthalates (butyl benzyl phthalate and bis(2-ethylhexyl)phthalate) that are present in Areas A and B. The lack of any elevated chemicals, besides phthalates, in these three sediment samples collected in front of the small SD outfall suggests there are no problem discharges to this small pipe that could be a potential recontamination source to Area B. Also, the City of Seattle carries out periodic business inspections in this basin.

While the two outfall pipes that boarder cleanup Area B (historic treatment plant outfall and small Diagonal Ave. S. SD) are not considered to be a potential source of recontamination to the cleanup area, regulatory agencies wanted to know about other possible discharges from the property. There have been numerous activities at the old Diagonal Avenue sewage treatment plant property that could have introduced chemicals into the sediments. Consequently, regulatory agencies have asked whether surface drainage, groundwater discharge, or bank erosion from that property could pose a potential source of recontamination to the Duwamish/Diagonal cleanup project. These topics are discussed in detail in the source control summary document, which concluded that it is unlikely that these three potential sources would be a recontamination source to the cleanup project. Most of the shoreline of the old treatment plant property is covered with rip rap rock to stabilize the bank. The one area of exposed intertidal sediment was sampled and chemical analysis resulted in low chemical concentrations. The row of sediment samples collected closest to shore near the old treatment plant property were

low in most chemicals including PCBs. A large part of the property has been paved over which will limit surface water contact with underlying sediment and prevent input from surface water. The Port of Seattle sampled groundwater at 14 wells drilled on the property in 1992 and the data do not indicate any problem chemicals in ground water.

As part of the lower Duwamish River Superfund activities, Ecology has taken the lead to develop a comprehensive source control program that will protect sediments in the Duwamish River, including all sediment remediation sites. This comprehensive source control program will be developed during the next couple of years and will apply to the Diagonal CSO/SD.

## 9. MONITORING PLAN FOR CLEANUP PROJECT AT AREA A AND AREA B

Appendix Q of the Duwamish/Diagonal Cleanup Study Report contains a preliminary draft of a Construction and Post-Construction Monitoring Plan for cleanup Area A. This draft monitoring plan extends over a period of 10 years and will be expanded to included cleanup Area B. It is envisioned that the monitoring plan will be updated and revised following final design and permitting. The hydraulic permit issued by the Washington State Department of Fish and Wildlife typically requires a formal monitoring plan to approve sediment cleanup projects (required for 1999 EBDRP Norfolk CSO/SD cleanup project).

Environmental monitoring for the Duwamish/Diagonal cleanup project involves both short-term and long-term activities. Various short-term monitoring activities are needed to facilitate dredging activities and the placement of capping material according to plan specifications. There are two long-term monitoring activities, which focus on documenting stability of the sediment cap and also determining the amount of chemical recontamination that occurs on the surface of the cap. The strategy for long-term monitoring is to conduct sampling more frequently during the early years after capping and then to reduce the frequency of sampling over time. The long-term activities are patterned after the 10 year monitoring plan being carried out at another EBDRP sediment capping project called the Pier 53-55 capping project, which was constructed in Elliott Bay during 1992.

There are seven main objectives associated with the monitoring plan and these objectives apply to both cleanup Areas A and B. Each objective is listed below along with a summary of the main activities included in the monitoring program to achieve these objectives (see Appendix Q for additional information).

Monitoring Objective # 1 is to ensure that water quality guidelines are met during dredging, and transport of contaminated sediment from the dredging barge to the rail/truck loading area. Most of the chemical pollutants in the sediments to be dredged stay attached to the sediment particles and do not become soluble in river water. Prior to field dredging operation, the existing chemistry data from the site assessment at Duwamish/Diagonal will be used to calculate a TCLP (Toxic Characteristic Leaching Procedure) prescreening to see if chemical levels in sediments are predicted to be a

potential problem for leaching. If chemicals exceed the TCLP prescreening, then additional sediment sampling will be performed during the design phase to directly measure the potential for contaminants to leach from the sediment during dewatering on the barge and whether this would pose any adverse impact to the receiving waters.

Turbidity is another water quality parameter that has established standards, but this parameter is not always measured. Turbidity monitoring of the water column is not currently proposed during dredging operations, but could be included if required by permitting agencies. There are three main reasons for not recommending turbidity monitoring: 1) Dredging will occur during the winter flood season when there is typically high river flow and high turbidity; 2) The winter dredging window has been established for regulatory purposes because during this time of year there is minimal use of the river by important salmonid species; 3) Dredging at the Duwamish/Diagonal site represents a relatively small volume of material compared to maintenance dredging projects. As in past sediment cleanup projects, the contractor will be required to conduct the dredging operations at the Duwamish/Diagonal site with care to minimize the amount of turbidity produced. If water column sampling were required during dredging operations, King County Environmental Laboratory (KCEL) staff would collect the turbidity data using PSEP recommended guidelines (PSEP 1996).

Monitoring Objective # 2 is to insure that the dredging and capping constructions are performed according to plan specification. The dredging depths and capping elevations will be monitored to document that the construction of the cap adheres to the specifications in the dredge and cap plan. Accurate measurements of the dredging depths and capping depths are required because the payment schedule for the construction contractor is based on the calculated volume of material dredged and the calculated volume of capping material placed on the site. Detailed bottom depth surveys will be conducted prior to dredging, after dredging is completed, and after the capping material has been placed. If surveys detect deviations from either the dredging or capping plan, the contractor will be required to make corrections, which will be verified by conducting additional bottom depth surveys.

Monitoring Objective # 3 is to verify that the dredged material is below the PCB dangerous waste level (50 ppm) and will be acceptable for landfill disposal. For those areas of the cleanup Area A and B that are anticipated to contain the highest PCB values, a few composite samples of the dredged material will be collected from the haul barge and analyzed over night to determine the PCB concentration. Previous sampling at the Duwamish/Diagonal site has shown that in cleanup Area A all samples were well below the PCB dangerous waste value of 50 ppm, which means that all dredged sediment is anticipated to be acceptable for disposal at an approved landfill. In cleanup Area B one of the 3 surface samples from the hot spot had a value of 85 ppm (station DUD 027), which is over the dangerous waste value of 50 ppm. A core sample collected from this same station contained a value of 9 ppm in the 0-3 foot section with the highest value of 23 ppm in the 3-6 foot section. This data showed that even though the surface grab exceeded the dangerous waste value of 50 ppm, the core samples were substantially below the standard. The composite sample will be collected from the barge of dredged

sediment and analyzed over night. If the composite sample of dredged sediment shows PCBs at a value of 45 ppm or greater, then the disposal contractor will be notified and the associated batch of dredge material will be directed to a landfill approved to take hazardous waste.

Monitoring Objective # 4 is to make sure that the capping backfill material is clean prior to placement. The chemical quality of the capping backfill material will be determined base on collecting and analyzing one composite sample of the capping backfill material prior to placement of the capping material. If this capping material is obtained from maintenance dredging at the head of navigation channel in the Duwamish River, the sediment chemistry quality data routinely produced by the U.S. Army Corps of Engineers for open water disposal will be compared to the SMS as a preliminary screening. Confirmatory testing of maintenance dredge material will be performed on the first load of dredge material while it is on the barge. Staff from King County environmental laboratory will collect and analyze the composite sample to represent sediment quality of the entire barge load. If capping material is purchased from a supplier, one composite sample will be collected and analyzed prior to acceptance and placement of the material.

Monitoring Objective #5 is to document cap stability for isolating contaminants over time. Checking for sediment erosion using one of two methods will monitor stability of the cap material. The preferred method for measuring erosion is to use a grid of fixed measuring stakes that extent through the cap and also extend above the cap to allow measurement. However, concern has been raised that the fixed stakes would become an obstruction for Tribal gill net fishing activities conducted in this area of the river. Efforts will be made to design a flexible stake (similar to a bicycle flagpole) that would not snag gill nets and would be approved by the tribe. A grid of 13 stakes was proposed for Area A, but a grid pattern has not yet been proposed for Area B.

The alternate approach that could be used to measure cap erosion is to conduct detailed bottom depth surveys each monitoring year similar to the detailed bottom survey that was conducted at the end of cap construction to verify the cap surface elevations. Survey data from each year would be used as input to a computer program designed to calculate the bottom elevations of the cap surface. If bottom depth increased then erosion would be indicated and would be evaluated by taking sediment cores. If cores confirmed erosion, then meetings would be held with regulatory agencies to determine the cause and required solution.

Monitoring Objective # 6 is to document future recontamination of the cleanup Area A from continuing point source discharges from the Diagonal CSO/SD outfall (primarily the 1,230 MGY of separated storm water). Accumulation of surface sediment contamination on the Duwamish/Diagonal sediment cap will be evaluated by collecting and analyzing grab samples from five stations. These stations are in a "V" pattern with the point towards the outfall.

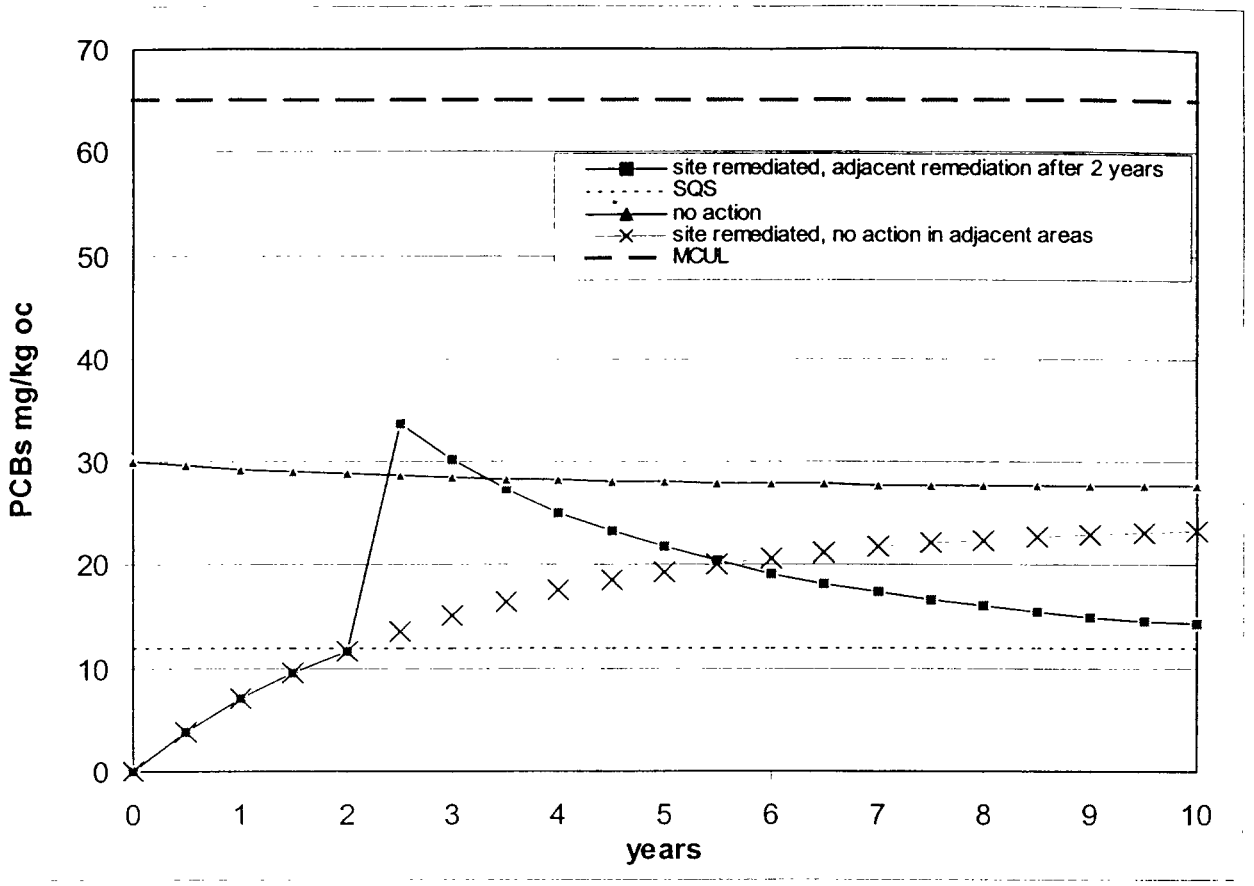
Monitoring Objective # 7 is to document whether PCB contamination located on adjacent property migrates onto the cap. Now that the cleanup project has been expanded to

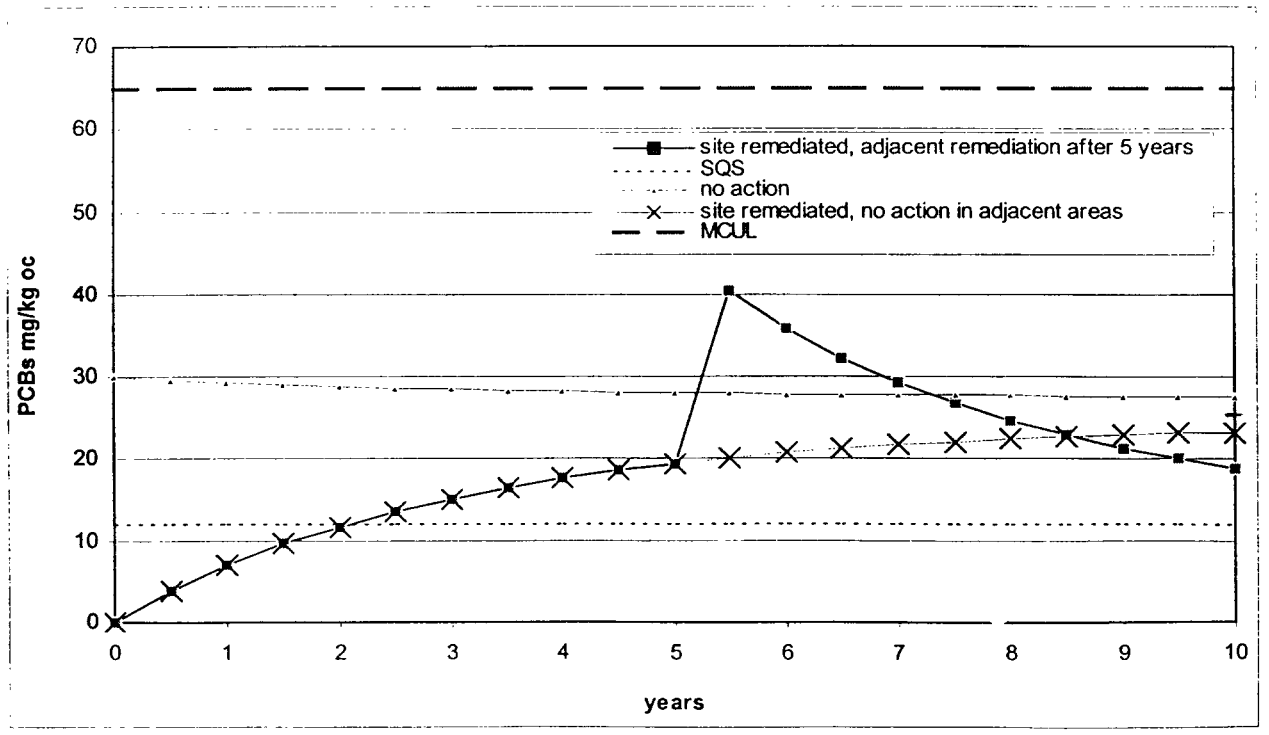
remove the PCB hot spot there should be minimal PCB recontamination from surrounding areas. Two or three surface grab stations would be placed on cleanup Area B to document any potential PCB recontamination to the cleanup area.

Staff from King County environmental laboratory will collect all surface samples using a small vessel outfitted with a crane and Van Veen grab sampler. All samples will be collected, handled, and processed in accordance with previous Duwamish/Diagonal Sampling and Analysis Plans/Addenda (EBDRP 1994, 1995). At each station a minimum of three grab samples will be composited and homogenized for laboratory analysis. A stainless steel spoon will be used to collect the top 10 centimeters of sediment from three replicate grab samples per station. Each 0-10 cm composite sample will be analyzed for SMS chemicals and associated parameters such as total organic carbon, total solids, and particle size distribution.

The cap will be sampled within 3 months after cap placement to document baseline surface sediment conditions. Surface sediment stations will be sampled each year for the first 5 years following cap placement. However, the frequency of sampling events to be carried out during the second 5 years of the 10-year monitoring will be determined based on the rate of recontamination during the first 5 years. If recontaminaton appears to be stabilized, then sampling may be reduced to alternating years or longer between sampling events. A project monitoring review meeting will be held after 5 years to decide future monitoring frequency. Chemistry data for each station will be reported in dry weight values to show trends in chemical levels each year and will also be normalized to organic carbon where appropriate for comparison to SMS criteria values.

Modifications may be required to the monitoring plan before it is finalized. During the permitting process and public review for the project, regulatory agencies or affected parties may request additional monitoring. Even after the annual monitoring program is underway, revisions may be needed to the monitoring plan to respond to the results obtained. For example, if chemical levels in surface sediments eventually reach the CSL value for phthalates, then the monitoring program will be expanded to include bioassay testing methods outlined in the sediment management standards, which will show whether biological toxicity occurs at the numeric CSL value.



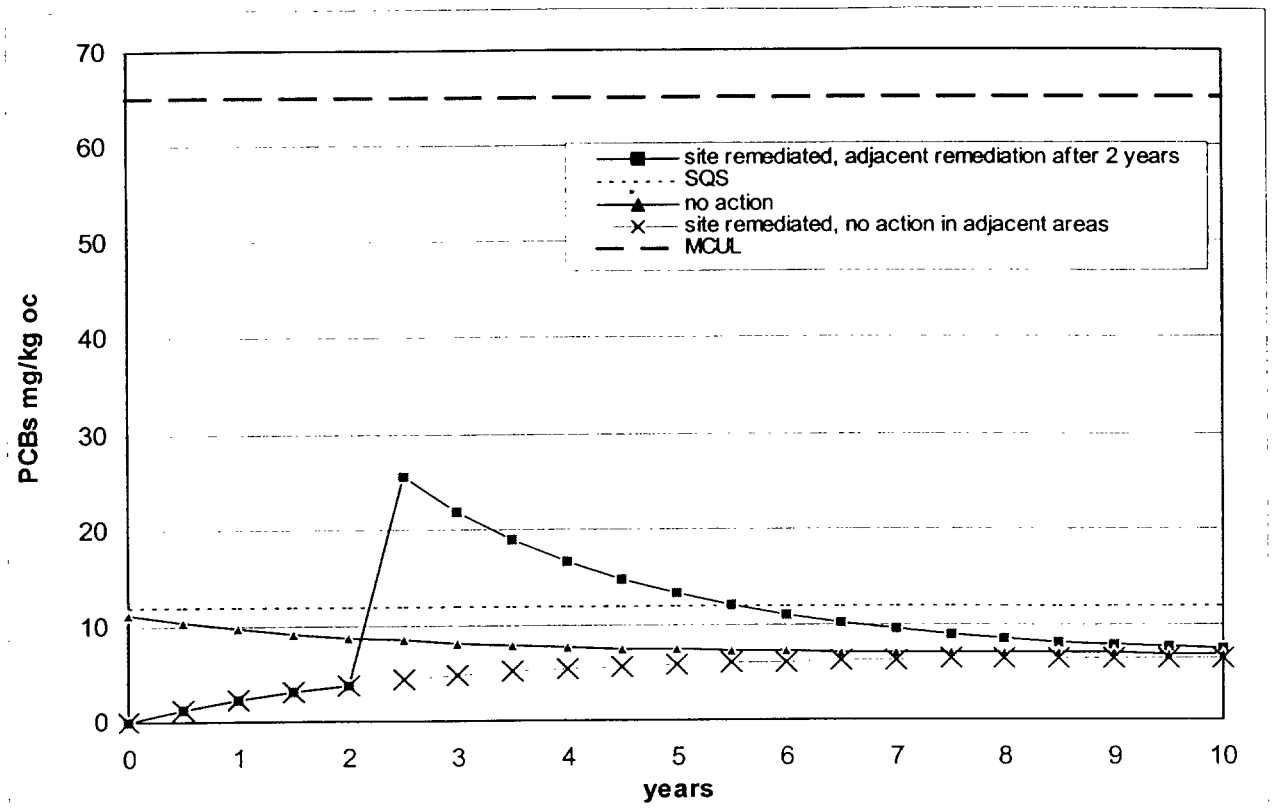



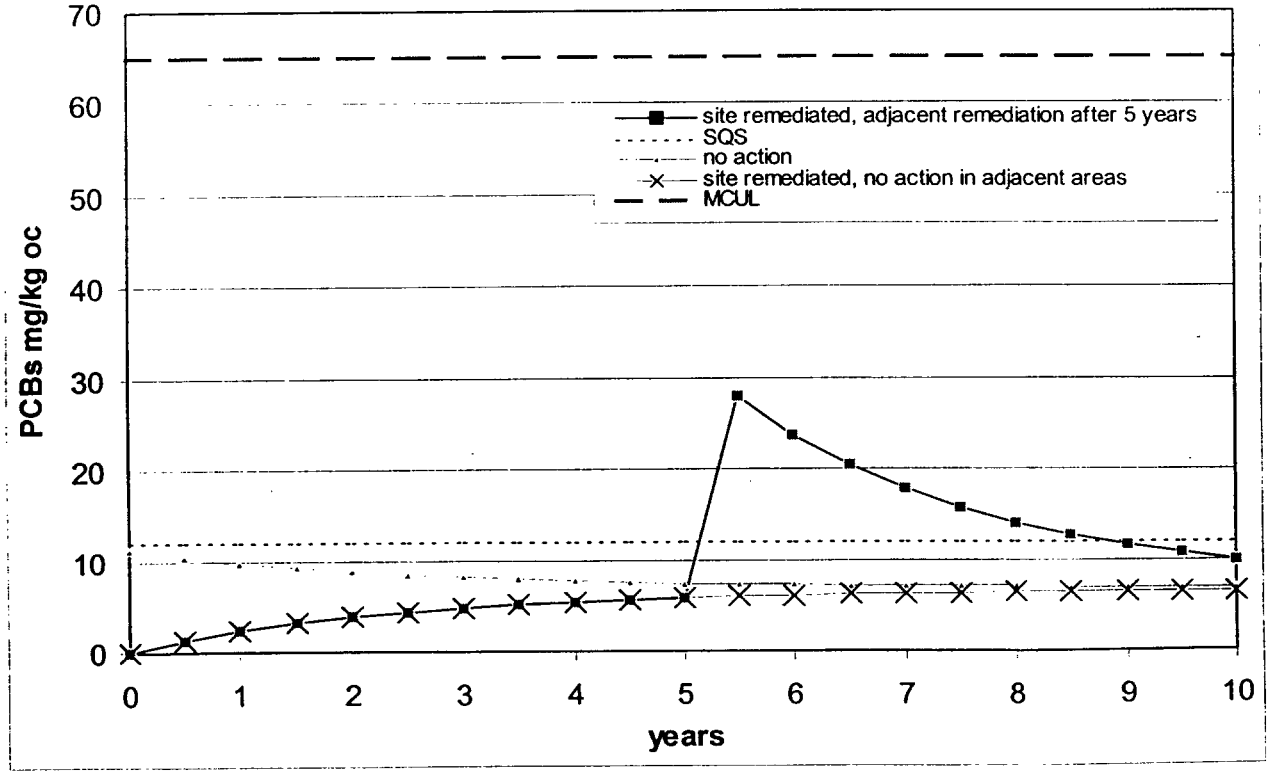

| | | |
|---|---|---|
| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 7-5 |
| | Natural Recovery Model Results<br>Away from the Outfalls | |

00-086-01

DWD010-01

12/19/01

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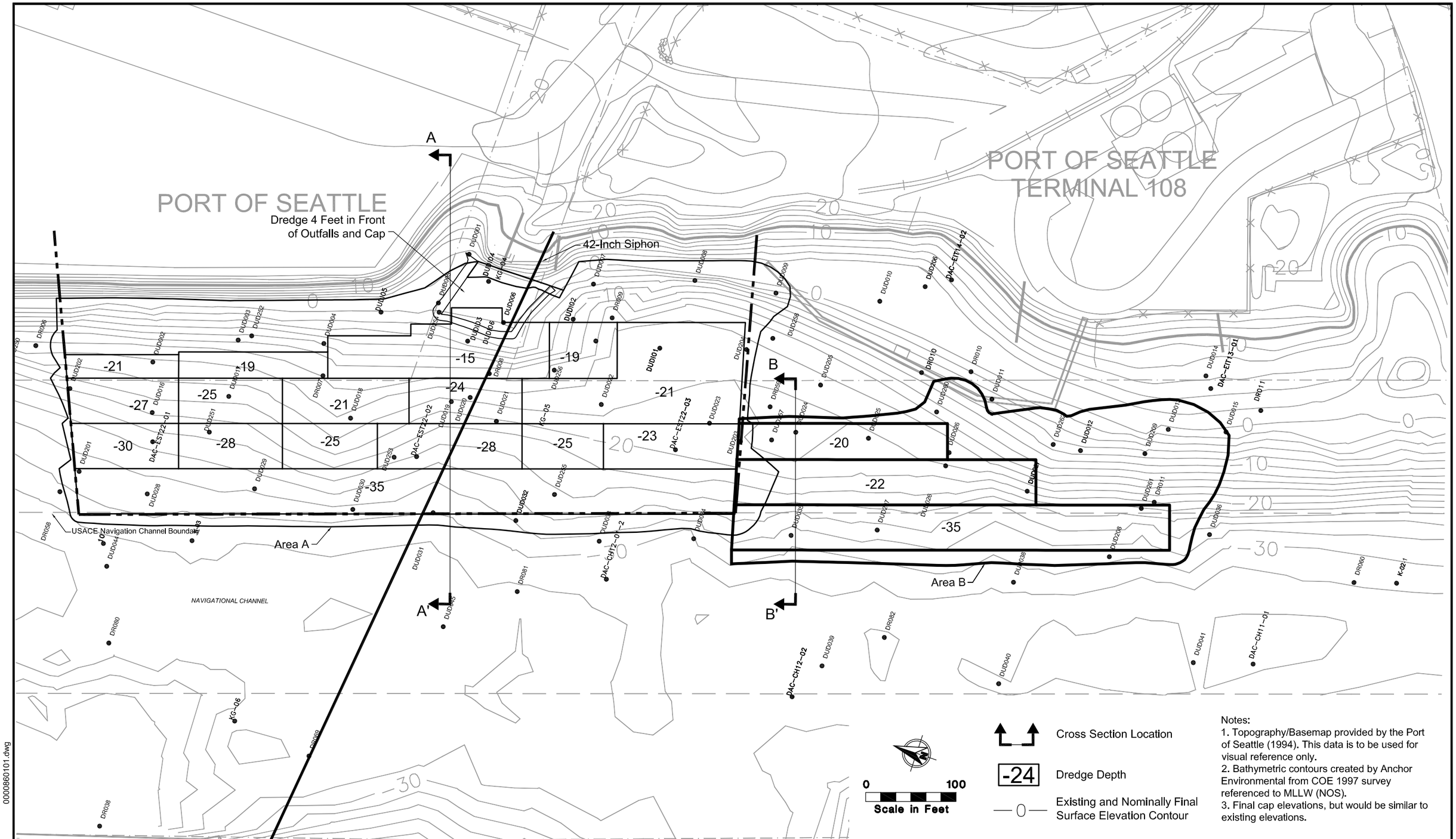
| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 7-6 |
|---|---|---|
| | Natural Recovery Model Results Near the Outfalls | |




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 COE 1997 survey referenced to MLLW (NOS).
3. Final cap elevations, but would be similar to existing elevations.

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4/4/02

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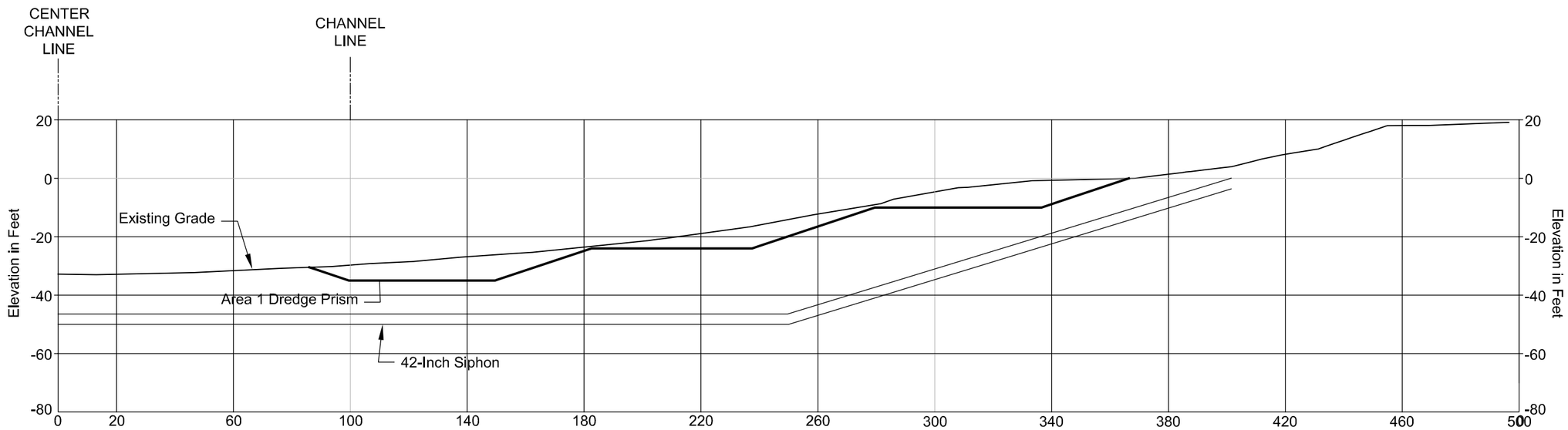
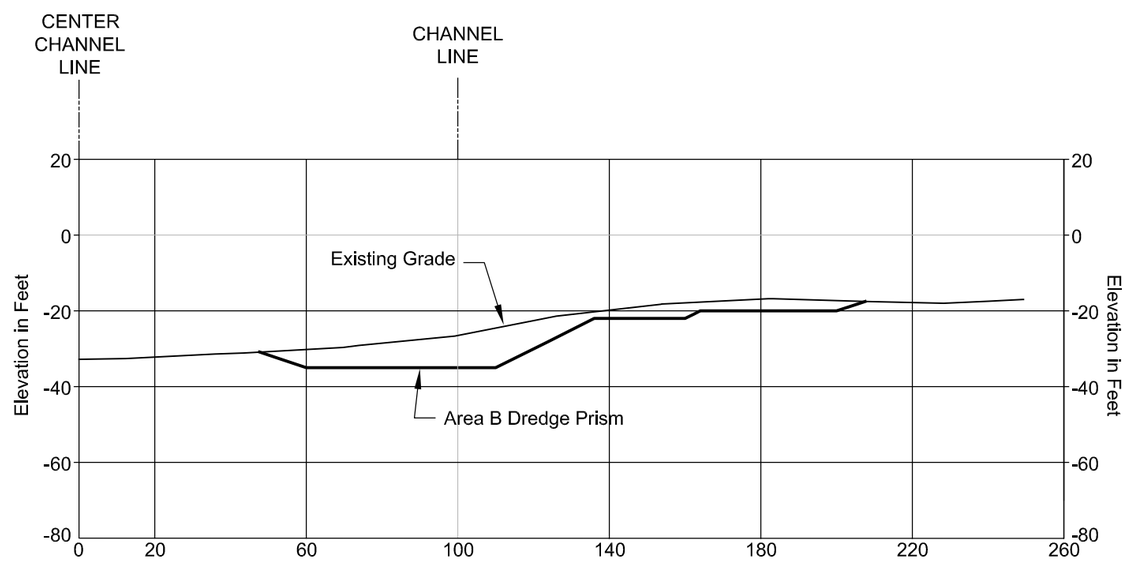
Duwamish/Diagonal Sediment Remediation Project

Alternative 3: No Change in Existing Elevations, Dredge Layout (Plan View; including Area B Removal)

Figure EX-1



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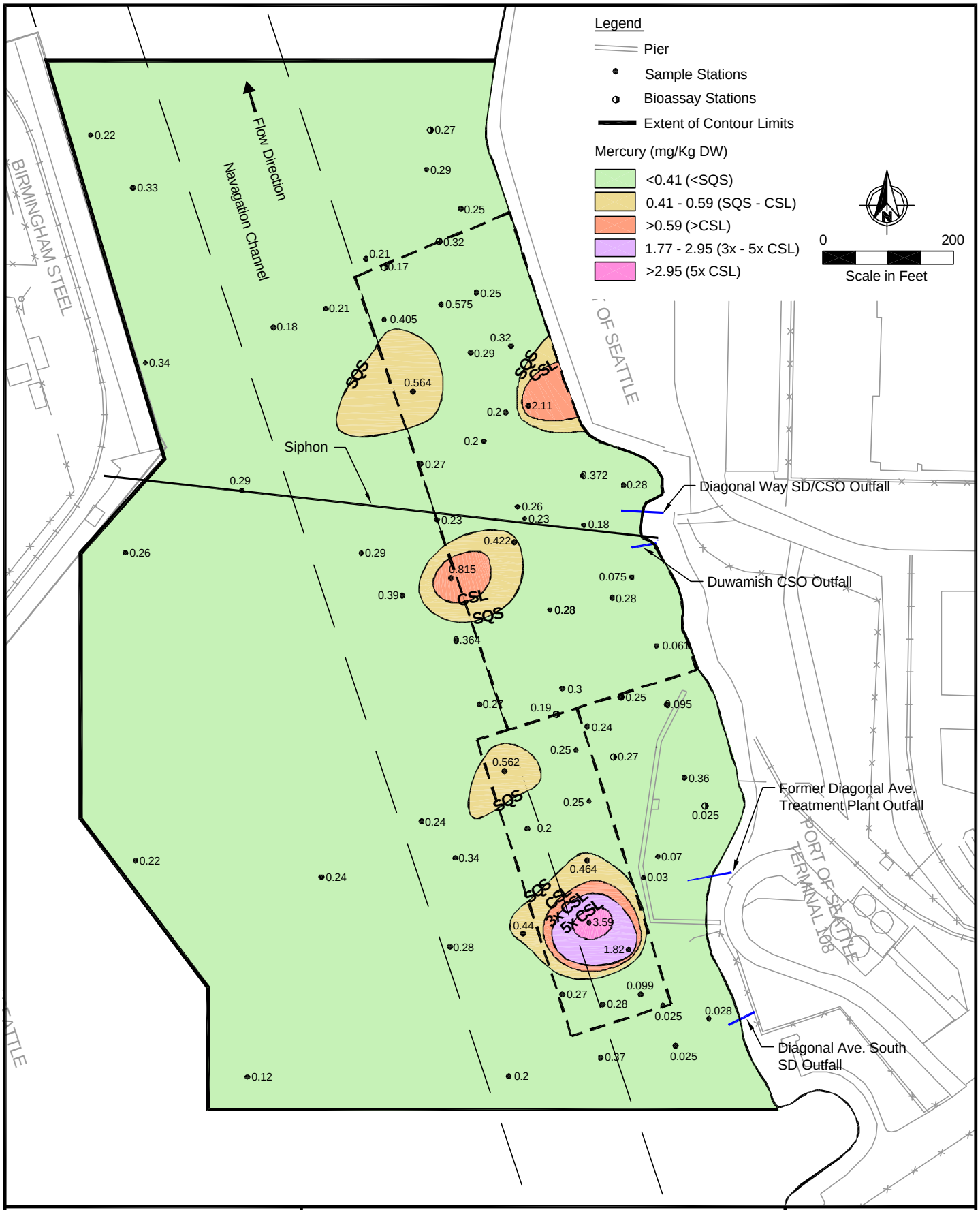
| | | |
|---|---|---|
| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure EX-2 |
| | Alternative 3: Cross Sections | |




| | | |
|---|---|---|
| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 5-1 |
| | Mercury Concentrations in Surface Sediments | |

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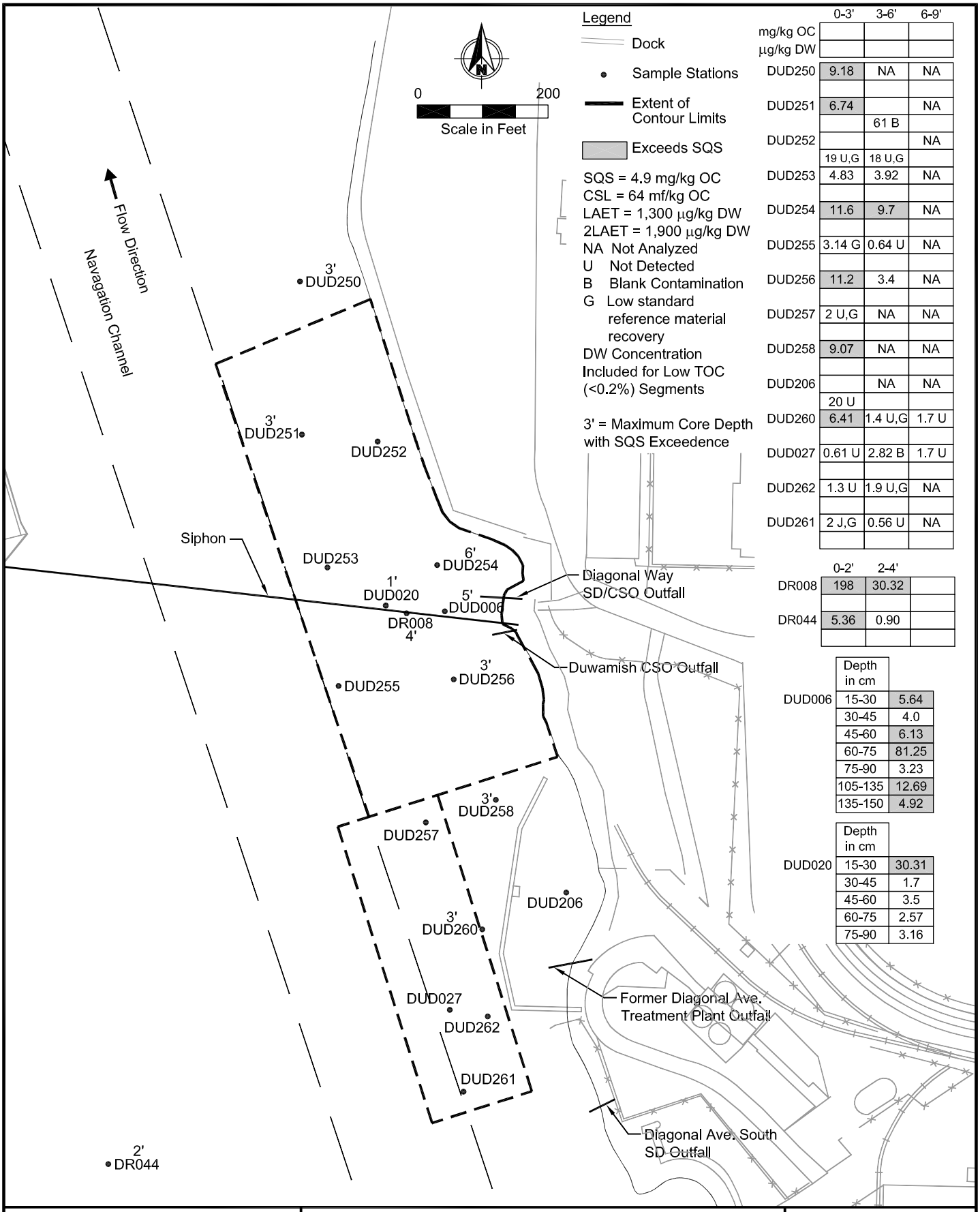


| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| mg/kg OC | | | |
| µg/kg DW | | | |
| DUD250 | 9.18 | NA | NA |
| | | | |
| DUD251 | 6.74 | | NA |
| | | 61 B | |
| DUD252 | | | NA |
| | 19 U,G | 18 U,G | |
| DUD253 | 4.83 | 3.92 | NA |
| | | | |
| DUD254 | 11.6 | 9.7 | NA |
| | | | |
| DUD255 | 3.14 G | 0.64 U | NA |
| | | | |
| DUD256 | 11.2 | 3.4 | NA |
| | | | |
| DUD257 | 2 U,G | NA | NA |
| | | | |
| DUD258 | 9.07 | NA | NA |
| | | | |
| DUD206 | | NA | NA |
| | 20 U | | |
| DUD260 | 6.41 | 1.4 U,G | 1.7 U |
| | | | |
| DUD027 | 0.61 U | 2.82 B | 1.7 U |
| | | | |
| DUD262 | 1.3 U | 1.9 U,G | NA |
| | | | |
| DUD261 | 2 J,G | 0.56 U | NA |
| | | | |

| | 0-2' | 2-4' | |
|---|---|---|---|
| DR008 | 198 | 30.32 | |
| | | | |
| DR044 | 5.36 | 0.90 | |
| | | | |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | 5.64 |
| | 30-45 | 4.0 |
| | 45-60 | 6.13 |
| | 60-75 | 81.25 |
| | 75-90 | 3.23 |
| | 105-135 | 12.69 |
| | 135-150 | 4.92 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | 30.31 |
| | 30-45 | 1.7 |
| | 45-60 | 3.5 |
| | 60-75 | 2.57 |
| | 75-90 | 3.16 |

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4/3/02

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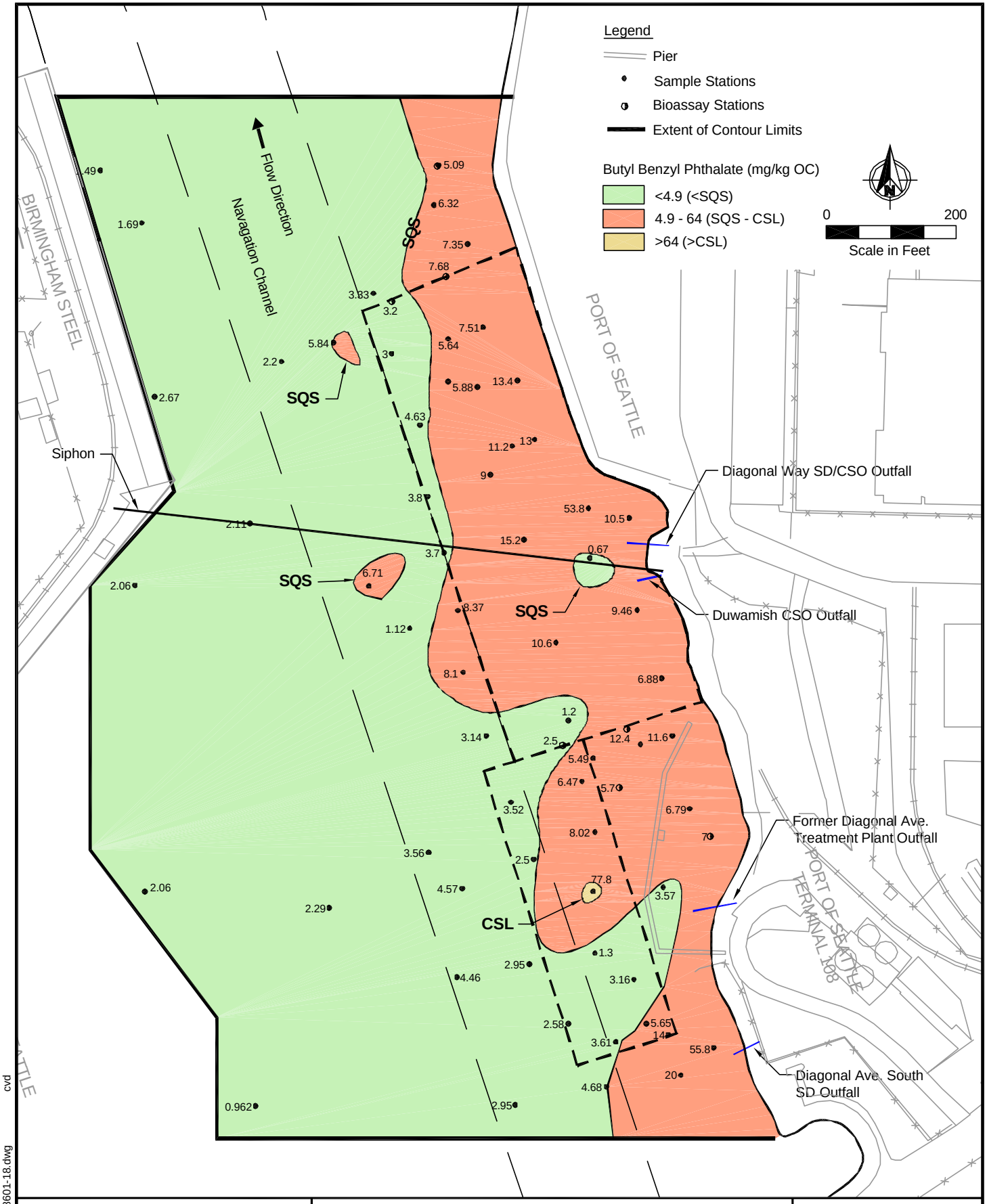
Duwamish/Diagonal Sediment Remediation Project

Butyl Benzyl Phthalate in Subsurface Sediments

Figure 5-8




| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 5-7 |
|---|---|---|
| | Butyl Benzyl Phthalate (mg/kg OC) Contours in Surface Sediments (0-10 cm) | |

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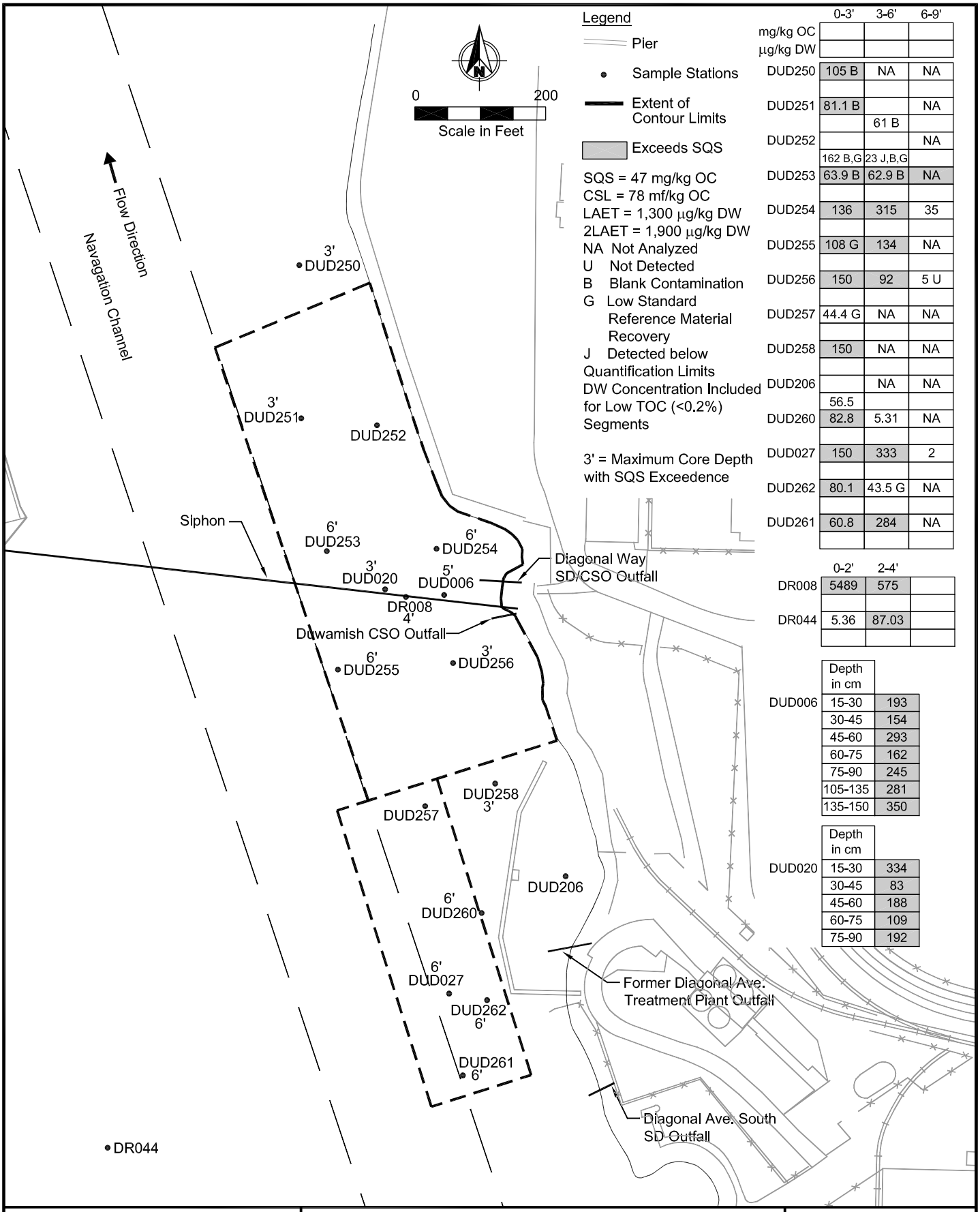


| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| mg/kg OC | | | |
| µg/kg DW | | | |
| DUD250 | 105 B | NA | NA |
| | | | |
| DUD251 | 81.1 B | | NA |
| | | 61 B | |
| DUD252 | | | NA |
| | 162 B,G | 23 J,B,G | |
| DUD253 | 63.9 B | 62.9 B | NA |
| | | | |
| DUD254 | 136 | 315 | 35 |
| | | | |
| DUD255 | 108 G | 134 | NA |
| | | | |
| DUD256 | 150 | 92 | 5 U |
| | | | |
| DUD257 | 44.4 G | NA | NA |
| | | | |
| DUD258 | 150 | NA | NA |
| | | | |
| DUD206 | | NA | NA |
| | 56.5 | | |
| DUD260 | 82.8 | 5.31 | NA |
| | | | |
| DUD027 | 150 | 333 | 2 |
| | | | |
| DUD262 | 80.1 | 43.5 G | NA |
| | | | |
| DUD261 | 60.8 | 284 | NA |
| | | | |

| | 0-2' | 2-4' | |
|---|---|---|---|
| DR008 | 5489 | 575 | |
| | | | |
| DR044 | 5.36 | 87.03 | |
| | | | |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | 193 |
| | 30-45 | 154 |
| | 45-60 | 293 |
| | 60-75 | 162 |
| | 75-90 | 245 |
| | 105-135 | 281 |
| | 135-150 | 350 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | 334 |
| | 30-45 | 83 |
| | 45-60 | 188 |
| | 60-75 | 109 |
| | 75-90 | 192 |

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4/3/02

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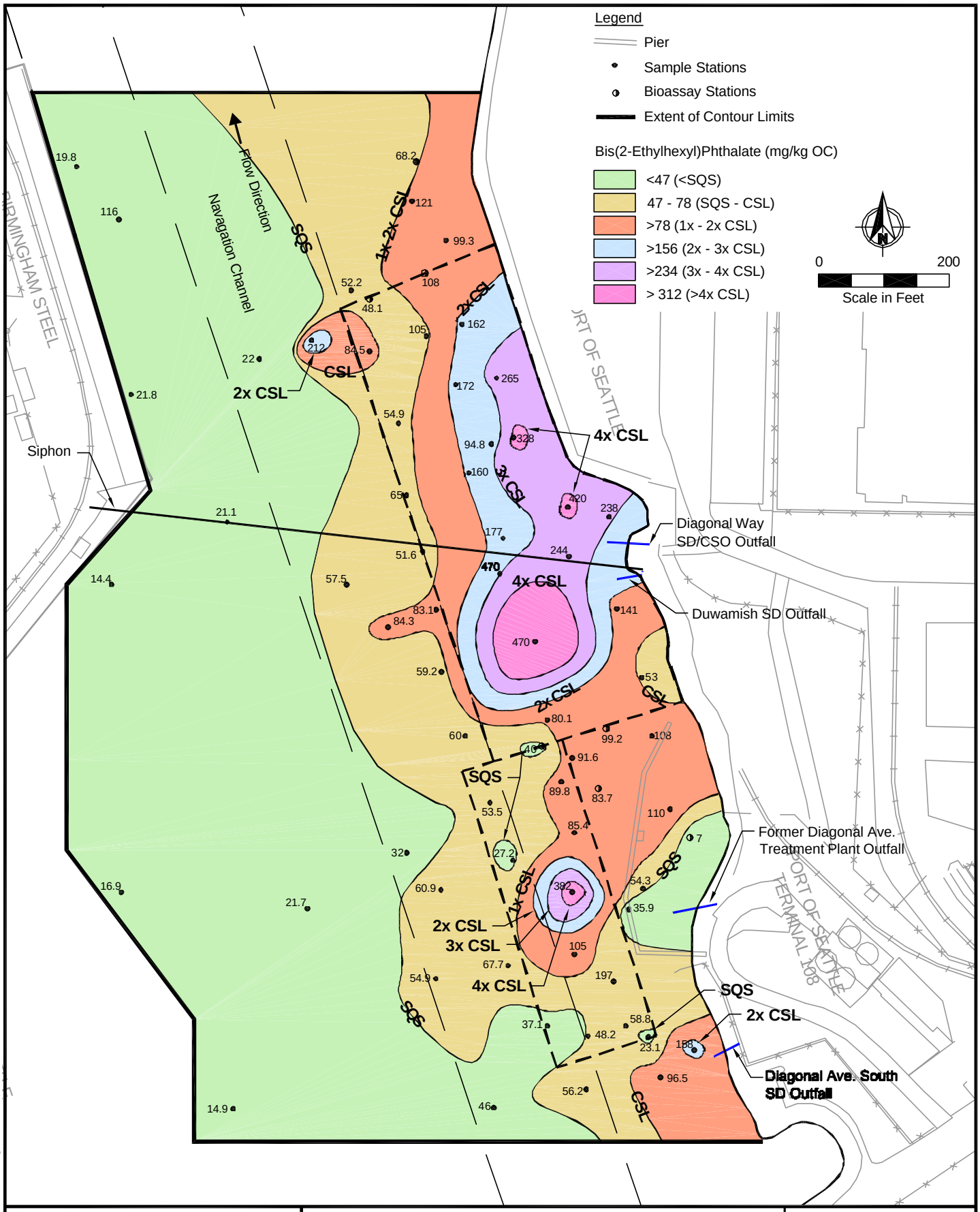
Duwamish/Diagonal Sediment Remediation Project

Bis(2-Ethylhexyl)Phthalate in Subsurface Sediments

Figure 5-6




| | | |
|---|---|---|
| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 5-5 |
| | Bis(2-ethylhexyl)phthalate Concentrations in Surface Sediments | |

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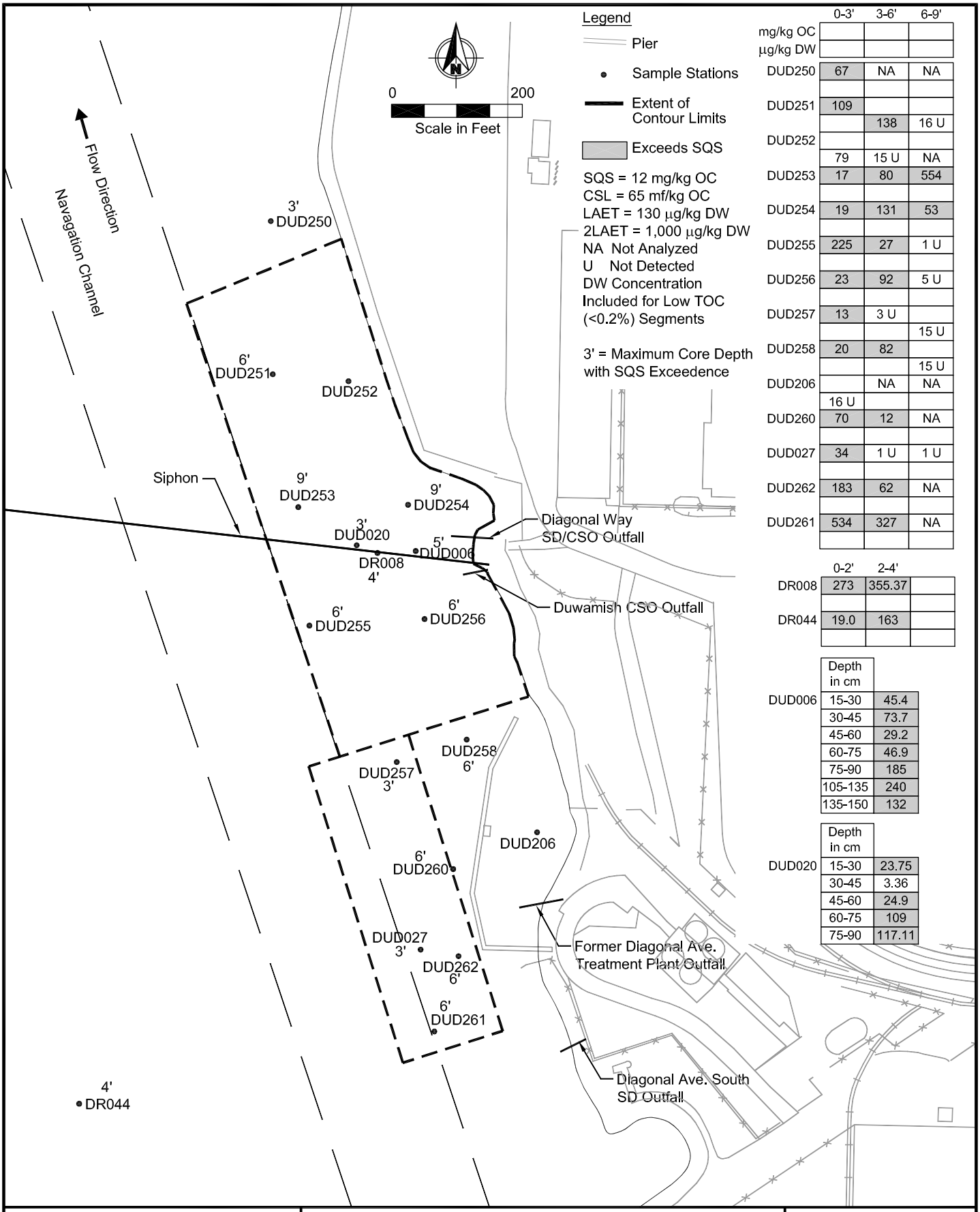


| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| mg/kg OC | | | |
| µg/kg DW | | | |
| DUD250 | 67 | NA | NA |
| | | | |
| DUD251 | 109 | | |
| | | 138 | 16 U |
| DUD252 | | | |
| | 79 | 15 U | NA |
| DUD253 | 17 | 80 | 554 |
| | | | |
| DUD254 | 19 | 131 | 53 |
| | | | |
| DUD255 | 225 | 27 | 1 U |
| | | | |
| DUD256 | 23 | 92 | 5 U |
| | | | |
| DUD257 | 13 | 3 U | |
| | | | 15 U |
| DUD258 | 20 | 82 | |
| | | | 15 U |
| DUD206 | | NA | NA |
| | 16 U | | |
| DUD260 | 70 | 12 | NA |
| | | | |
| DUD027 | 34 | 1 U | 1 U |
| | | | |
| DUD262 | 183 | 62 | NA |
| | | | |
| DUD261 | 534 | 327 | NA |
| | | | |

| | 0-2' | 2-4' | |
|---|---|---|---|
| DR008 | 273 | 355.37 | |
| | | | |
| DR044 | 19.0 | 163 | |
| | | | |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | 45.4 |
| | 30-45 | 73.7 |
| | 45-60 | 29.2 |
| | 60-75 | 46.9 |
| | 75-90 | 185 |
| | 105-135 | 240 |
| | 135-150 | 132 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | 23.75 |
| | 30-45 | 3.36 |
| | 45-60 | 24.9 |
| | 60-75 | 109 |
| | 75-90 | 117.11 |

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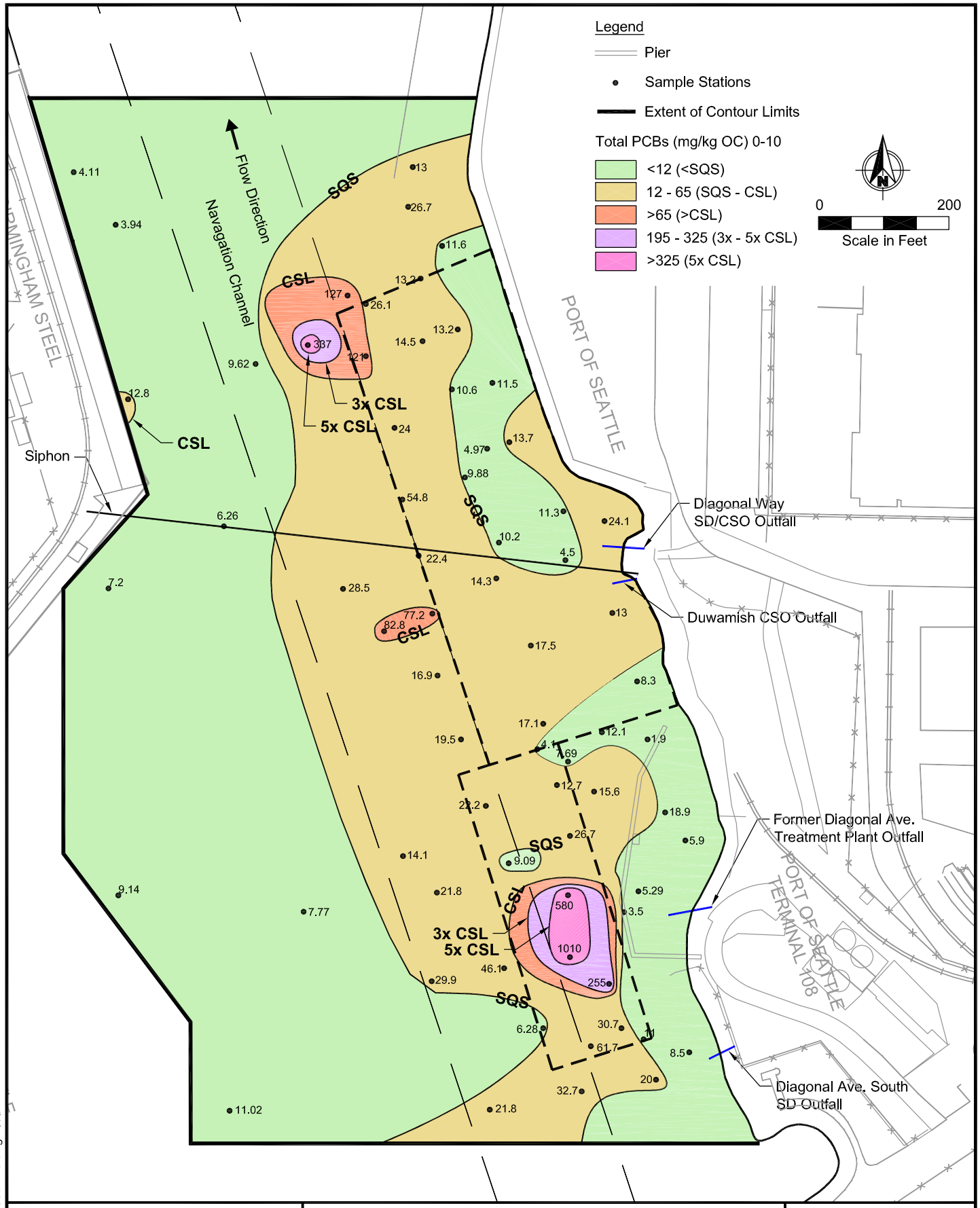
4/3/02

EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

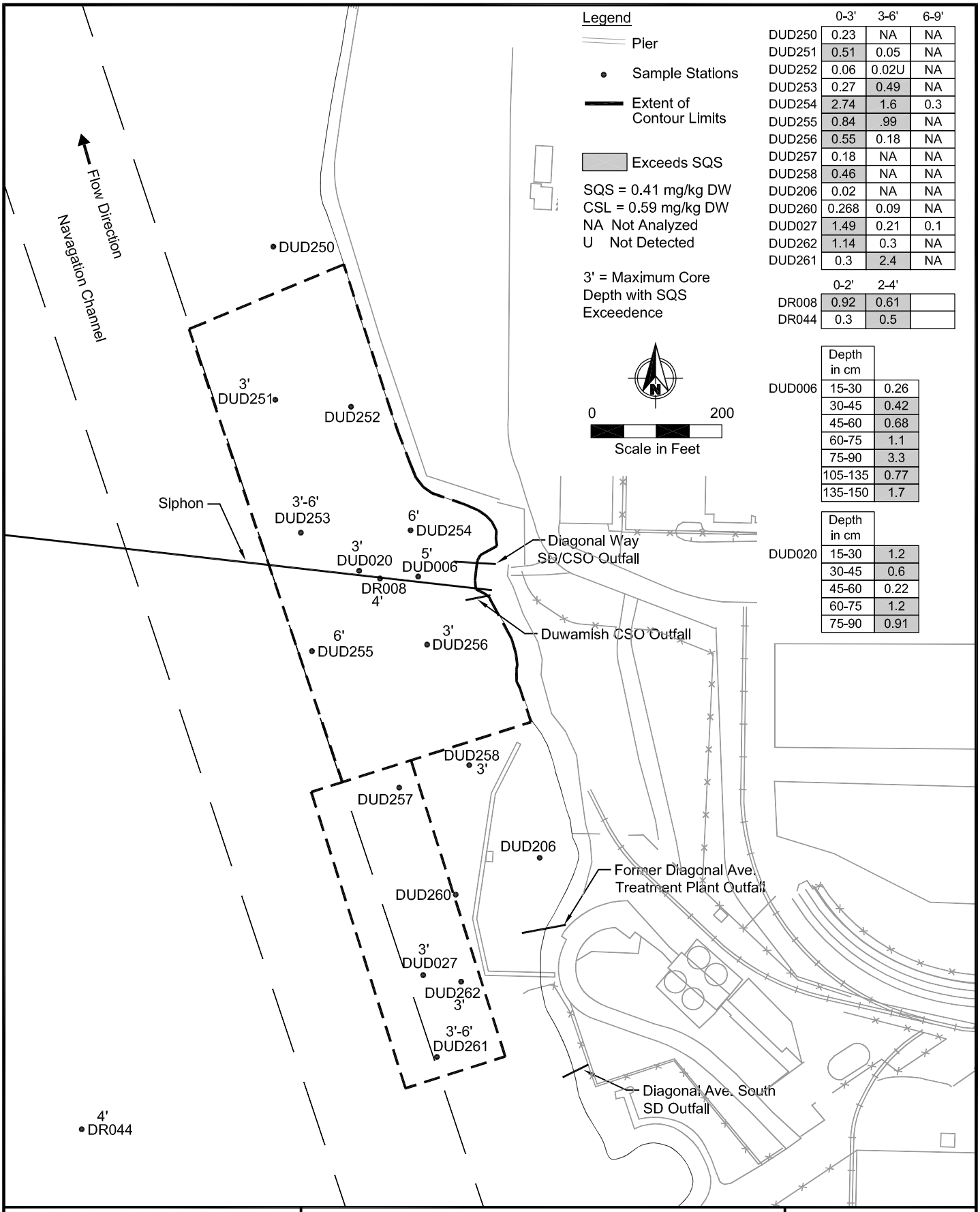
Total PCBs in Subsurface Sediments

Figure 5-4




| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 5-3 |
|---|---|---|
| | Total PCBs (mg/Kg OC) Contours in Surface Sediments (0-10 cm) | |

4/8/02 DWD-00008601-16.dwg cvd




| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| DUD250 | 0.23 | NA | NA |
| DUD251 | 0.51 | 0.05 | NA |
| DUD252 | 0.06 | 0.02U | NA |
| DUD253 | 0.27 | 0.49 | NA |
| DUD254 | 2.74 | 1.6 | 0.3 |
| DUD255 | 0.84 | .99 | NA |
| DUD256 | 0.55 | 0.18 | NA |
| DUD257 | 0.18 | NA | NA |
| DUD258 | 0.46 | NA | NA |
| DUD206 | 0.02 | NA | NA |
| DUD260 | 0.268 | 0.09 | NA |
| DUD027 | 1.49 | 0.21 | 0.1 |
| DUD262 | 1.14 | 0.3 | NA |
| DUD261 | 0.3 | 2.4 | NA |

| | 0-2' | 2-4' |
|---|---|---|
| DR008 | 0.92 | 0.61 |
| DR044 | 0.3 | 0.5 |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | 0.26 |
| | 30-45 | 0.42 |
| | 45-60 | 0.68 |
| | 60-75 | 1.1 |
| | 75-90 | 3.3 |
| | 105-135 | 0.77 |
| | 135-150 | 1.7 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | 1.2 |
| | 30-45 | 0.6 |
| | 45-60 | 0.22 |
| | 60-75 | 1.2 |
| | 75-90 | 0.91 |

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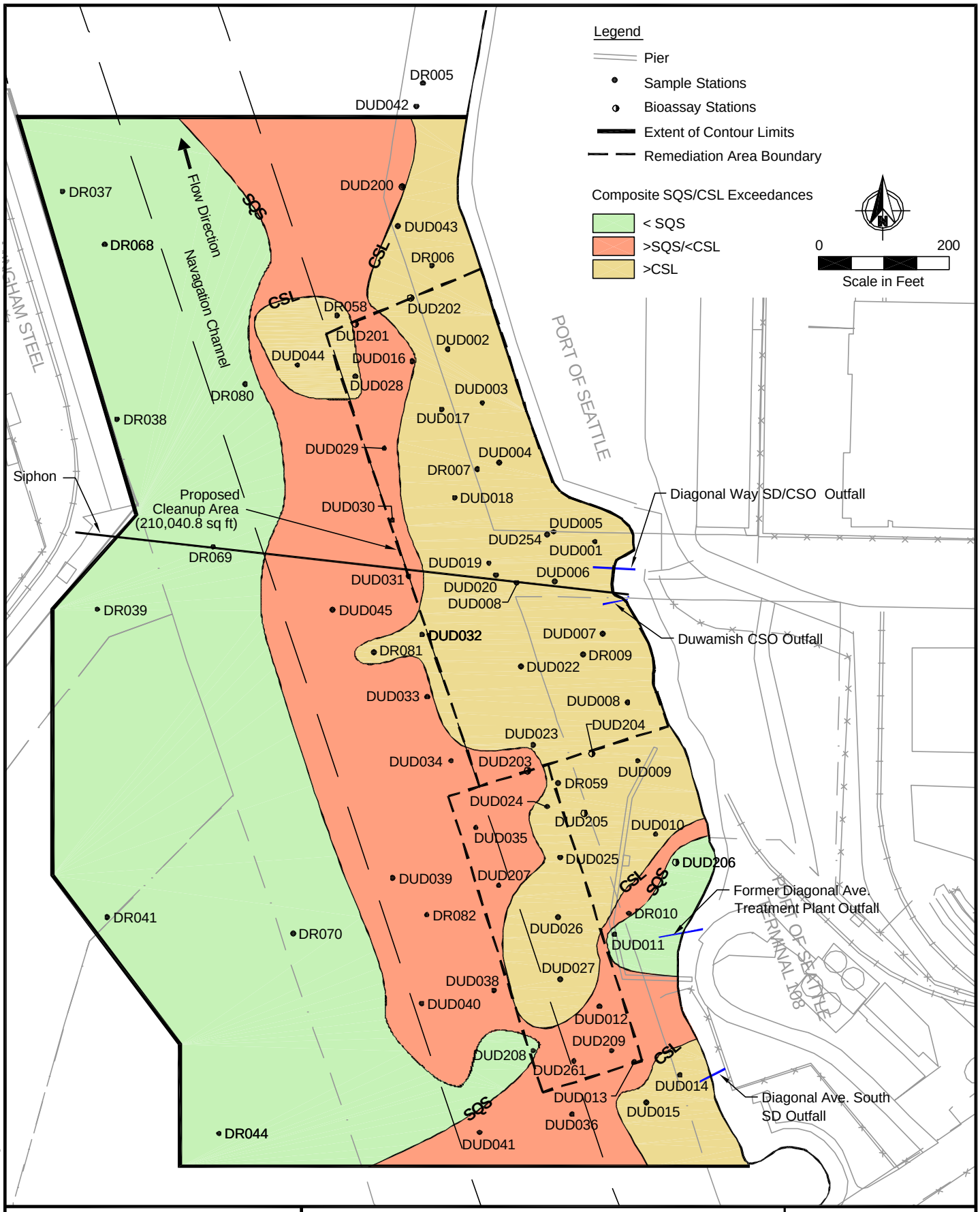
EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Mercury Concentrations in Subsurface Sediments

Figure 5-2




| | | |
|---|---|---|
| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure 5-9 |
| | Composite SQS/CSL Exceedance Areas | |

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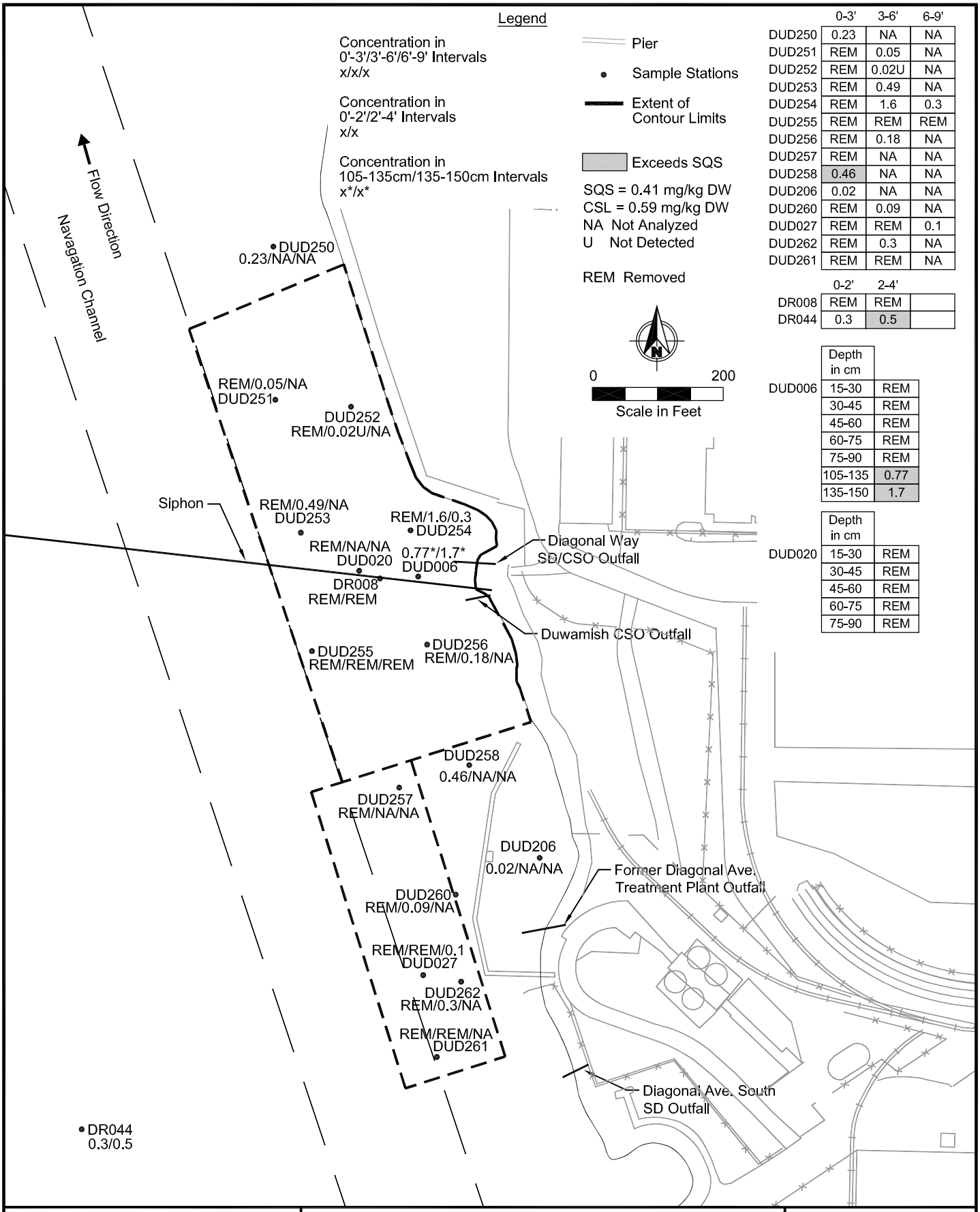


| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| DUD250 | 0.23 | NA | NA |
| DUD251 | REM | 0.05 | NA |
| DUD252 | REM | 0.02U | NA |
| DUD253 | REM | 0.49 | NA |
| DUD254 | REM | 1.6 | 0.3 |
| DUD255 | REM | REM | REM |
| DUD256 | REM | 0.18 | NA |
| DUD257 | REM | NA | NA |
| DUD258 | 0.46 | NA | NA |
| DUD206 | 0.02 | NA | NA |
| DUD260 | REM | 0.09 | NA |
| DUD027 | REM | REM | 0.1 |
| DUD262 | REM | 0.3 | NA |
| DUD261 | REM | REM | NA |

| | 0-2' | 2-4' |
|---|---|---|
| DR008 | REM | REM |
| DR044 | 0.3 | 0.5 |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |
| | 105-135 | 0.77 |
| | 135-150 | 1.7 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |

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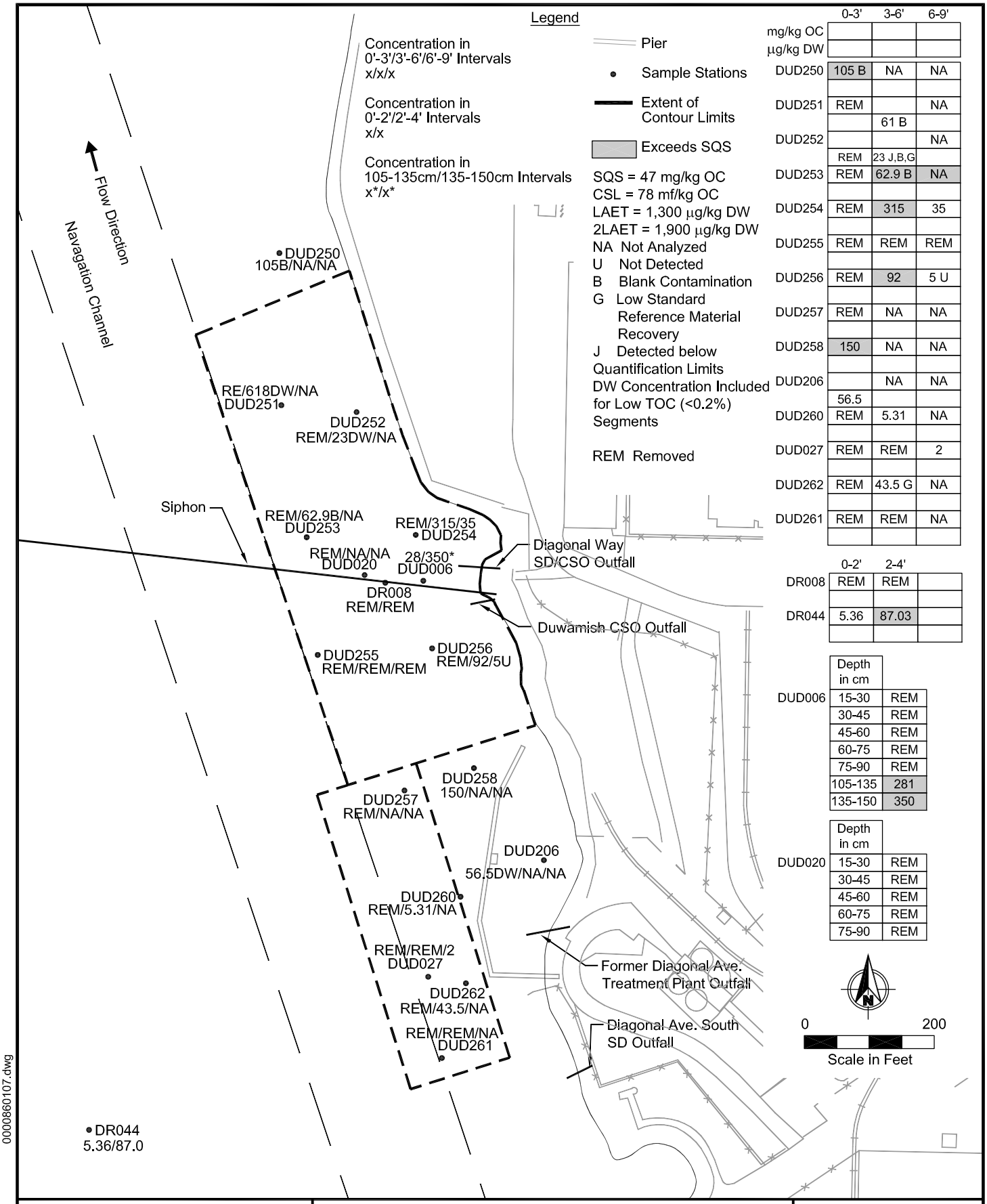
EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Mercury Concentrations in Subsurface Sediments

Figure EX-3




| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| mg/kg OC | | | |
| µg/kg DW | | | |
| DUD250 | 105 B | NA | NA |
| | | | |
| DUD251 | REM | | NA |
| | | 61 B | |
| DUD252 | | | NA |
| | REM | 23 J,B,G | |
| DUD253 | REM | 62.9 B | NA |
| | | | |
| DUD254 | REM | 315 | 35 |
| | | | |
| DUD255 | REM | REM | REM |
| | | | |
| DUD256 | REM | 92 | 5 U |
| | | | |
| DUD257 | REM | NA | NA |
| | | | |
| DUD258 | 150 | NA | NA |
| | | | |
| DUD206 | | NA | NA |
| | 56.5 | | |
| DUD260 | REM | 5.31 | NA |
| | | | |
| DUD027 | REM | REM | 2 |
| | | | |
| DUD262 | REM | 43.5 G | NA |
| | | | |
| DUD261 | REM | REM | NA |
| | | | |

| | 0-2' | 2-4' | |
|---|---|---|---|
| DR008 | REM | REM | |
| | | | |
| DR044 | 5.36 | 87.03 | |
| | | | |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |
| | 105-135 | 281 |
| | 135-150 | 350 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |

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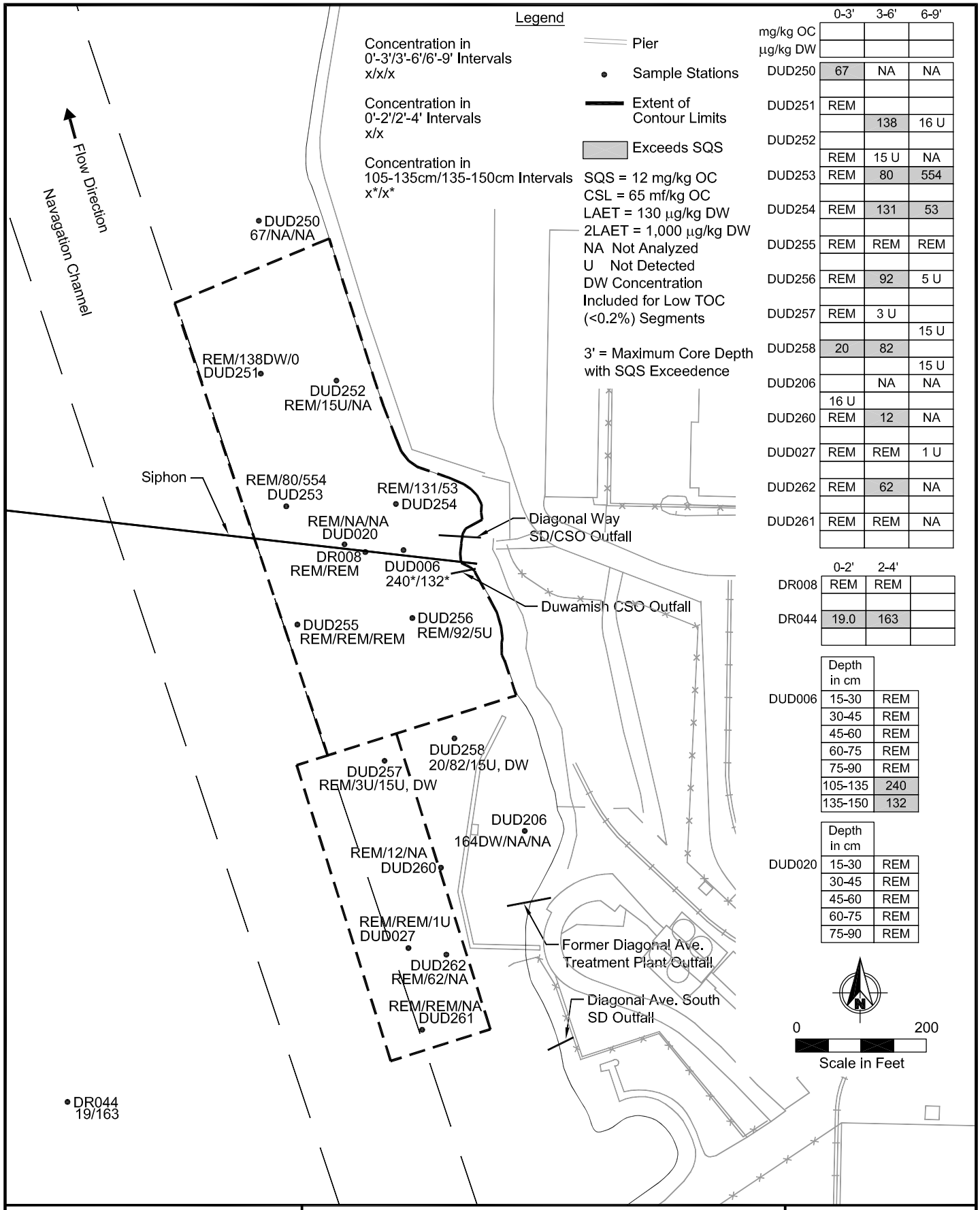
EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Bis(2-Ethylhexyl)Phthalate in Subsurface Sediments

Figure EX-5




| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| mg/kg OC | | | |
| µg/kg DW | | | |
| DUD250 | 67 | NA | NA |
| | | | |
| DUD251 | REM | | |
| | | 138 | 16 U |
| DUD252 | | | |
| | REM | 15 U | NA |
| DUD253 | REM | 80 | 554 |
| | | | |
| DUD254 | REM | 131 | 53 |
| | | | |
| DUD255 | REM | REM | REM |
| | | | |
| DUD256 | REM | 92 | 5 U |
| | | | |
| DUD257 | REM | 3 U | |
| | | | 15 U |
| DUD258 | 20 | 82 | |
| | | | 15 U |
| DUD206 | | NA | NA |
| | 16 U | | |
| DUD260 | REM | 12 | NA |
| | | | |
| DUD027 | REM | REM | 1 U |
| | | | |
| DUD262 | REM | 62 | NA |
| | | | |
| DUD261 | REM | REM | NA |
| | | | |

| | 0-2' | 2-4' | |
|---|---|---|---|
| DR008 | REM | REM | |
| | | | |
| DR044 | 19.0 | 163 | |
| | | | |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |
| | 105-135 | 240 |
| | 135-150 | 132 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |

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| EcoChem Team | Duwamish/Diagonal Sediment Remediation Project | Figure EX-4 |
|---|---|---|
| | Total PCBs in Subsurface Sediments | |

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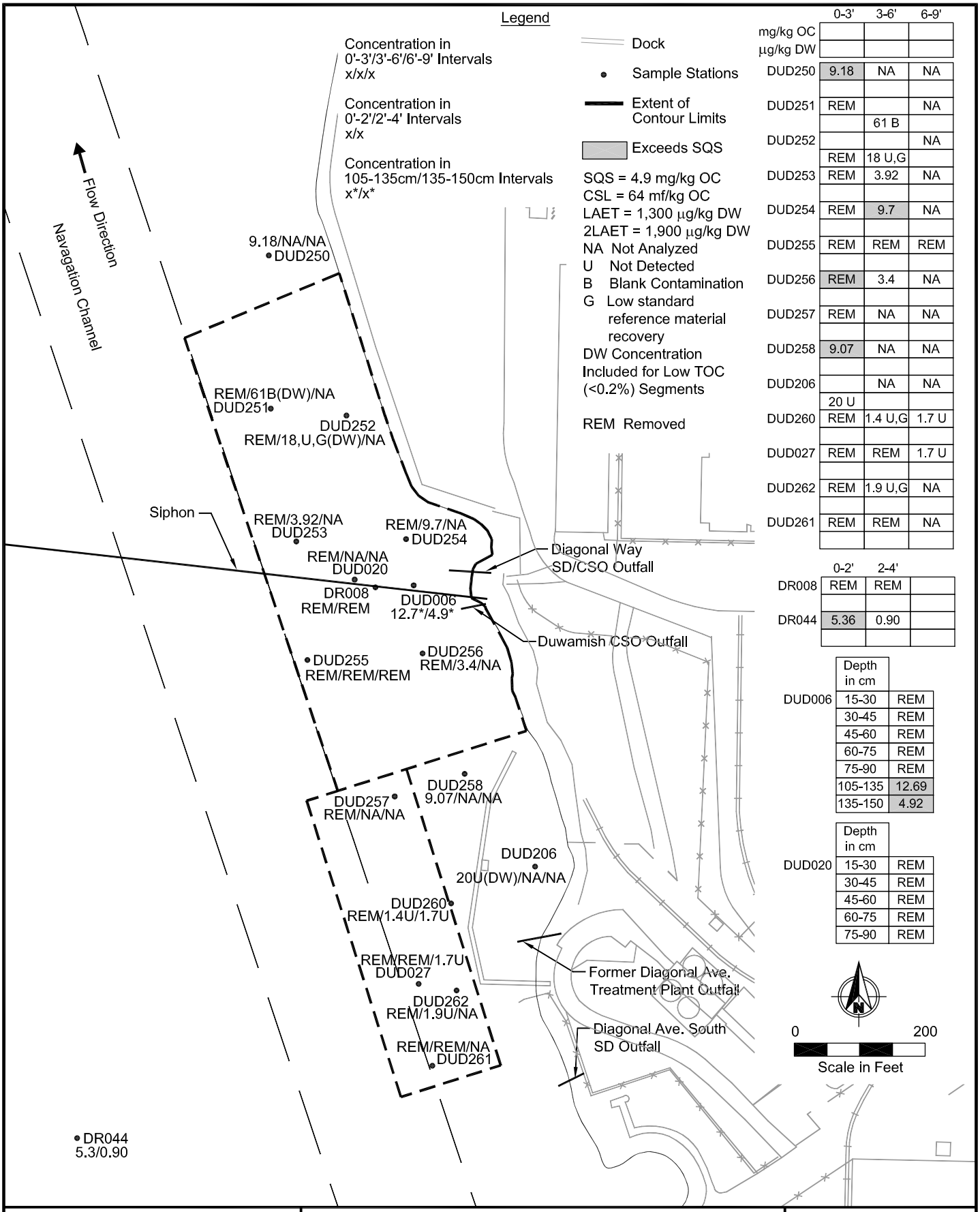


| | 0-3' | 3-6' | 6-9' |
|---|---|---|---|
| mg/kg OC | | | |
| µg/kg DW | | | |
| DUD250 | 9.18 | NA | NA |
| | | | |
| DUD251 | REM | | NA |
| | | 61 B | |
| DUD252 | | | NA |
| | REM | 18 U,G | |
| DUD253 | REM | 3.92 | NA |
| | | | |
| DUD254 | REM | 9.7 | NA |
| | | | |
| DUD255 | REM | REM | REM |
| | | | |
| DUD256 | REM | 3.4 | NA |
| | | | |
| DUD257 | REM | NA | NA |
| | | | |
| DUD258 | 9.07 | NA | NA |
| | | | |
| DUD206 | | NA | NA |
| | 20 U | | |
| DUD260 | REM | 1.4 U,G | 1.7 U |
| | | | |
| DUD027 | REM | REM | 1.7 U |
| | | | |
| DUD262 | REM | 1.9 U,G | NA |
| | | | |
| DUD261 | REM | REM | NA |
| | | | |

| | 0-2' | 2-4' | |
|---|---|---|---|
| DR008 | REM | REM | |
| | | | |
| DR044 | 5.36 | 0.90 | |
| | | | |

| | Depth in cm | |
|---|---|---|
| DUD006 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |
| | 105-135 | 12.69 |
| | 135-150 | 4.92 |

| | Depth in cm | |
|---|---|---|
| DUD020 | 15-30 | REM |
| | 30-45 | REM |
| | 45-60 | REM |
| | 60-75 | REM |
| | 75-90 | REM |

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EcoChem Team

Duwamish/Diagonal Sediment Remediation Project

Butyl Benzyl Phthalate in Subsurface Sediments

Figure EX-6

## Table EX-1
## Cost Estimate for Alternative 3: Capping with No Change in Existing Elevations for Area A

| Item | Quantity | Unit | Unit Cost | Cost | Notes |
|---|---|---|---|---|---|
| Preconstruction | | | | | |
| Mobilization/Demobilization | 1 | EA | $ 60,000 | $ 60,000 | 1, 2 |
| Pre- and Post-Dredge Surveys | 4 | EA | $ 10,000 | $ 40,000 | |
| Dredge and Transport | 42,500 | CY | $ 10.00 | $ 425,000 | 3, 4, 5, 6, 7 |
| Rehandle to Rail Cars | 46,750 | CY | $ 2.00 | $ 93,500 | 8, 9 |
| Upland Disposal | 70,125 | Ton | $ 24.00 | $ 1,683,000 | 10, 11 |
| Thick Cap | | | | | |
| Purchase and Deliver | 63,750 | Ton | $ 8.25 | $ 525,938 | 11, 12 |
| Place | 63,750 | Ton | $ 6.25 | $ 398,438 | |
| Armor Shore Protection | | | | | |
| Purchase and Deliver | 2,500 | Ton | $ 13.00 | $ 32,500 | 11, 13 |
| Place | 2,500 | Ton | $ 8.50 | $ 21,250 | |
| Habitat Mitigation | 1 | LS | TBD | $ - | 14 |
| Subtotal | | | | $ 3,279,625 | |
| | | | | | |
| Tax | | Percent | 8.61% | $ 282,376 | |
| Bond | | Percent | 1% | $ 32,796 | |
| Profit | | Percent | 10% | $ 327,963 | |
| Total Construction Cost | | | | $ 3,922,759 | |
| | | | | | |
| Engineering Design | | Percent | 8% | $ 313,821 | |
| Construction Monitoring/Mgmt. | | Percent | 5% | $ 196,138 | |
| Legal/ Administrative | 3 | FTE | $ 90,000 | $ 243,000 | |
| Permits, Fees, Misc. Expenses | 1 | EA | $ 25,000 | $ 25,000 | |
| Long Term Monitoring | 1 | LS | $ 165,000 | $ 165,000 | 15 |
| Total Project Cost | | | | $ 4,865,718 | |
| | | | | | |
| Contingency | | Percent | 20% | $ 973,144 | |
| TOTAL (Rounded to $10,000) | | | | **$ 5,840,000** | |

Notes:

1 No demolition of structures required.
2 Coordination with the Port of Seattle not included.
3 No costs for land rental or lease for dewatering facility included.
4 Mechanical dredging with a 12 cy digging bucket.
5 Two 1,500 cy haul barges used.
6 One tug boat dedicated to project.
7 Minimal debris will be encountered.
8 Ten percent bulking factor included for rehandling.
9 Rail car will be adjacent to the wharf.
10 Disposal cost based on Quote from Rabanco, November 15, 2001. Includes off load from barge, placement into lined container, haul to landfill and tipping fee at landfill. Variation between Alternatives due to quantities.
11 One cubic yard assumed to equal 1.5 tons (or one ton equals 0.67 cubic yard)
12 Prices for sand, gravel, and armor stone from LoneStar Industries. (Could be obtained for minimal cost from Turning Basin.)

13 Shore protection included for dressing up the bank, includes 2-foot thick layer.
14 Habitat Mitigation costs are To Be Determined (TBD)
15 Long -Term Monitoring based on $20,000/yr for 10 yrs; discount=7%, Inflation=3%

## Table EX-2
## Cost Estimate for Alternative 3: Capping with No Change in Existing Elevations for Areas A and B

| Item | Quantity | Unit | Unit Cost | Cost | Notes |
|---|---|---|---|---|---|
| Preconstruction | | | | | |
| Mobilization/Demobilization | 1 | EA | $ 60,000 | $ 60,000 | 1, 2 |
| Pre- and Post-Dredge Surveys | 4 | EA | $ 10,000 | $ 40,000 | |
| Dredge and Transport | 62,000 | CY | $ 10.00 | $ 620,000 | 3, 4, 5, 6, 7 |
| Rehandle to Rail Cars | 68,200 | CY | $ 2.00 | $ 136,400 | 8, 9 |
| Upland Disposal | 102,300 | Ton | $ 24.00 | $ 2,455,200 | 10, 11 |
| Thick Cap | | | | | |
| Purchase and Deliver | 93,000 | Ton | $ 8.25 | $ 767,250 | 11, 12 |
| Place | 93,000 | Ton | $ 6.25 | $ 581,250 | |
| Armor Shore Protection | | | | | |
| Purchase and Deliver | 2,500 | Ton | $ 13.00 | $ 32,500 | 11, 13 |
| Place | 2,500 | Ton | $ 8.50 | $ 21,250 | |
| Habitat Mitigation | 1 | LS | TBD | $ - | 14 |
| Subtotal | | | | $ 4,713,850 | |
| | | | | | |
| Tax | | Percent | 8.61% | $ 405,862 | |
| Bond | | Percent | 1% | $ 47,139 | |
| Profit | | Percent | 10% | $ 471,385 | |
| Total Construction Cost | | | | $ 5,638,236 | |
| | | | | | |
| Engineering Design | | Percent | 8% | $ 451,059 | |
| Construction Monitoring/Mgmt. | | Percent | 5% | $ 281,912 | |
| Legal/ Administrative | 3 | FTE | $ 90,000 | $ 243,000 | |
| Permits, Fees, Misc. Expenses | 1 | EA | $ 25,000 | $ 25,000 | |
| Long Term Monitoring | 1 | LS | $ 165,000 | $ 165,000 | 15 |
| Total Project Cost | | | | $ 6,804,207 | |
| | | | | | |
| Contingency | | Percent | 20% | $ 1,360,841 | |
| TOTAL (Rounded to $10,000) | | | | **$ 8,170,000** | |

Notes:

1 No demolition of structures required.
2 Coordination with the Port of Seattle not included.
3 No costs for land rental or lease for dewatering facility included.
4 Mechanical dredging with a 12 cy digging bucket.
5 Two 1,500 cy haul barges used.
6 One tug boat dedicated to project.
7 Minimal debris will be encountered.
8 Ten percent bulking factor included for rehandling.
9 Rail car will be adjacent to the wharf.
10 Disposal cost based on Quote from Rabanco, November 15, 2001. Includes off load from barge, placement into lined container, haul to landfill and tipping fee at landfill. Variation between Alternatives due to quantities.
11 One cubic yard assumed to equal 1.5 tons (or one ton equals 0.67 cubic yard)
12 Prices for sand, gravel, and armor stone from LoneStar Industries. (Could be obtained for minimal cost from Turning Basin.)

13 Shore protection included for dressing up the bank, includes 2-foot thick layer.
14 Habitat Mitigation costs are To Be Determined (TBD)
15 Long -Term Monitoring based on $20,000/yr for 10 yrs; discount=7%, Inflation=3%