**PRELIMINARY FINAL**

**KING COUNTY DEPARTMENT OF NATURAL RESOURCES**
**YEAR 2000 CSO PLAN UPDATE PROJECT**
**SEDIMENT MANAGEMENT PROGRAM**

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# SEDIMENT MANAGEMENT PLAN

*Task 1400*
Technical Memorandum

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In collaboration with King County


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# ABBREVIATIONS

| | |
|---|---|
| CAD | confined aquatic disposal |
| CDF | confined disposal facility |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) |
| cm | centimeter |
| COE | U.S. Army Corps of Engineers |
| CSL | cleanup screening level |
| CSO | combined sewer overflow |
| DR | Duwamish River |
| EB | Elliott Bay |
| EBDRP | Elliott Bay/Duwamish Restoration Program |
| Ecology | Washington Department of Ecology |
| EIS | environmental impact statement |
| EPA | U.S. Environmental Protection Agency |
| LIMS | King County Laboratory Information Management System |
| MCUL | minimum cleanup level |
| MLLW | mean lower low water |
| mg/kg | milligrams per kilogram |
| MTCA | Washington Model Toxics Control Act |
| MUDS | multi-user disposal site |
| NOAA | National Oceanic and Atmospheric Administration |
| NPL | National Priorities List (Superfund) |
| PAH | polynuclear aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| PRP | potentially responsible party |
| PSDDA | Puget Sound Dredged Disposal Analysis |
| RCW | Revised Code of Washington |
| RDT | Regional Decision Team |
| RM | river mile |
| ROD | record of decision |
| SIZ | sediment impact zone |
| SMP | Sediment Management Plan |
| SMS | Washington Sediment Management Standards |
| SQS | Sediment Quality Standards |
| TMDL | total maximum daily load |
| WAC | Washington Administrative Code |
| WADNR | Washington Department of Natural Resources |
| WQA | Water Quality Assessment |
| WRDA | Water Resources Development Act |
| WSDOT | Washington State Department of Transportation |

# EXECUTIVE SUMMARY

This document identifies and evaluates programmatic long-range remediation alternatives for consideration at seven identified sediment cleanup sites near King County combined sewer overflow (CSO) outfalls. By completing this planning-level evaluation, King County is not claiming responsibility either in full or in part for the existing sediment contamination. Rather, this information can be used by King County and other parties to evaluate the range of cleanup options available for specific sites within Elliott Bay and the Duwamish River.

The information presented here for each site was initially developed as a series of technical memoranda that evaluated: screening level recontamination modeling (Task 900); evaluation of sediment remediation technologies (Task 1000); review and development of sediment site prioritization (Task 1100); analysis of programmatic sediment remediation alternatives and strategies (Task 1200); and identification of cooperative project and funding opportunities associated with the sediment cleanup sites (Task 1300). The information contained within the various technical memoranda, including several additional work products prepared by King County, have been assembled into this Sediment Management Plan (SMP).

The Washington Department of Ecology (Ecology) is granted legal authority under Washington Administrative Code (WAC) 173-204, Sediment Management Standards to direct the identification, screening, ranking and prioritization, and cleanup of contaminated sediment sites in the state. Once a site is ranked and placed on the contaminated sites list, it may then be considered for cleanup. WAC 173-204 provides for the voluntary cleanup of contaminated sediments with oversight and guidance by Ecology. In meeting its legal responsibilities, King County and/or other parties may choose to seek out potentially responsible parties (PRPs) having past or current involvement at the site to conduct voluntary cleanup. In doing so, the parties would retain some flexibility and the ability to direct these cleanup activities, including cooperative cleanup efforts with other jurisdictions. If King County, another party, or group of parties does not choose to move ahead with voluntary cleanup, other jurisdictions may conduct the cleanup and bill the parties the amount they believe is the correct share. Alternatively, Ecology or the U.S. Environmental Protection Agency (EPA) may initiate enforcement actions (including cost recovery) at some time in the future, under the Washington Model Toxics Control Act (MTCA) or the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund. To date, King County has not identified PRPs associated with the identified sediment contamination.

While Ecology developed a site ranking for the seven sediment sites based primarily on ecological factors, this Sediment Management Plan also evaluated these sites from a sediment management perspective. Using available sediment quality data, the general nature and extent of sediment contamination in the vicinity of each CSO outfall were summarized and used as input to the SMP's initial site ranking model, along with general cleanup cost information. This effort identified the following preliminary site cleanup

priorities among the seven identified sediment cleanup sites located near King County CSOs:

| Ecology Site Number | Nearby Combined Sewer Overflow | Cleanup Priority |
|---|---|---|
| • DR31 | • Duwamish/Diagonal* | • High |
| • EB27 | • King Street | • High |
| • EB8 | • Hanford Street | • Medium/high |
| • EB7 | • Lander Street | • Medium/high |
| • EB26 | • Denny Way* | • Medium |
| • EB13 | • Chelan Avenue | • Low/medium |
| • DR32 | • Brandon Street | • Low |

An asterisk (*) indicates that cleanup efforts at some or all areas of the site are being addressed in current King County projects, separate from this Sediment Management Plan.

## Potential Cleanup Options

Next, the available site characterization data were reviewed in the context of potential cleanup options, to determine the general scope of practicable sediment remediation alternatives that could be applied to some or all of the seven sites. The initial development of sediment remediation options focused on the more practicable technologies identified from a preliminary review of technical feasibility, implementability, and cost. The primary sediment remedial technologies considered in this preliminary assessment include:

- Source control/natural recovery (potentially including detailed risk assessment)
- Capping
- Dredging with confined disposal.

For the latter option, low- and high-range removal alternatives were developed that represent different cleanup strategies, in recognition of the limited number of potentially available and cost-effective disposal facilities. A preliminary cost estimate was developed that considered the full range of prospective costs associated with each cleanup option, including studies (e.g., filling data gaps), engineering, construction, monitoring, land easements/encumbrances, and mitigation. For in-water options (i.e., excluding upland landfill disposal), the estimated total costs for the various cleanup alternatives applied to all seven sediment cleanup sites range from approximately $26 to $36 million. If upland disposal is necessary, the upper-bound cost estimate could approach $75 million.

Final decisions about the preferred cleanup option for each site can be made only after further study and preparation of a detailed cleanup study report for each site. The preferred cleanup action also must be approved by Ecology and other regulatory agencies during the permitting process.

## Cooperative Project Opportunities

Sediment contamination at the seven identified sites appears to have resulted from some combination of historical inputs and current practices. Cooperative project opportunities with other jurisdictions and potential funding mechanisms have been identified that may reduce potential cleanup costs for any single sediment cleanup site. These opportunities include integration of multiple stakeholders into cooperative projects that address a range of regional sediment cleanup, disposal, redevelopment, and habitat restoration actions. Depending on the alternative selected and the specific funding arrangement, much of the cost of cleanup could be shared among cooperative parties. Partnership arrangements will likely be required to achieve a beneficial outcome for all parties concerned. Among the sediment sites near King County CSOs, potential cooperative projects identified include:

- **EB27 (near King Street CSO) –** As part of the South Downtown Waterfront Master Development Plan, long-term redevelopment plans are currently being drafted by Washington State Ferries (WSF) and the Port of Seattle (Port) for an expanded Colman Dock ferry terminal within the King Street CSO site vicinity. A City of Seattle storm drain also discharges into this area. A sediment cleanup study was recently initiated at the site by WSF and the Port as part of this larger planning effort, and cleanup decisions are currently scheduled for spring and summer of 2000 (The current King County schedule for implementing further King Street CSO source controls is 2025).
- **EB8 and EB7 (near Hanford Street and Lander Street CSOs) –** The Port and U.S. Army Corps of Engineers (COE) are currently performing planning studies for dredging and confined disposal of sediment in this area as part of the East Waterway Stage II navigation improvement project. Sediment sampling has been completed; dredging and disposal decisions may occur in late 1999 (The current King County schedule for implementing further CSO source controls is 2017 for Hanford Street and 2019 for Lander Street).
- **EB13 (near Chelan Avenue CSO) –** The COE may perform dredging of the channel area of this site, if the action is performed as part of future routine channel maintenance and if a suitable sediment disposal location is identified. However, no channel maintenance or navigation improvement project is currently planned at this site (The current King County schedule for implementing future Chelan CSO controls is 2024).

## Recommendations

### Key Assumptions

The recommendations generated in the development of this Sediment Management Plan are based upon several assumptions, including the following:

- Ecology and/or EPA will ultimately require active sediment remediation in those site areas that exceed Sediment Management Standards cleanup screening level (CSL) chemical or biological criteria.
- The Elliott Bay/Duwamish Restoration Program has sufficient funding to complete its projects, and specifically to implement planned sediment cleanup actions at the Duwamish/Diagonal site.
- The Port will be successful in its efforts to receive regulatory approvals to develop the least costly disposal option for contaminated sediments, i.e., to place Stage II sediments that are unsuitable for open-water disposal in Slip 27 on the East Waterway or in a similarly cost-effective disposal site. If this lower-cost disposal option is not available, then costs will increase significantly to use upland disposal sites.

Based upon the above assumptions, general and site-specific recommendations for sediment management at the seven sites were developed. These recommendations are outlined below.

## Site-Specific CSO Project Recommendations

The planning-level staff recommendations derived from the Sediment Management Plan analysis for the seven sediment sites involve implementing limited removal and confined disposal of those contaminated sediments that are present in federal navigation channels and prospective harbor improvement areas. The recommendation for contaminated sediments not located within these identified dredging areas involves capping with a clean sand layer to accomplish remediation. This selection was made following a detailed evaluation of the technical feasibility, implementability, and costs of a range of potentially viable remediation alternatives.

Specific recommendations identified in this Sediment Management Plan for each of the seven sites are presented below.

- **EB31 (near Duwamish/Diagonal CSO)—**King County has previously allocated and committed resources to perform cleanup of this site through a National Resource Damage Assessment settlement agreement. Although cleanup is underway as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program, the request for additional funds to complete planning is still pending. Construction funds are adequate to complete the prospective sediment remediation (i.e., capping with limited dredging).

  Cleanup actions at this site should continue and be completed under the Elliott Bay/Duwamish Restoration Program. However, King County and the City of Seattle may want to consider providing part of the planning funds to move the project forward to completion. Another consideration is that cleanup boundaries, remediation methods, and costs have not yet been finalized.

- **EB27 (near King Street CSO)—**A cooperative project could be formulated between WSF, the Port, King County and City of Seattle to perform sediment cleanup at this site concurrent with long-term redevelopment plans for an expanded Colman Dock ferry terminal at Pier 48. The planning-level cleanup remedy for the site involves capping approximately 15 to 19 acres of contaminated sediments with a 1- to 3-foot sand layer designed to protect against propeller wash. WSF or the Port may decide to perform some or all of the required sediment cleanup as part of site redevelopment with input and cooperation from King County and the City of Seattle. The cooperating parties should negotiate responsibilities for providing long-term sediment quality monitoring services as part of an overall cooperative implementation agreement. The total cost of this Sediment Management Plan cleanup recommendation is approximately $2.2 million.

- **EB8 and EB7 (near Hanford Street and Lander Street CSOs)—**In consideration of the Port's navigation improvement plans for the East Waterway, the recommended cleanup plan involves dredging and confined aquatic disposal of 190,000 cubic yards of contaminated sediments near the Hanford Street CSO and 50,000 cubic yards near the Lander Street CSO. The COE and/or Port may perform dredging of these sites as part of navigation improvements. A cooperative project could be formulated between the Port, COE, King County, and other entities to perform and fund sediment cleanup concurrent with the Port's Stage II navigation improvement project. The cooperating parties should negotiate responsibilities for providing long-term monitoring services as part of an overall cooperative implementation agreement. The total cost of this Sediment Management Plan cleanup recommendation is approximately $17 million.

- **EB26 (near Denny Way CSO)—**King County is currently conducting cleanup and remediation of a portion of this site as part of an aquatic lands easement agreement from the Washington Department of Natural Resources (WADNR). Outside the existing cap area and planned sediment removal area, three lower-level contamination areas have been delineated within the greater Denny Way site. These areas encompass a total of approximately 4 acres that exceed Sediment Quality Standards (SQS) criteria; none of the areas exceed CSL criteria. King County may consider capping the additional SQS areas, following the completion of source control at Denny Way, thus completing all of the various components simultaneously to obtain timely resolution and closure at the site. Denny Way is King County's largest CSO, and control to one untreated overflow per year with discharge of treated effluent will be achieved by 2003. (Cleanup at the site is continuing under direction of the state Model Toxics Control Act). The total cost of this Sediment Management Plan cleanup recommendation is approximately $700,000.

- **DR13 and DR32 (near Chelan Avenue and Brandon Avenue CSOs)—**These sites currently have low priority for cleanup. The total cost of this Sediment Management Plan cleanup recommendation is approximately $2 million near the Chelan Avenue CSO, and $300,000 near the Brandon Street CSO.

## General Recommendations

- **Maintain cooperative project involvement in Elliott Bay and the Duwamish River and support TMDL design team.** All of the sediment sites located near King County CSO outfalls reflect contamination from a variety of historical sources. The role of current sources needs to be better defined to develop appropriate corrective approaches. The County should develop partnerships with other entities to pursue corrective measures. King County is currently participating with Ecology and other design team agencies in the development of total maximum daily loads (TMDLs) for pollutants within the CSO sediment site area. The findings of the design team should be incorporated into future phases of the Sediment Management Plan. The TMDL process is focusing on the reduction of pollutants to receiving waters that currently exceed water or sediment quality standards. Specifically, the TMDL project has identified contaminated sediments in the Duwamish River and Elliott Bay as one of the highest-priority work elements. King County sponsorship of sediment TMDL work by Ecology is scheduled to occur through December 2000.

- **Develop model for potential sediment recontamination from existing CSO and storm drain (SD) sources.** Results from the screening-level recontamination modeling analysis (presented in the Task 900 technical memorandum) indicate that, given current discharge levels, there is a potential for localized recontamination of sediments near some or all of the CSO outfalls following completion of a cleanup action. Ongoing SD discharges to these same areas may be associated with similar or greater risks of recontamination. The primary chemical of potential recontamination concern is bis(2-ethylhexyl)phthalate (see below), which has numerous sources within the basin. However, because the screening-level modeling performed to date has used a number of conservative simplifying assumptions, more detailed near-field modeling studies are recommended to confirm whether the potential for recontamination currently exists, particularly at the higher-priority sites (e.g., near Duwamish/Diagonal and King Street). The modeling should incorporate current and expected future CSO controls. Other entities with point or non-point source discharges could also use such a model. Model development could be completed within 7 to 12 months, at an estimated total cost of approximately $250,000.

- **Perform further evaluation of phthalates and other chemicals of concern for potential sediment recontamination from existing CSO and SD sources.** It is known that phthalates are used in a wide range of residential, commercial, and industrial applications; however, the actual sources of phthalates to regional CSOs and SDs is largely unknown. Therefore, it is difficult to determine the best methods to control their entry into the system. Further studies of the source, fate, and toxicity of bis(2-ethylhexyl)phthalate within regional CSO and SD basins near the listed sediment sites should be initiated. Such studies could be used to determine the level of CSO and SD controls necessary to prevent future sediment recontamination. The phthalate study could be completed within 12 months, at an estimated total cost of approximately $250,000.

- **Negotiate timing of CSO control versus sediment remediation with Ecology.** Based on results of the recontamination modeling and phthalate control studies outlined above, it should be possible to determine the extent of ongoing sediment recontamination near each CSO site, given the current Regional Wastewater Services Plan source control schedule. Currently the extent of recontamination appears to be highly localized, although this condition would be refined with the new modeling and phthalate studies. Following completion of the studies, King County could negotiate with Ecology the appropriate timing of site-specific sediment cleanup actions and the need for further CSO source controls at one or more of the sites. Important considerations in this determination would include the magnitude and extent of historical sediment contamination addressed by cleanup versus ongoing recontamination sources, among other factors. Negotiations with Ecology are currently scheduled to occur in late 1999 through mid-2000.

# INTRODUCTION

Although industrial discharges, stormwater discharges, and combined sewer overflows (CSOs) to Elliott Bay and the Duwamish River have been reduced substantially in the last 20 years, persistent contaminants in sediments continue to pose a potential risk to aquatic life, wildlife, and human health. Adverse ecological effects and potential human health risks associated with chemical contaminants present in bottom sediments have been well documented within the greater King County Sediment Management Plan (SMP) area (King County 1998; Parametrix and King County 1998; Striplin and Black & Veatch 1998).

Regulation of contaminated sediments in the marine environment of Washington State typically falls under the authority of the Washington State Department of Ecology (Ecology). In 1991, Ecology adopted Sediment Management Standards (SMS) for designating marine sediments that have acute or chronic adverse effects on aquatic organisms. As set forth in the SMS, Ecology developed a sediment site prioritization scheme to identify and prioritize their resources to implement the SMS. The general ecological and human health risk reduction objectives of sediment cleanup, as defined by the SMS, have been transformed by Ecology into a set of sediment site scoring guidelines, which are periodically applied to prioritize the agency's resources from among the total state list of contaminated sediment sites. Ecology's ranking model incorporates sediment chemistry values with information collected during hazard assessment. The rank scores allow the sites to be compared. The higher the score, the greater the degree of ecological hazard.

The most recent Ecology ranking results for Puget Sound were released in May 1996. Of the 49 sites identified in Puget Sound, 19 are in the Elliott Bay (EB)/Duwamish River (DR) area. Seven of these 19 sites are near King County CSO outfalls (Figure 1). The seven sediment sites identified by Ecology were ranked as follows (EB and DR refer to Ecology site numbers):

- EB8 (near Hanford Street CSO)
- EB7 (near Lander Street CSO)
- DR31 (near Duwamish Pump Station/Diagonal CSO*)
- DR 32 ( near Brandon Street CSO)
- EB27 (near King Street CSO)
- EB26 (near Denny Way CSO*)
- EB13 (near Chelan Avenue CSO; within existing Harbor Island Superfund site boundary).

As indicated above and elsewhere in this document, an asterisk (*) denotes that cleanup efforts at a given site are being addressed as a separate King County project.

In response to Ecology's listing, King County contracted (contract #E83034E) with Brown & Caldwell and its subconsultants (Anchor Environmental and Herrera Environmental Consultants) to develop a Sediment Management Plan (SMP) for King County's CSO program. The evaluation was performed to support planning-level decisions.

This SMP develops remedial strategies for correcting short- and long-term hazards associated with contaminated sediments near the seven King County CSO sites. However, the same evaluation process could be used to prioritize other areas of contamination. The SMP process included various technical memoranda including: screening level recontamination modeling performed by King County (Task 900; Appendix A); evaluation of sediment remediation technologies (Task 1000; Appendix B); review and development of sediment site prioritization (Task 1100; Appendix C); analysis of programmatic sediment remediation alternatives and strategies (Task 1200; Appendix D); and identification of cooperative project and funding opportunities associated with the sediment cleanup sites (Task 1300; Appendix E). The information contained within the various technical memoranda, including a literature review (Appendix F) and a legal review (Appendix G) prepared by King County, have been assembled into this SMP. Other associated documents include: *Review/Analysis of Previous/Current/Future Actions and Coordination with Related Projects*, *CSO Sampling and Monitoring Data Inventory*, and *Identification of Nearby Contaminated Sites*.

King County must also meet existing Washington State CSO regulations requiring that untreated CSO discharges be limited to no more than one occurrence per year, on average, at each CSO location. King County has had a CSO control program in place since 1988 and has completed several projects. However, CSO control is expensive; it will cost King County approximately $566 million (1998 dollars, cumulative capital) over the life of the program to control CSOs to one untreated discharge per year. Of this total, $255 million has been spent or committed for spending to achieve the initial volume and frequency reductions (Parametrix and King County 1998). As outlined in the King County *Executive's Preferred Plan for Regional Wastewater Services* released in May 1998, another $311 million is expected to be spent over the next 30 years to complete the program (King County 1998b). The current schedule for undertaking CSO control projects was developed prior to this Sediment Management Plan and could be influenced by the recommendations in the plan.

As part of this larger planning effort, King County has recently completed a separate CSO Water Quality Assessment (WQA) for the Duwamish River and Elliott Bay to better understand the risk to aquatic life, wildlife, and people who use the resources of this estuary (Parametrix and King County 1998). Among other tasks, the WQA developed a model of the river and bay to describe how water and sediment-bound pollutants from CSOs, SDs and "other" sources move through the system. (In the case of at least one CSO, i.e., Duwamish/Diagonal, City of Seattle SD discharges are also implicated in sediment contamination). By combining the modeling with detailed risk assessments, the WQA model provided an improved understanding of the CSO contribution (in relation to other sources) to the overall risk to the estuarine ecosystem and to people who recreate or work in or on these waterbodies. With this information, King County can develop an overall CSO control program that targets the areas and causes of greatest risk and achieves a level of benefit reflective of the cost. The WQA model can also be used to provide assessments of source control and sediment recontamination in the general vicinity of each of the seven listed sediment sites (see Appendix A: Task 900 Technical Memorandum). This information is important input to the development of an overall SMP strategy.

Missing Figure 1

CSO Sediment Site Location Map

# SEDIMENT MANAGEMENT PLAN
# SITES

In May 1996, Ecology released a list of contaminated sediment sites in the state of Washington. Of the 49 sites identified in Puget Sound, 19 are in the Elliott Bay/Duwamish River area. Seven of these 19 sites are located near King County CSO outfalls. This section presents information on the seven listed SMP sites pertaining to:

- Ecology's Sediment Management Standards
- Ecology's prioritization of the seven listed sites
- King County prioritization of the seven SMP sites
- General characteristics of the SMP sites.

## Sediment Management Standards

Regulation of contaminated sediments in the marine environment of Washington State typically falls under the authority of Ecology. In 1991, Ecology adopted the Sediment Management Standards (SMS; Chapter 173-204 WAC) for designating marine sediments that have acute or chronic adverse effects on aquatic organisms. Three sets of standards were established under the SMS: sediment quality standards, sediment cleanup standards, and source control standards.

Sediment quality standards (SQS) correspond to a sediment quality that will result in no adverse effects, including acute or chronic adverse effects on biological resources and no significant health risk to humans. The SQS includes chemical concentration criteria for 47 chemicals. If sediment chemical concentrations exceed SQS chemical concentration criteria, the sediments being evaluated are designated as having an adverse effect on biological resources and fail the SQS. Sediments failing the SQS may be reevaluated using biological tests described in WAC 173-204-315 to confirm or refute the original designation.

If sediments exceed the SQS for any one of the 47 listed chemicals, they are subject to sediment cleanup standards set forth in WAC 173-204-520 which establish sediment chemical concentrations that determine if contaminated sediments require cleanup. Cleanup screening levels (CSL) set the maximum degree of concentration on a site before cleanup is required. Similarly, minimum cleanup levels (MCUL) establish the maximum degree of contamination to be allowed on a site after cleanup, and are to be used in the evaluation of cleanup alternatives as specified in the SMS. Minimum cleanup levels are set at the same concentration as CSLs.

A third set of standards, source control standards, define the maximum level of sediment contamination allowed in sediments impacted by ongoing discharges (WAC 173-204-420). Ecology has the ability to designate a zone (sediment impact zone or SIZ) in which

contamination above cleanup standards is allowed provided that appropriate source control and remedial activities have occurred (WAC 173-204-500/510).

## 1996 Ecology Site Prioritization

As discussed above, Ecology previously developed a sediment site prioritization scheme to identify and prioritize its resources to implement the SMS. The general ecological and human health risk reduction objectives of sediment cleanup, as defined by the SMS, have been transformed by Ecology into a set of sediment site scoring guidelines, which are periodically applied to prioritize sites from among the total list of contaminated sediment sites Ecology has identified. The most recent Ecology ranking results were released in May 1996. Of the 49 sites identified in Puget Sound, seven are located near King County CSO outfalls. These seven sites were ranked as follows (ecological score out of a possible 100 points; higher score indicates higher contamination):

- EB8 (near Hanford Street CSO) – 42
- EB7 (near Lander Street CSO) – 13
- DR31 (near Duwamish Pump Station/Diagonal CSO*) – 12
- DR32 (near Brandon Street CSO) – 11
- EB27 (near King Street CSO) – 10
- EB26 (near Denny Way CSO) – 6
- EB13 (near Chelan Avenue CSO) – not scored (within existing Harbor Island Superfund site boundary).

## SMP Site Prioritization

Since publication of the 1996 Ecology site prioritization, considerable additional data have become available that provide a more accurate characterization for the ranking of each of the prospective sediment cleanup sites listed above (see Appendix C). In addition, King County has developed a sediment prioritization scheme that builds upon Ecology's ranking model, and also addresses some of the important roadblocks that have complicated cleanup of contaminated sediments throughout Puget Sound. Typically, these roadblocks have included high costs, limited disposal site options, concerns about environmental liability, source control issues, habitat alterations, and complex regulatory and land owner constraints. The SMP ranking model was applied to the SMP area to prioritize the seven listed sites. The SMP prioritization model integrated available information on toxicity potential, extent of contamination, source control, natural recovery potential, habitat attributes, fisheries utilization, and other factors to derive a total score for each sediment site. Inputs to the ranking model included the following:

- Maximum cluster concentration of individual contaminants
- Extent of contaminated sediments near CSO outfalls
- Potential for natural recovery or sediment recontamination

- Water depth of contaminated sediments
- Habitat complexity
- Proximity to special resource areas.

The application of these input parameters in the SMP ranking model is explained in detail below.

**Maximum cluster concentration of individual contaminants**—The SMP ranking model used as input the maximum station cluster, which is defined as a group of geographically and chemically similar stations that together define the highest average chemical concentrations or biological effects. The station cluster concept addresses to some extent the characteristic variability of environmental measurements, and is also being used in Ecology's SMS program to define sediment contaminant hotspots. In the ranking model, the station cluster concentration was compared with conservative Puget Sound SQS chemical criteria and other applicable toxicity benchmarks (e.g., verified cancer potency factors for human health risk assessment).

The determination of maximum cluster concentrations at each CSO sediment site was based on surface (0 to 10 centimeters) sediment samples collected over the past 10 years. The data considered in this preliminary analysis included:

- King County Laboratory Information Management System (LIMS) data provided as spreadsheet files (see King County Task 5 SMP report)
- Ecology's most recent update of the SEDQUAL database (updated August 1998)
- Duwamish/Diagonal CSO/SD site characterization reports (e.g., King County 1997)
- Denny Way site characterization reports (e.g., Striplin and Black & Veatch 1998a)
- Pier 48 (near King Street CSO) sediment site characterization reports (e.g., Hart Crowser 1994; Ecology 1995)
- Other readily available information on file at Anchor Environmental.

A station cluster analysis was performed in accordance with SMS guidelines at each site to determine whether the site could be identified as an area of potential concern for any given analyte or compound in exceedance of the SQS chemical criterion. The station cluster analysis involved identifying the highest concentration of the analyte or compound, then calculating the average concentration at three contiguous stations (including the one identified with the highest concentration) provided that the distance between stations did not exceed 500 feet. Station cluster results are presented in Table 1.

## Table 1. Maximum Station Cluster Concentrations of Analytes of Potential Concern at the Seven SMP Sites, King County

| Analytes of Potential Concern[a] | SQS Chemical Criterion | CSL Chemical Criterion | Maximum Detected Station Cluster Concentration (three Contiguous Surface Samples) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Brandon Street CSO (DR32) | Duwamish/ Diagonal SD/CSO (DR31) | Chelan Avenue CSO (EB13) | Hanford Street CSO (EB8) | Lander Street CSO[b] (EB7) | King Street CSO (EB27) | Denny Way CSO[c] (EB26) |
| **METALS** (mg/kg dry): | | | | | | | | | |
| Arsenic | 57 | 93 | | 37 | | 14 | | | |
| Cadmium | 5.1 | 6.7 | | | | 2.2 | | | |
| Copper | 390 | 390 | | | | | | 180 | |
| Mercury | 0.41 | 0.59 | 0.18 | 1.50 | | 0.48 | 0.63 | 1.45 | 0.54 |
| Lead | 450 | 530 | | | | | | 190 | |
| Silver | 6.1 | 6.1 | | | | | | 6.7 | |
| Zinc | 410 | 960 | | | | | | 477 | |
| **POLAR ORGANICS** (mg/kg dry): | | | | | | | | | |
| 4-Methylphenol | 0.67 | 0.67 | | 1.54 | | | | | |
| **NON-POLAR ORGANICS** (mg/kg organic carbon): | | | | | | | | | |
| 1,4 Dichlorobenzene | 3.1 | 9 | 0.4 | 8.9 | 12 | 3.8 | | | |
| Bis(2-ethylhexyl)phthalate | 47 | 78 | 57 | 275 | 42 | 71 | 58 | 98 | 83 |
| Butylbenzylphthalate | 4.9 | 64 | | | | | | | 14 |
| Total PAHs | ~ 1,300 | ~ 6,100 | | | 1,424 | 320 | | 1,864 | 862 |
| Total PCBs | 12 | 65 | | 564 | | 81 | 44 | | 48 |

Concentration exceeded SQS criteria.

Concentration exceeded CSL criteria.

[a]For the purpose of sediment site ranking, only those analytes that exceeded SQS criteria in at least one surface sample were included in this summary.
[b]Based on sediment core sample intervals ranging from 0–86 to 0–169 cm depth intervals; no surface (0 to 10 cm) sediment samples available.
[c]Includes inshore areas exceeding CSL that will be remediated per CSO control project agreements.

Missing Figure 2

Figure 2. Approximate Extent of Sediment Contamination in the Vicinity of the Seven King County CSO Sediment Sites.

**Extent of contaminated sediments near CSO outfalls—**The footprint of a CSO is the immediately adjacent area of deposition of quickly sinking CSO-derived chemicals adsorbed to sediment particles that settle to the bottom at varying distances from the end of the pipe, depending on particle size and hydrographic conditions. The estimated areal extent of contaminated sediments within each CSO footprint was defined for the purpose of ranking as exceedance of the SQS, although the footprint of CSL exceedances was also delineated (see below). The more conservative SQS provides a regulatory goal by identifying surface sediments that are predicted to have no adverse effects (chronic or acute) on biological resources and do not pose a significant risk to humans. The higher CSL identifies sediments that may represent minor adverse effects to some sensitive species, and is sometimes used by Ecology as the enforceable sediment cleanup standard when the cost of achieving the SQS is substantial and disproportionate to the degree of additional protection provided. Within the Puget Sound region, Ecology has used both SQS and CSL criteria to derive enforceable cleanup standards, depending upon site-specific considerations.

In addition, the footprint determinations focused only on those chemicals that are at least partially attributable to CSO discharges, based on a review of the findings of related King County investigations. For example, King County's Water Quality Assessment (WQA) and other King County documents have concluded that the cumulative sediment quality effects of the Duwamish/Diagonal CSO and SD discharges have led to a distinct benthic infaunal community grading from impacted at stations nearest the CSO and SD outfalls to relatively unimpacted at the station farthest from shore (Parametrix and King County 1998). The areal extent of these impacts, as determined by biological testing, appears to be limited to the footprint of elevated sediment concentrations of bis(2-ethylhexyl)phthalate and 1,4 dichlorobenzene that exceed CSL chemical criteria, even though elevated concentrations of other chemicals such as polychlorinated biphenyls (PCBs) are also present in the area. In consideration of these findings, and since bis(2-ethylhexyl)- phthalate and 1,4 dichlorobenzene are commonly detected in CSO and SD discharges (while chemicals such as PCBs typically are not), the footprint of contaminated sediments associated with each outfall was determined solely on the basis of these marker chemicals. As discussed above, the more conservative SQS criteria were used to delineate the footprints. The results of the footprint analysis are presented in Figure 2. When available, confirmatory bioassay data were used to supplement and refine the spatial distributions, consistent with the SMS regulations.

**Potential for natural recovery and/or sediment recontamination**—The determination of natural recovery and/or sediment recontamination potential can be difficult because the seven SMP sites are all located in the immediate vicinity of CSO and SD outfalls, potentially requiring the aid of sophisticated mathematical modeling (see Appendix A). For the purposes of the SMP site prioritization, the potential for recontamination at each of the seven sites was assessed using a combination of nearfield (PLUMES) and farfield (WQA) screening-level model runs. Both model runs used current source level inputs from CSOs and SDs. Although future source inputs will be reduced as initial volume reduction projects are completed and as the King County *Executive's Preferred Plan for Regional Wastewater Services* is implemented over the next 30 years, these future reductions have not been factored into the conservative PLUMES and WQA modeling

performed for this SMP. Future CSO source controls scheduled for the SMP area will reduce recontamination potential by removing particles that settle near the outfalls. The nearfield modeling determined the (approximate) probability distribution that sediment recontamination above SQS and/or CSL criteria could occur within a distance of approximately 20 to 50 feet from each CSO outfall, based on a statistical analysis of PLUMES output. The farfield modeling assessed the potential for recontamination approximately 100 to 400 feet from the CSO outfall (within the closest WQA model grid), incorporating other regional sources including SD discharges and local sediment resuspension.

Modeling results for the nearfield and farfield assessments are presented in Figures 3 and 4, respectively. Model results are expressed in terms of the predicted probability that suspended sediments (i.e., prior to incorporation into bottom sediments) within the seven CSO plumes may currently exceed sediment quality criteria. These results suggest that localized accumulations of bis(2-ethylhexyl)phthalate above CSL chemical criteria may occur within a localized nearfield area immediately adjacent to each of the seven CSO outfalls. No other chemical was predicted to regularly exceed CSL criteria in the nearfield area, though site-specific exceedances of individual chemicals such as copper and lead were noted (King Street and Denny Way CSOs; see Appendix A). The nearfield and farfield model outputs were combined to estimate the areal-weighted sediment input concentration of marker chemicals throughout the CSO footprint defined above.

Except for the Brandon Street site, the areal-weighted input concentrations of bis(2-ethylhexyl)phthalate and 1,4 dichlorobenzene calculated in this manner were all below conservative SQS criteria. These data suggest that source controls achieved to date may be sufficient to allow future natural recovery to achieve SQS criteria throughout most of the CSO footprint area, with a low probability of future sediment recontamination throughout much of the site. Although the PLUMES model results reveal that a localized zone immediately adjacent to each outfall (representing an area of less than 1 acre) has a significantly higher probability of sediment recontamination, the extent of these potential sediment impact zones is small in comparison to the existing CSO footprints. In the case of the Brandon Street site, the total existing footprint is already small (less than 1 acre; see Figure 2), and not likely to change significantly at current source levels. Thus, all information considered, sediment contamination at the listed SMP sites appears to be largely the result of historical inputs and/or ongoing SD discharges, and not ongoing CSO sources. This preliminary result may have important ramifications to the SMP strategy.

The rate of natural recovery within the CSO site footprint area, an important site ranking parameter, was estimated for this site prioritization by using the SEDCAM sediment recovery model, an Ecology-approved method to estimate sediment recovery under the SMS program. SEDCAM incorporates the effects of sedimentation, biodegradation, and diffusion processes (Tetra Tech 1988), though in this initial application biodegradation rates were conservatively set to zero. The model assumed a well-mixed system and allowed for the continual input of contaminants (at current discharge levels) with sedimentation. Using available estimates of net sedimentation rates at each site

## Table 8. Sediment Management Matrix

| Site | Cooperative Cleanup Opportunities | Potential Partners | Possible Funding Sources | Recommended Remedial Action | **Total SMP Cost Estimate** (including planning, construction, and cooperative partner contributions) | Recommended SMP Implementation Action |
|---|---|---|---|---|---|---|
| **High-Priority Cleanup Sites:**<br><br>DR 31 (near Duwamish/ Diagonal CSO) | A sediment cleanup study of this site has been completed as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program (EBDRP). However, cleanup implementation activities are currently stalled due to a lack of planning funds.<br>In addition, the U.S. Army Corps of Engineers may perform dredging of the channel area of the site, if the action is performed as part of routine channel maintenance, and if a suitable sediment disposal location is identified.<br>EPA is currently considering adding the Duwamish/Diagonal site, along with other areas of the Duwamish River, to the National Priorities List (Superfund). | Elliott Bay/ Duwamish Restoration Program<br>U.S. Army Corps of Engineers and Port of Seattle (local sponsor)<br>City of Seattle<br>King County | As part of a Natural Resource Damage Assessment settlement agreement, King County and the City of Seattle previously allocated and committed resources to the Elliott Bay/Duwamish Restoration Program for cleanup of this site.<br>Funding of U.S. Army Corps of Engineers dredging activities could occur under existing Water Resources Development Act authorities, and would require Congressional appropriations and participation of the local sponsor (Port of Seattle). | Continuation of site cleanup as part of the existing Elliott Bay/Duwamish Restoration Program.<br>Cooperative involvement of the U.S. Army Corps of Engineers could be pursued by the Elliott Bay/Duwamish Restoration Program and/or the Port of Seattle. | $0 | None |
| EB 27 (near King Street CSO) | Long-term redevelopment plans are currently being developed for an expanded Colman Dock ferry terminal within the existing Pier 48 area, as part of the South Downtown Waterfront Master Development Plan. Washington State Ferries and the Port of Seattle recently initiated a sediment cleanup study of the site as part of this larger planning effort. Cleanup decisions are currently scheduled for spring and summer of 2000. | Washington State Ferries (WSF)<br>Port of Seattle<br>City of Seattle<br>King County | Washington State Ferries and/or the Port of Seattle may decide to perform some or all of the required sediment cleanup as part of site redevelopment. King County could potentially accelerate CSO control and long-term monitoring as part of an overall cooperative implementation agreement. | Capping of approximately 15–19 acres of contaminated sediments at the site with a 1- to 3-foot sand capping layer (thickness to be determined during final design). | $2.2 million (excluding possible land encumbrance fees from Washington Department of Natural Resources and/or Port of Seattle) | Begin cooperative discussions with Washington State Ferries and Port of Seattle.<br>Perform further evaluation and/or modeling of potential recontamination from existing CSO discharges to determine whether CSO control should be accelerated. |
| **Medium-Priority Cleanup Sites:**<br><br>EB8 (near Hanford Street CSO) | The Port of Seattle and Corps of Engineers are currently performing planning studies for dredging and confined disposal of sediments at this site as part of the East Waterway Stage II navigation improvement project. Sediment sampling has been completed. Dredging and disposal decisions may occur in late 1999. | Port of Seattle<br>U.S. Army Corps of Engineers<br>King County | The U.S. Army Corps of Engineers may perform dredging; King County and the Port of Seattle could potentially share disposal costs. | Removal and confined aquatic disposal of 190,000 cubic yards of contaminated sediments. | $13 million (assuming the availability of a relatively low-cost confined aquatic disposal site) | Contact Port of Seattle regarding the current status of Stage II.<br>Perform further evaluation and/or modeling of potential recontamination from existing CSO discharges to determine whether CSO control should be accelerated. |
| EB7 (near Lander Street CSO) | | | | Removal and confined aquatic disposal of 50,000 cubic yards of contaminated sediments. | $3.7 million (assuming the availability of a relatively low-cost confined aquatic disposal site) | |
| EB 26 (near Denny Way CSO) | King County recently completed a cleanup study of the site as part of the Denny Way CSO control project. Cleanup of portions of the site is currently proceeding under this separate program. | King County | As part of the year 2000 capital budget process, King County will consider a separate capital project request for remediation of inshore contaminated sites (areas A and B) for 2004 (i.e., after Denny Way CSO has been controlled). | Consider remediation of all contaminated areas after CSO control in 2003. | $0.7 million (excluding possible land encumbrance fees from Washington Department of Natural Resources) | Submit budget request to complete all sediment remediation after CSO project construction. |
| **Low-Priority Cleanup Sites:**<br><br>EB13 (near Chelan Avenue CSO) | No cleanup studies have been completed at this site, although data have been collected by King County and others on the extent of sediment contamination, some of which extends into the federal navigation channel.<br>The U.S. Army Corps of Engineers may conduct dredging of the channel area of the site if the action is performed as part of routine channel maintenance, and if a suitable sediment disposal location is identified. | U.S. Army Corps of Engineers<br>Port of Seattle (local sponsor)<br>King County | The U.S. Army Corps of Engineers may conduct dredging if dredging is performed as part of channel maintenance; disposal costs are uncertain. | Removal and confined aquatic disposal of 20,000 cubic yards of contaminated sediments. Cap approximately 2 acres of contaminated sediments at the site with a 1- to 3-foot sand capping layer (thickness to be determined during final design). | $2.0 million (excluding possible land encumbrance fees from Port of Seattle) | No action at this time |
| DR32 (near Brandon Street CSO) | No cooperative opportunities have been identified. The available data suggest highly localized sediment contamination at this site, not extending into the federal navigation channel.<br>EPA is currently considering adding the Brandon Street site, along with other areas of the Duwamish River, to the National Priorities List (Superfund). | King County | No source identified | Capping of approximately 1 acre of contaminated sediments at the site with a 1- to 3-foot sand capping layer (thickness to be determined during final design). | $0.3 million (excluding possible land encumbrance fees from Port of Seattle) | No action at this time |

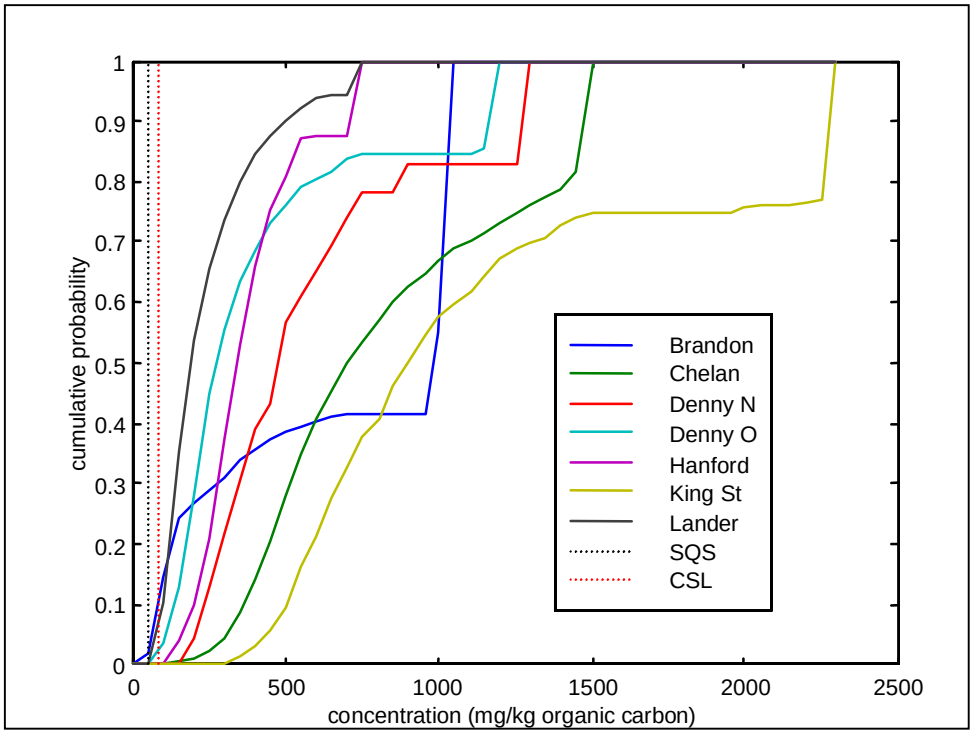


**Figure 3. Nearfield PLUMES Results: Bis(2-ethylhexyl)phthalate**

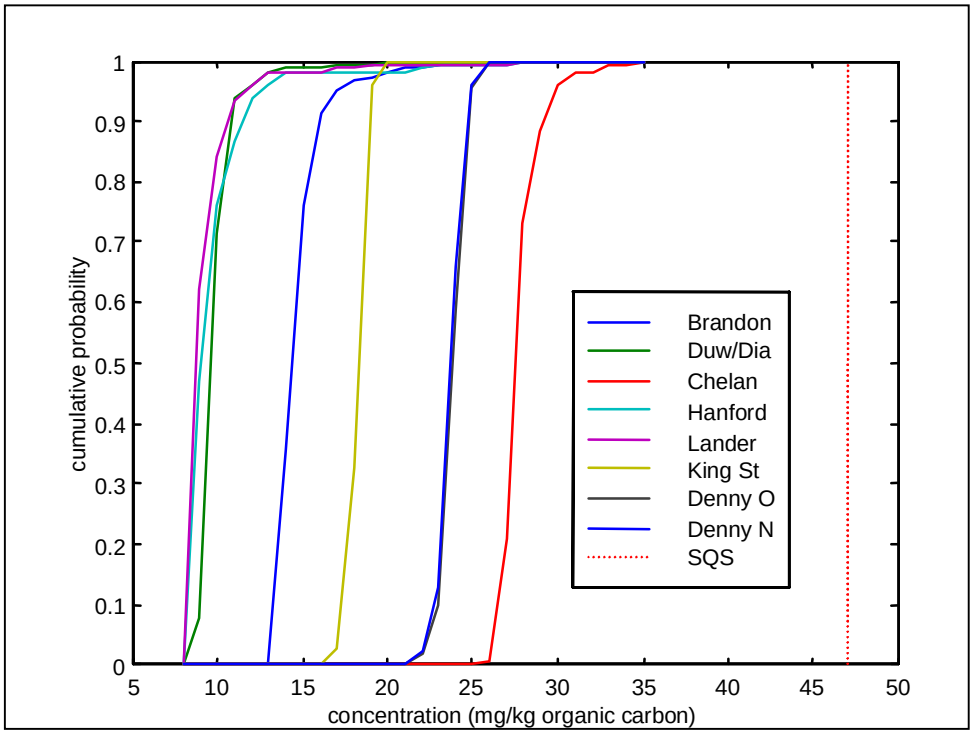


**Figure 4. Farfield WQA Results: Bis(2-ethylhexyl)phthalate**

(available from several sources, e.g., Patmont et al. 1983; Ecology 1995), and assuming a conservative mixed layer thickness of 10 centimeters, an overall 10-year sediment recovery factor (ratio of year 0 to year 10 surface sediment concentrations near each CSO) was calculated using the SEDCAM model. The results of this screening-level modeling are summarized in Table 2. Except for the relatively small Brandon Street and Chelan Avenue sites, significant natural recovery is expected to occur within the CSO footprint over the next 10 years. This expected recovery is conservative because it does not account for planned future CSO source controls.

**Water depth of contaminated sediments**—In consideration of the well-documented preference of many fish and shellfish species for shallow-water habitats over deeper zones, the SMP ranking model assigned a higher score to those sediment sites that are located within relatively shallow water. The scale for this analysis was adjusted to represent the range of depths observed within the study area. Typical water depths for each listed sediment site are summarized in Table 2.

**Habitat complexity**—In developing the ecological risk score, the SMP ranking model used information on site relief or the areal extent of habitat-enhancing materials such as eelgrass, shell hash, or other similar enhancements within the contamination area.

**Proximity to special resource areas—**The final set of parameters used in the model referred to the location of the sediment site relative to important ecological and human health exposure areas, including special marine habitats, tribal fisheries, and public access points.

Using the input data described above, the SMP site prioritization model calculated overall ecological and human health scores, which were added together to obtain a subtotal site score. Subsequently, other qualitative criteria defined in Appendix C were used as modifying criteria, and applied to identify priority sites in cases where the initial site scores were equivalent. These criteria include resource management; faster, better, cheaper; economic vitality; and the potential for cooperative projects.

The results of the SMP sediment site analysis, as summarized in Table 2, resulted in the following initial site prioritization (presented in descending order of priority) modified from the original Ecology site ranking:

| Ecology Site Number | Nearby Combined Sewer Overflow | Cleanup Priority |
|---|---|---|
| • DR31 | • Duwamish/Diagonal[a] | • High |
| • EB27 | • King Street | • High |
| • EB8 | • Hanford Street | • Medium/high |
| • EB7 | • Lander Street | • Medium/high |
| • EB26 | • Denny Way[b] | • Medium |
| • EB13 | • Chelan Avenue | • Low/medium |
| • DR32 | • Brandon Street | • Low |

[a] The Duwamish Pump Station/Diagonal CSO site (DR31) will be remediated following the terms of an existing NOAA settlement under NRDA.

[b] A portion of the Denny Way CSO site (EB26) will be remediated as part of the ongoing CSO control project.

## Table 2. Sediment Cleanup Site Scoring Using Modified SEDRANK Model and Other King County Criteria

| Parameter | Brandon Street CSO (DR32) | Duwamish/ Diagonal SD/CSO (DR31)* | Chelan Avenue CSO (EB13) | Hanford Street CSO (EB8) | Lander Street CSO (EB7) | King Street CSO (EB27) | Denny Way CSO (EB26) |
|---|---|---|---|---|---|---|---|
| Approximate Area Exceeding SQS Criteria in acres [a] | 0.8 | 8 | 4 | 15 | 6 | 19 | 4.5 |
| Maximum Exceedance Ratio of Cluster Concentration Above SQS [b] | 1.2 | 47.0 | 3.9 | 6.7 | 3.7 | 3.5 | 4.0 |
| Max. Ratio of Input/Existing Surface Sediment Concentrations [b,c] | 1.0 (d) | 0.1 | 1.0 (d) | 0.2 | 0.3 | 0.3 | 0.4 |
| Estimated Sedimentation Rate in cm/year | 10 | 8 | 4 | 3 | 3 | 1 | 1 |
| Year-10 concentration / Year-0 concentration [e] | 1.0 | 0.1 | 1.0 | 0.2 | 0.4 | 0.6 | 0.6 |
| Typical Water Depth Range in feet MLLW | -15' to 0' | -15' to 0' | -30' to -15' | -30' to -15' | -30' to -15' | -30' to -15' | -30' to -15' |
| Habitat Complexity (areal extent of high quality habitat) | < 10% | < 10% | < 10% | < 10% | < 10% | < 10% | < 10% |
| Special Marine Habitats | Near Kellogg Island | Near Kellogg Island | None | None | None | None | None |
| Wildlife Refuges/Sanctuaries | Near Kellogg Island | Near Kellogg Island | None | None | None | None | None |
| Commercial Fisheries | Within tribal fisheries | Within tribal fisheries | Within tribal fisheries | Near tribal fisheries | Near tribal fisheries | Near tribal fisheries | Near tribal fisheries |
| Recreational Fisheries | Fishery near site | Fishery near site | Fishery near site | Fishery near site | Fishery near site | Fishery near site | Fishery near site; shoreline park |
| Primary Score Based on Modified SEDRANK Model | Low (0) | High (18) | Low (3) | Medium (6) | Medium (6) | Medium/High (11) | Medium (8) |
| Modifying Criteria: Resource Management | No effect expected | Localized salmonid habitat benefits | No effect expected | No effect expected | No effect expected | No effect expected | No effect expected |
| Faster, Better, Cheaper | No effect expected | No effect expected | No effect expected | Multiple use opportunities | Multiple use opportunities | Multiple use opportunities | No effect expected |
| Economic Vitality | No effect expected | Possible future navigation limitations | Possible future navigation limitations | Possible future development limitations | Possible future development limitations | Possible future development limitations | No effect expected |
| Potential for Cooperative Sediment Cleanup Projects | No cooperative opportunity identified | Potential WRDA Projects (COE/Port) | Potential WRDA Projects (COE/Port) | Port of Seattle Redevelopment (Port/COE) | Port of Seattle Redevelopment (Port/COE) | Colman Dock Redevelopment (WDSOT/Port) | No cooperative opportunity identified |
| OVERALL SITE PRIORITIZATION | Low | High | Low/Medium | Medium/High | Medium/High | High | Medium |

Notes:
[a] Only those chemicals that are reasonably associated with CSO discharges are included in this evaluation. Exceedance ratio based on SQS chemical criteria.
[b] All chemicals included.
[c] Based on the estimated areal-weighted average of screening-level nearfield and farfield recontamination modeling (Task 900).
[d] Input value adjusted downward to reflect relatively low sediment concentrations measured in the CSO discharge area.
[e] 10-year natural recovery factor calculated using SEDCAM, assuming a 10-cm mixed layer depth.

The initial site prioritization may be refined during subsequent phases of the SMP process as cleanup strategies are developed in more detail. Additional factors that may influence the site prioritization include estimated cleanup costs, availability of disposal sites, liability considerations, source control refinement, habitat issues (e.g., Endangered Species Act listing), land owner constraints, the potential for new cooperative projects to arise, and the potential Superfund listing of the Duwamish River.

## General Site Characteristics

This section presents an inventory of sediment quality data collected in the vicinity of the seven King County SMP sites.

### DR31 (near Duwamish Pump Station/Diagonal CSO)

The Duwamish Pump Station, located at 4501 East Marginal Way South, receives flows from both the Elliott Bay Interceptor and the Duwamish Siphon. This location overflows only in the event of an extremely large flow or during a power outage. The outfall for the pump station overflow structure is located near the City of Seattle Diagonal Way CSO and storm drain outfall, which also receives CSO flow from the county's Hanford 1 CSO at Rainier Avenue. The Diagonal CSO/SD outfall is totally exposed at low tide and can discharge directly onto exposed intertidal sediment. The discharge, which is primarily stormwater, averages about 1,200 million gallons per year. Sampling locations in the vicinity of the Duwamish Pump Station/Diagonal CSO/SD outfalls are shown in Figure 2.

Cleanup of sediments at the Duwamish/Diagonal CSO/SD site is currently proceeding as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program (EBDRP), a cooperative, intergovernmental program established to implement the requirements of a 1991 consent decree. The scope of the EBDRP efforts includes remediation of contaminated sediment associated with King County Department of Natural Resources (previously Metro) and City of Seattle CSOs and SDs. The EBDRP Concept Document released in 1994 prioritized 24 potential project sites and both the Duwamish Pump Station emergency overflow, and the Diagonal CSO/SD were ranked in the top one-third. Because the two outfalls are close together, the project is called the Duwamish/Diagonal site. The Cleanup Study Plan for the site was released in June 1994.

Three sampling events were conducted from August 1994 to September 1996 to characterize sediment chemistry at the Duwamish/Diagonal site. Contaminants of concern identified from the site assessment included mercury, bis(2-ethylhexyl) phthalate, polychlorinated biphenyls (PCBs), and benzyl butyl phthalate (King County 1997). However, the primary chemical dictating the outer cleanup boundary was bis(2-ethylhexyl)phthalate. For this chemical there was a band of sediment exceeding CSL criteria that extended both up and down the river to the edge of the sampling grid and offshore to the edge of the dredged channel. However, confirmatory SMS bioassay

testing performed in the area allowed the establishment of an upstream and downstream boundary for a potential sediment cleanup area. The depth of contamination extends from 3 feet in some areas to 9 feet in a few other areas. Dredging may be required at the site, but a preferred remediation alternative has not yet been determined.

The available surface sediment sampling data for the Duwamish/Diagonal site are depicted on Figure 2. Approximately 5 acres within the site vicinity exceed CSL criteria, while roughly 8 acres exceed the more conservative SQS criteria. Assuming a nominal contaminated sediment thickness of 6 feet, the total volume of contaminated sediments (above SQS) at the site is roughly 70,000 cubic yards.

The draft Site Assessment Report and a few chapters of the Alternatives Evaluation Report were released for review in 1997. However, work on these reports had to be suspended due to the lack of planning and design funds for EBDRP projects. It is estimated that work will resume, perhaps in 1999, when the court who signed the consent decree allocates additional planning and design funds. The additional funds will allow development of a preferred remediation alternative.

Also, the EBDRP has determined that further work is needed on the Site Assessment Report to evaluate recontamination potential at the Duwamish/Diagonal site. New information indicates that nearly double the amount of separated storm water is discharged out the Diagonal outfall than was used in the initial modeling calculations. A preliminary assessment is currently underway by the EBDRP to estimate the amount of source reduction needed for bis(2-ethylhexyl)phthalate to avoid sediment recontamination of the site following cleanup.

## EB27 (near King Street CSO)

The King Street CSO regulator station is located at 499 Alaskan Way South. The outfall for this CSO discharges into Elliott Bay at Pier 46. This outfall is located under the northeast edge of the pier, and about half of the pipe is exposed at extreme low tides. In an average year, King Street CSO overflows 14 times, with a total volume of 41 million gallons per year. A City of Seattle SD (South Washington Street) also discharges into the same general area. Sampling locations in the vicinity of the King Street CSO and South Washington SD outfalls are shown in Figure 2.

As part of a previous expansion of Colman Dock in 1989, the Washington Department of Transportation (WSDOT) placed a thin layer cap to isolate contaminated sediments that underlie the northern boundary of the site (Sumeri 1996; see Figure 2). Subsequently, more detailed sediment sampling within the area was performed by WSDOT, King County, and the EBDRP. These data reveal that approximately 15 acres within the site vicinity exceed CSL criteria, while roughly a combined total of 20 acres exceed the more conservative SQS criteria. Assuming a nominal contaminated sediment thickness of 8 feet (based on available sediment core data), the total volume of contaminated sediments (above SQS) at the site is roughly 250,000 cubic yards. Chemicals of potential concern identified at the

site include metals (including lead, mercury, silver, and zinc), bis(2-ethylhexyl)phthalate, and polynuclear aromatic hydrocarbons (PAHs).

Long-term redevelopment plans for an expanded Colman Dock ferry terminal in the immediate vicinity of the site are currently being developed and evaluated as part of the ongoing South Downtown Waterfront Master Development Plan and environmental impact statement (EIS). The plan and EIS are being developed by Washington State Ferries, in coordination with the Port of Seattle and City of Seattle. Conceptual alternatives being considered include construction of new auto ferry slips positioned offshore (near the outer harbor line) and slightly north of the existing slips. An expanded passenger-only ferry terminal, potentially including a cruise ship terminal, may be located within the existing Pier 48 area immediately offshore of the King Street CSO outfall. Under this scenario, expanded ferry operations would be located within the existing King Street CSO and/or Washington Street SD footprints (see Figure 2).

As part of the EIS process, WSDOT and the Port of Seattle will be collecting and analyzing additional sediment samples (including confirmatory bioassays as appropriate) at the site to complete the site characterization and to support an evaluation of combined cleanup and redevelopment alternatives. Consistent with earlier planning documents prepared for the area by EBDRP, WSDOT, and the Port of Seattle, the presumptive cleanup remedy for this site is capping. However, the MTCA Cleanup Action Plan for the site will be developed with Ecology and Washington Department of Natural Resources (WADNR) following more detailed analysis of alternative cleanup and redevelopment options. The EIS and Cleanup Action Plan are currently scheduled to be completed in mid-2000, when they will be provided for public review.

Currently, the proposed King county schedule for implementing CSO control at King Street is 2026.

## EB8 (near Hanford Street CSO)

The Hanford Street CSO regulator and outfall stations are located at 2999 East Marginal Way South, within the trailer yard of the Port of Seattle Terminal 25. The outfall for this CSO discharges into the East Waterway of the Duwamish River, underneath the container pier. The outfall is located in a riprap wall on the east bank and is exposed during very low tides. The original outfall extended to the middle of the East Waterway but, in the late 1970s, the outfall was shortened to the current location on the east bank. In an average year, Hanford CSO overflows 16 times, with a total volume of 173 million gallons per year. Sampling locations in the vicinity of the Hanford Street CSO outfall are shown in Figure 2.

Based on the available data summarized in Figure 2, the footprint of the Hanford CSO may extend into the navigation channel of the East Waterway. Approximately 9 acres within the site vicinity exceed CSL criteria, while roughly 15 acres exceed the more conservative SQS criteria. Assuming a nominal contaminated sediment thickness of 8

feet (based on available coring data), the total volume of contaminated sediments (above SQS) at the site is roughly 190,000 cubic yards. Chemicals of potential concern identified at the site include metals, bis(2-ethylhexyl)phthalate, PCBs and PAHs.

The East Waterway, including the Hanford Street CSO footprint, is a critical element of the Port of Seattle's *Container Terminal Development Plan* (Port of Seattle 1991). Stage I of the East Waterway project, resulting in the dredging of key approach channels and berthing areas near Harbor Island to a depth of 51 feet mean lower low water (MLLW), is expected to be completed by mid-2000. Stage II of the project, which will include dredging of most of the rest of the East Waterway, including nearly all of the Hanford (and Lander Street) CSO footprints, is currently in the design phase. In consideration of these navigation improvement plans, the presumptive remedy for the site is dredging and offsite disposal.

As part of Stage II planning efforts, the U.S. Corps of Engineers recently collected 86 composite sediment cores from the greater Hanford (and Lander) site area, and submitted the samples for detailed chemical and biological analyses following Puget Sound Dredged Disposal Analysis (PSDDA) guidelines. Sediment chemistry, bioassay, and bioaccumulation analyses were conducted on most of the surface composite samples collected (0 to 4 feet depth), and also on subsurface samples (below 4 feet). These determinations, which are expected to greatly improve the characterization of sediment contaminants and disposal requirements within the Stage II area, are expected to be available by summer, 1999. Prospective disposal sites currently being considered by the Port of Seattle include the PSDDA open-water disposal site in Elliott Bay (for suitable materials), and a range of nearshore confined disposal facilities (CDF), confined aquatic disposal (CAD), or upland disposal sites for materials found to be unsuitable for open-water PSDDA disposal.

Currently, the proposed King County schedule for implementing CSO control at Hanford Street is 2017.

## EB7 (near Lander Street CSO)

The Lander Street CSO regulator station is located at Colorado Avenue South and South Lander Street. The outfall station is located at 2701 East Marginal Way South. The outfall for this CSO discharges into the East Waterway of the Duwamish River. The outfall is submerged and never exposed. In an average year, Lander Street CSO overflows 17 times, with a total volume of 80 million gallons per year. Sampling locations in the vicinity of the Lander Street CSO are shown in Figure 2. Similar to the Hanford CSO site, the footprint of the Lander Street CSO extends into the navigation channel and Stage II dredging area of the East Waterway. Approximately 1 acre within the site vicinity exceeds CSL criteria, while roughly 6 acres exceed the more conservative SQS criteria. Assuming a nominal contaminated sediment thickness of 8 feet (based on available coring data), the total volume of contaminated sediments (above SQS) at the

site is roughly 50,000 cubic yards. Chemicals of potential concern identified at the site include metals, bis(2-ethylhexyl)phthalate, PCBs, and PAHs.

As discussed above, additional sediment quality data are being collected by the Corps of Engineers as part of Stage II planning efforts. In consideration of navigation improvement plans, the presumptive remedy for the Lander Street site is dredging and offsite disposal at either the PSDDA open-water disposal site in Elliott Bay (for suitable materials) or at possible CDF, CAD, or upland disposal sites for materials found to be unsuitable for open-water PSDDA disposal.

Currently, the proposed King County schedule for implementing CSO control at Lander Street is 2019.

## EB26 (near Denny Way CSO)

The Denny Way CSO regulator station is located at 3165 Alaskan Way. The outfall for this CSO discharges into Elliott Bay along the northeastern shoreline in Myrtle Edwards Park. This outfall is exposed during normal low tide and frequently discharges directly across exposed intertidal sediment. Sampling locations in the vicinity of the Denny Way CSO outfall are shown in Figure 2. In an average year, the Denny Way CSO discharges 51 times, with a total volume of 455 million gallons per year. After CSO control is implemented in 2003, the average yearly condition will be one untreated discharge (approximately 8 million gallons per year) and about 8–12 treated discharges (approximately 567 million gallons per year) from a new offshore outfall.

In 1990, King County and the U.S. Army Corps of Engineers sponsored the Denny Way CSO capping project to test the feasibility of capping contaminated sediments in Elliott Bay with clean dredged material from the Duwamish River. Sediments offshore of the Denny Way CSO are contaminated with mercury, silver, PAHs, and bis(2-ethylhexyl)-phthalate. A 3-foot layer of clean sand, dredged from the upper Duwamish River during routine maintenance, was placed over a 3-acre area. The sand was placed with a split hull barge at water depths ranging from 20 to 60 feet (Romberg et al. 1995; Sumeri 1996).

King County monitored the effectiveness of the cap at containing contaminated sediment between 1991 and 1996 (Romberg and Wilson 1999). Results show that the cap is stable and is not eroding, and has successfully isolated the underlying contaminated sediments. However, chemical concentrations on the cap surface layer increased between 1991 and 1994, suggesting possible recontamination from the continued CSO discharges from Denny Way, or potential redistribution of remaining contaminated sediments from the intertidal area and the inshore edge of the cap (King County 1997).

In addition to the 1990 capping project, additional contaminated sediment areas located immediately inshore of the existing cap and CSO outfall are currently scheduled for remediation at the request of Ecology and WADNR in coordination with King County's Denny Way/Lake Union CSO Control Project. Under the terms of a recent agreement,

sediments within this area that exceed CSL criteria will be dredged and disposed of at an offsite upland landfill. The planned sediment removal area is depicted on Figure 2. The removal action will occur following completion of the Denny Way/Lake Union CSO Control Project.

Outside of the existing cap area and agreed upon/planned sediment removal area, there are three lower-concentration contaminated areas that have been delineated within the greater Denny Way CSO site. These areas, which are denoted areas C, D, and E in Figure 2, encompass a total of approximately 4 acres that exceed SQS criteria; none of the areas exceed CSL criteria. Assuming a nominal contaminated sediment thickness of 6 feet (based on available coring data), the total volume of contaminated sediments (above SQS) at the site is roughly 40,000 cubic yards.

## EB13 (near Chelan Avenue CSO)

The Chelan Avenue CSO regulator station is located at 3455 Chelan Avenue Southwest. The outfall for this CSO discharges at the intersection of the head of the West Waterway and the terminus (mouth) of the Duwamish Waterway navigation channel, approximately 40 yards offshore of the west bank. The outfall is submerged at a depth of about 30 feet and is never exposed. In an average year, Chelan Avenue CSO overflows 9 times, with a total volume of 30 million gallons per year.

The available surface sediment sampling data for the Chelan Avenue CSO site are depicted on Figure 2. Approximately 0.3 acres within the immediate vicinity of the outfall exceed CSL criteria, while roughly 4 acres exceed the more conservative SQS criteria. The extent of SQS exceedance appears to encompass the adjacent Duwamish Waterway navigation channel. Assuming a nominal contaminated sediment thickness of 6 feet, the total volume of contaminated sediments (above SQS) at the site is roughly 40,000 cubic yards. Because of the overlap of sediment contamination into the federal navigation channel, and also because portions of the channel have already shoaled to depths that are shallower than the authorized channel depth (thus possibly requiring future maintenance dredging in the area), the presumptive sediment cleanup remedy for channel portions of the site is dredging and offsite disposal. Similar to the East Waterway sites, disposal could occur at either the PSDDA open-water disposal site in Elliott Bay (for suitable materials) or at possible CDF, CAD, or upland disposal sites for materials found to be unsuitable for open-water PSDDA disposal. However, nearshore areas located outside the navigation channel may be suitable for in-place capping.

Currently, the proposed King County schedule for implementing CSO control at Chelan Avenue is 2024.

## DR32 (near Brandon Street CSO)

The Brandon Street CSO regulator and outfall stations are located at 5241 East Marginal Way South. The outfall for this CSO discharges along the eastern shoreline of the main channel of the Duwamish River. This outfall is exposed during normal low tides and, during extremely low tides, can discharge directly across exposed intertidal sediment. In an average year, Brandon Street CSO overflows 27 times, with a total volume of 47 million gallons per year.

The available surface sediment sampling data for the Brandon Street CSO site are depicted on Figure 2. Approximately 0.7 acres within the immediate vicinity of the outfall exceed SQS criteria; none of the site exceeds CSL criteria. Unlike the Chelan Avenue site, SQS exceedances do not appear to extend into the adjacent Duwamish River navigation channel. Assuming a nominal contaminated sediment thickness of 6 feet, the total volume of contaminated sediments (above SQS) at the site is roughly 10,000 cubic yards. However, these nearshore areas may be suitable for in-place capping.

Additional sediment chemistry data were recently collected by EPA. These data may be used to supplement and refine the characterization of sediment contamination at the site. A preliminary review of the EPA information suggests that the data confirm the localized extent of contaminated sediments in this area; inclusion of the EPA data would not result in substantive modifications of the CSO footprint depicted in Figure 2.

Currently, the proposed King County schedule for implementing CSO control at Brandon Street is 2022.

# SEDIMENT REMEDIATION TECHNOLOGIES

A compilation of sediment remediation technologies (Appendix B) has been prepared for consideration as part of this SMP. This review is based on information and projects located primarily within the Puget Sound region. A site-by-site review of sediment remedial technologies that have been applied and/or evaluated at various Puget Sound sites containing contaminated sediments is presented in Appendix F. In addition, EPA (1994) has prepared a guidance document with complete descriptions of most of the technologies considered.

Sediment remediation technologies considered in King County's SMP included source control/natural recovery, containment (i.e., capping), removal (e.g., dredging), upland and aquatic disposal, and treatment. Each technology was evaluated relative to technical feasibility, implementability, and cost. Among the range of potential technologies considered, only treatment was considered impracticable to address relatively large volumes of sediment (i.e., greater than 100,000 cubic yards) containing relatively low contaminant levels (e.g., part-per-million chemical concentrations). However, the potential application within the SMP area of the remaining technologies (i.e., natural recovery, containment, and removal/disposal) varied widely.

## Technology Review

Sediment remediation technologies that were considered to be potentially feasible and practicable for King County's SMP were grouped into four main categories:

- Source control and natural recovery
- *In situ* containment technologies
- Removal technologies
- Disposal technologies.

The following presents a brief summary of these four technologies, their use in the Puget Sound region, and their overall effectiveness.

### Source Control and Natural Recovery Alternatives

Contaminated sediment may naturally recover over time through a combination of several processes including chemical degradation, diffusion from the sediment matrix into the water column, burial of contaminated sediment under newly deposited clean material, and mixing of the contaminated sediment with clean sediments from above and below through bioturbation. A number of parameters need to be evaluated when considering source control and natural recovery as an option for sediment remediation. Factors to be considered include location of the contaminant within the sediment, the contaminant's

half-life, the contaminant's chemical breakdown potential, biodegradation potential, and the risk of recontamination. If source control/natural recovery is chosen as a sediment remediation alternative, a long-term monitoring plan would be necessary to demonstrate the overall success. Source control/natural recovery has not been shown to be effective unless the major ongoing sources of contaminants in the watershed are controlled.

A critical factor dictating the feasibility of any form of sediment cleanup at the listed sites is the degree to which ongoing contaminant sources are effectively controlled. One possible (though not the only) trigger signifying that CSO control is complete is flow reduction that meets the one untreated overflow event per year criterion. The only CSO site that is currently scheduled to meet this flow reduction criterion in the near-term (i.e., 2003) is Denny Way (King County 1999). Alternatively, contaminant transport modeling may be performed to evaluate whether existing CSO controls are already adequate to prevent sediment recontamination. Modeling may also be necessary to evaluate stormwater recontamination potential at the listed sites.

The Elliott Bay waterfront recontamination study (Ecology 1995) concluded that (with the exception of the King Street CSO) none of the CSOs or SDs along the Seattle waterfront currently discharge enough contaminants to result in recontamination above SQS chemical criteria. Similar results were obtained using the County's Water Quality Assessment model. However, the nearfield probability analysis conducted by King County modeling staff indicated that a localized zone (i.e., less than one acre) immediately adjacent to each CSO outfall has a higher probability of sediment recontamination given the current level of source control (Figures 3 and 4). Ongoing SD discharges to these same areas may be associated with similar or greater risks of recontamination. Presently, definitive modeling results do not exist with which to evaluate the extent of recontamination in the nearfield area around each of the CSO and SD outfalls. The scope of modeling efforts that may be performed to address recontamination concerns is outlined in Appendix A.

Source control and natural recovery has been demonstrated as an effective process and approved as a major element of sediment cleanup plans for the following projects and locations:

- **Commencement Bay Nearshore/Tideflats Superfund Site** (Sitcum Waterway; Hylebos Waterway; and Thea Foss Waterway) (EPA 1989)
- **Eagle Harbor Superfund Site**—West Harbor operable unit (EPA 1995).

Source control and natural recovery is also being evaluated in detail as part of ongoing sediment cleanup analyses for the Thea Foss Waterway (Tacoma) and Whatcom Waterway (Bellingham).

## *In Situ* Containment Technologies

*In situ* containment technologies involve remediating contaminated sediments in-place. These technologies are typically the most cost-effective approach. They offer a means to remediating contaminated sediments without the costs, environmental impacts, and permitting associated with removal and disposal. Additionally, by keeping contaminated sediments in the waterway, stable geochemical and geohydrological conditions are maintained in the sediment, minimizing release of contaminants to surface water, ground water, and air.

*In-situ* containment technologies function by placing a covering or cap over the contaminated sediment to effectively isolate or reduce the amount of contaminants in surface sediments. The cap may be constructed of clean sediment, sand or gravel, or geotextile materials. Determining if capping is a viable alternative is dependent on a number of factors such as existing and future uses of the waterway and erosive forces present at the site. Capping may not be a viable option in or near active navigation channels because of the risk of raising the bottom sediment level. Scouring by passing vessels and wave action can remove portions of the cap which may result in the release of contaminants into the water column.

Various types of material may be used for *in situ* capping. If available, sediment dredged for navigational purposes can be beneficially reused as capping material. For instance, materials dredged by the U. S. Army Corps of Engineers have been successfully reused for capping at the Denny Way CSO, Eagle Harbor, and Seattle waterfront locations. Alternatively, clean material from a nearby source can be used if available.

Two *in situ* containment technologies are available: enhanced natural recovery (ENR)/thin layer capping and thick layer capping.

### *Enhanced Natural Recovery with Thin-Layer Capping*

Enhanced natural recovery with thin-layer capping places 15 to 30 centimeters (6 to 12 inches) of clean sediment over the contaminated sediment to accelerate the natural recovery sedimentation process. The thin-layer cap initially isolates the underlying contaminated sediment. Over time, the sediment is recolonized by organisms that survived below the cap and burrowed to the surface.

Thin-layer capping is typically not effective in areas of high sediment erosion. However, preventive measures can mitigate sediment migration by covering the cap with a protective armor, such as rocks and riprap. In addition, the potential for recontamination of the caps needs to be addressed through the use of contaminant transport modeling, estimated future CSO and SD source control, and a long-term monitoring plan.

Thin-layer capping has been effectively implemented in and around Elliott Bay. Thin-layer caps were effectively placed at the following projects:

- **Pier 51 Washington State Department of Transportation Ferry Terminal Expansion, Seattle** (Sumeri 1996), implemented in 1989 (see regional case histories section below)
- **Pier 53 CSO, Seattle** (Sumeri 1996; Metro 1993b), implemented in 1992 (see regional case histories section below)
- **Pier 64, Seattle** (Sumeri 1996), implemented in 1994 (see regional case histories section below)
- **Eagle Harbor—West Harbor Operable Unit, Bainbridge Island** (Verduin et al. 1998), implemented in 1997.

### *Thick-Layer Capping*

Thick-layer capping is similar to thin-layer capping except a thicker cap section (typically greater than 90 centimeters (3 feet) is placed over the contaminated sediment to isolate the contaminants from the biologically active zone. The intent of the thicker cap is to provide additional resistance to erosive forces or to provide additional isolation of the contaminants of concern. Because a thick-layer cap effectively smothers underlying biological communities, recolonization proceeds from the surface.

Thick-layer capping has been implemented at the following projects:

- **Denny Way CSO, Seattle** (Sumeri and Romberg, 1991; Romberg et al. 1995), implemented in 1990 (see regional case histories section below)
- **Simpson Tacoma Kraft Co., Tacoma** (Sumeri 1996), implemented in 1998
- **Pier 53 CSO, Seattle** (Sumeri 1996; Metro 1993b), implemented in 1992 (see regional case histories section below)
- **Eagle Harbor—East Harbor Operable Unit, Bainbridge Island** (Sumeri 1996), implemented in 1992.
- **Eagle Harbor—West Harbor Operable Unit, Bainbridge Island** (Verduin et al. 1998), implemented in 1997.

## Removal Technologies

Sediment removal involves dredging contaminated sediments and moving them offsite for treatment, containment, or disposal. Dredging has been shown to be effective at removing contaminants to a depth of 8 feet below the mud line (EPA 1994).

Two types of dredging technologies are currently being utilized to remediate contaminated sediments: hydraulic and mechanical dredging. Hydraulic dredges remove and transport sediment in the form of a slurry and thus require considerable dewatering. They provide an economical means of removing large quantities of contaminated sediments. Sediment is most economically transported from a hydraulic dredge to a

disposal site via a pipeline. At the disposal site, the dredge slurry is allowed to settle before the effluent is discharged. It may be necessary to treat the effluent before it is discharged. However, environmental hydraulic dredging in the Pacific Northwest has only occurred on one main project. The Port of Tacoma completed the Sitcum Waterway Remediation Project in 1994 using hydraulic dredging (Port of Tacoma 1992; Verduin et al. 1994).

Mechanical dredges remove sediments by the direct application of mechanical force to dislodge sediment material. Typically, the material is scooped up with a bucket and hoisted to the surface at near *in situ* densities. That is, little additional water is entrained with the sediments as they are removed, so that the volume of the sediments is essentially the same before and after dredging, and the removed sediments need little dewatering if they are sandy. However, muddy sediments require extra work to dewater; they also may require the addition of fly ash to absorb moisture, in order to pass disposal requirements at landfills. Removed sediments are generally placed on a bottom-dump or flat barge for transport to a disposal site.

Environmental mechanical dredging in the Pacific Northwest has been successfully implemented on several projects including the following:

- **West Waterway Confined Aquatic Disposal, Seattle** (Sumeri 1996), implemented in 1984
- **One Tree Island Marina, Olympia** (Sumeri 1996), implemented in 1987
- **Port of Seattle, Terminal 91** (Boatman and Hotchkiss 1994), implemented in 1988
- **Port of Tacoma, Slip 2**, implemented in 1988
- **Bremerton Shipyard, Pier D**, implemented in 1994
- **Stage 1 Marine Terminal Improvements, Port of Everett**, implemented in 1997
- **Eagle Harbor—West Harbor Operable Unit, Bainbridge Island** (Verduin et al. 1998), implemented in 1997
- **Norfolk CSO, Seattle, implemented in 1999**.

## Disposal Technologies

Disposal is the placement of contaminated sediments into a site, structure, or facility on a temporary or permanent basis. Technologies for the disposal of contaminated sediments include open-water disposal, beneficial sediment use, and confined disposal facilities. No single disposal method is appropriate for all materials, but confined disposal technologies are the most commonly used technology for the disposal of contaminated sediments dredged for remediation projects (EPA 1994). There are typically three types of confined disposal facilities available for the disposal of contaminated sediments:

- Confined aquatic disposal

- Nearshore confined disposal
- Upland disposal.

### *Confined Aquatic Disposal*

Confined aquatic disposal (CAD) entails confining the contaminated sediment below water in either a natural depression, pit, or bermed area. A pit CAD fills a natural depression or excavated pit with contaminated sediment and a cap to create the CAD. A nearshore CAD constructs a toe berm offshore along a shoreline. Contaminated sediment is placed behind the berm and then a cap is placed to confine the sediments. The surface of a nearshore CAD can be constructed to convert deeper water substrate into shallower water (e.g., intertidal and shallow subtidal) habitat. These technologies are effective in shallow water areas with minimal current and few navigational constraints.

Confined aquatic disposal has been successfully used at the following projects:

- **West Waterway Confined Aquatic Disposal, Seattle** (Sumeri 1996), implemented in 1984
- **One Tree Island Marina, Olympia** (Sumeri 1996), implemented in 1987
- **Los Angeles Shallow-Water Habitat Site** (Mesa 1995), implemented in 1995
- **Boston Harbor Navigation and Improvement Project** (Murray et al. 1998; IDR 1999), implemented in 1997
- **Port Authority of New York/New Jersey Newark Bay Confined Aquatic Disposal** (Knoesel et al. 1998), ongoing
- **Ross Island Sand and Gravel Pit, Portland,** ongoing.

In addition, CADs were evaluated through the preliminary design stage at Southwest Harbor (Port of Seattle 1994), Thea Foss Waterway (Tacoma 1998), and Hylebos Waterway (HCC 1998). Nearshore CAD facilities, also providing concurrent habitat restoration, are currently being evaluated in Bellingham Bay and Sinclair Inlet.

### *Nearshore Confined Disposal*

Nearshore confined disposal requires the construction of a confined disposal facility underwater along the shoreline. A berm is constructed of clean material near the shoreline with land providing containment on the opposite side. The lower layer of the area between the berm and the shoreline is filled with contaminated sediment, while the upper layer is covered with clean sediment or fill material until it is above tidal level. Nearshore CDFs create new land that can be used for public shoreline access or for water-dependent businesses. Nearshore CDFs constructed in Puget Sound are often integrated with upland redevelopment and sited on existing contaminated sediment areas to provide further efficiencies.

Nearshore CDFs constructed in the Puget Sound region include:

- **Port of Seattle, Terminal 91** (Boatman and Hotchkiss 1994),implemented in 1988
- **Port of Tacoma, Slip 2,** implemented in 1988
- **Stage 1 Marine Terminal Improvements, Port of Everett**, implemented in 1997
- **Eagle Harbor – West Harbor Operable Unit, Bainbridge Island** (Verduin et al. 1998), implemented in 1997
- **Sitcum Waterway Remediation Project (Milwaukee Waterway Fill)** (Port of Tacoma 1992; Verduin et al. 1994), implemented in 1994.

***Upland Disposal***

Municipalities and commercial interests operate landfills which are categorized by the types of waste they accept and the laws regulating them. Most solid waste landfills will accept solid waste, while a limited number will accept hazardous waste and chemical waste materials.

Upland disposal involves placing dredged contaminated sediments on dry land, away from the aquatic environment. Placing contaminated sediments in a landfill would require the use of liners and a special water collection system so that leachate draining through the landfill would not escape and contaminate ground water.

The following Puget Sound projects have involved upland/landfilling disposal:

- **Norfolk CSO Sediment Cleanup Project**, implemented in 1999 (see regional case histories section below)
- **Bremerton Shipyard, Pier D**, implemented in 1994
- **Eagle Harbor—West Harbor Operable Unit, Bainbridge Island** (Verduin et al. 1998), implemented in 1997.

Upland disposal is also being planned for the East Waterway Stage I navigation improvement project (see above), and Boeing Company independent actions within the Duwamish River.

## Regional Case Histories

Since the early 1980s, a variety of sediment remediation projects have been conducted in the Puget Sound region. Although individual projects have different goals and regulatory authorities, the various jurisdictions overseeing sediment management have worked together to facilitate the cleanup of contaminated sediments in Puget Sound and environs. Sediment remediation projects have been implemented in the following locations:

- Elliott Bay/Duwamish River
- Commencement Bay

- Eagle Harbor.

This section provides a summary of historical remediation projects and ongoing efforts to clean up contaminated sediments.

## Elliott Bay/Duwamish River

Since the 1980s, King County (formerly Metro) has been involved in efforts to remediate contaminated sediments in Elliott Bay and the Duwamish River. In 1990, King County (as Metro) conducted a voluntary sediment capping project at the Denny Way CSO, in an experimental demonstration project intended to immediately improve bottom conditions and provide information on the effectiveness of the capping method. Subsequent monitoring shows that the cap is functioning as expected, isolating contaminants and providing a clean, sandy substrate for animals. In 1991, King County and the City of Seattle entered into a consent decree with the National Oceanic and Atmospheric Administration (NOAA) which created the Elliott Bay/Duwamish Restoration Program (EBDRP) whose goal was sediment cleanup and habitat restoration in Elliott Bay and the Duwamish River. Twenty-four sites were identified by the EBDRP, of which four were selected for further investigation and remediation: Pier 53/55 sediment capping project, Seattle waterfront cleanup study, Norfolk CSO sediment cleanup project, and the Duwamish Pump Station/Diagonal CSO/SD sediment cleanup project.

**Pier 53/55 Sediment Capping Project—**The pier 53/55 area is located in Elliott Bay at Seattle's downtown waterfront area offshore of piers 53, 54, and 55. The site lies near the City of Seattle's Madison Street sewer outfall which released untreated sewage into Elliott Bay until 1969 after which the outfall was converted to a CSO. Sediments are contaminated with cadmium, mercury, silver, PAHs, and PCBs (King County 1996).

The Pier 53/55 site was remediated in 1992, with the City of Seattle as lead. The project involved using both thin layer capping and thick layer capping. A 3-foot thick cap covers approximately 2.9 acres of the site lying in deep water. A 1-foot thick cap covers approximately 1.6 acres of the inshore edge of the site where there was concern for the loss of navigation depth. Monitoring in 1992, 1993, and 1996 indicated that the caps were successful at isolating the underlying contamination and that they were stable. Significant recontamination was reported in 1993, apparently due to the removal of a nearby pier, though more recent monitoring has indicated recovery (King County 1997).

**Seattle Waterfront Cleanup Study—**The EBDRP sponsored the Elliot Bay Waterfront Recontamination Study to determine the feasibility of remediating contaminated sediment along the waterfront between Pier 46 to the south and Pier 59 to the north. In 1995, the study concluded that ongoing sources of contamination were adequately controlled, except for the King Street CSO, and that remediation was possible as of 1995. The study recommended two cleanup areas, one from Pier 46 north to the south end of Colman Dock and the other from the north end of Colman Dock to Pier 59.

EBDRP is considering the feasibility of undertaking a central Seattle waterfront project in the area between the north end of Colman Dock and Pier 59. Two City of Seattle CSOs are located within the project area as well as four City of Seattle SDs. There is also a permitted industrial discharge of backwash water from the City of Seattle's Western Avenue steam plant. Contaminants that are known to be elevated in sediments are: PCBs, PAHs, chlorinated benzene, phthalates, benzoic acid, copper, lead, mercury, silver and zinc (Ecology 1995). The purpose of the study is to determine the best approach for a cleanup study, the nature and extent of contamination, and set forth feasible cleanup alternatives. The study has been postponed since 1997 due to lack of funds for planning and design.

**Norfolk CSO Sediment Cleanup Project—**The Norfolk CSO outfall discharges combined sewage and stormwater collected from two drainage basins (a small basin near Boeing Field and a larger basin in Rainier Valley) that are dominated by residential, commercial, and industrial land uses. In addition, stormwater from five separated stormwater lines draining a small area of East Marginal Way and Boeing Field combines with the Norfolk CSO discharge near the outfall. There were four contaminants of concern for sediment remediation near the outfall: mercury, 1,4-dichlorobenzene, bis(2-ethylhexyl) phthalate, and PCBs.

Approximately 6,400 cubic yards of contaminated sediments were removed in early 1999 using mechanical dredging methods and upland disposal at two different landfills. An estimated 1,400 cubic yards will require disposal at a Subtitle C hazardous waste landfill, with the rest being disposed of at a Subtitle D landfill.

**Duwamish Pump Station/Diagonal CSO/SD Sediment Cleanup Project—**The Duwamish/Diagonal project is located on the east side of the river adjacent to the Diagonal Way CSO outfall and near the Duwamish CSO outfall. Stormwater and sewer separation projects in these two CSO basins have reduced the number of CSO events from the Diagonal Way CSO, but the frequency still exceeds one overflow per year (King County 1997). Currently, this outfall discharges about 1,200 million gallons per year of primarily commercial and industrial stormwater runoff. Four contaminants of concern were identified for sediment remediation through a site assessment: mercury, bis(2-ethylhexyl)phthalate, PCBs, and benzyl butyl phthalate (King County 1997). Computer modeling is being used to determine whether the remaining stormwater discharges would recontaminate a sediment cleanup project at this site.

### *Other Projects*

Several other sediment remediation projects not related to EBDRP have been implemented in the Elliott Bay/Duwamish River region since the 1980s:

- **Colman Dock Ferry Terminal Expansion, 1989—**In 1989, the Washington Department of Transportation (WSDOT) placed a thin-layer cap to isolate underlying contaminated sediments along the Seattle waterfront at the Colman Dock ferry terminal (Sumeri 1996).

- **Pier 64—**Sediments along the Seattle waterfront in the vicinity of Pier 64 at Bell Street were identified as being contaminated with chromium, mercury and phenols. In 1994 the Port of Seattle placed a thin layer cap to isolate underlying contaminated sediments (Sumeri 1996).

- **Harbor Island—**Harbor Island was listed as a Superfund site in 1983 because of contaminated island soils and nearby sediments. The contaminated site was divided into project areas, with the shipyard operable unit and the waterway operable unit of greatest interest to King County.

  A record of decision (ROD) was issued for the shipyard operable unit in November 1996 requiring all sediments exceeding CSL within this area to be dredged and placed in either a CAD facility or an upland disposal facility. All remaining areas exceeding the SQS criteria are to be capped and monitored. This project is currently in the initial design phase.

  EPA is currently evaluating the scope of the waterway operable unit ROD. Based on recently released human health and ecological risk data and evaluations, EPA is apparently considering a no-action ROD for the waterway operable unit. A formal determination is forthcoming.

## Commencement Bay

Commencement Bay nearshore tideflats, including the South Tacoma channel waterways, were included on the EPA National Priorities List (Superfund site) in 1983. Numerous industrial sources existed along the nearshore area including the ASARCO copper smelter and the Simpson-Tacoma Kraft paper mill. Comprehensive sediment studies identified numerous chemicals of concern including: arsenic, cadmium, copper, lead, mercury, nickel, zinc, phenols, PAHs, PCBs, phthalates, and dioxins (Tetra Tech 1985). The sediment remediation plan developed for Commencement Bay included control of upland sources of contamination followed by sediment remediation by dredging and containment or capping.

A variety of capping and dredging projects have been implemented in Commencement Bay. At the Simpson-Tacoma Kraft paper mill, a 17-acre area was thick-layer capped with dredged material from a sand bar in the adjacent Puyallup River (Sumeri 1996). Thick-layer caps have also been placed at the ASARCO sediment contamination study area off Ruston Point and at the Schnitzer Steel site in the Hylebos Waterway. Contaminated sediments not requiring Superfund cleanup were dredged from the Sitcum and Blair waterways and placed in a nearshore confined disposal facility (CDF) in the nearby Milwaukee Waterway (Verduin et al. 1994). In 1998, the City of Tacoma proposed to the EPA to dredge contaminated sediments from the Thea Foss Waterway and place them in a CDF located in the nearby St. Paul Waterway. This proposal is currently in review by EPA and the natural resource trustees.

## Bainbridge Island

The south shore of Eagle Harbor, Bainbridge Island, was the location of a former wood treating facility (Wyckoff) in operation for 80 years, while the north shore of the harbor was the site of a shipyard. In 1987 the wood treating facility, shipyard, and other upland sources were included on the EPA's National Priorities List (Superfund site). The Superfund site was divided into four work areas, of which the East Harbor operable unit (EHOU) and West Harbor operable unit (WHOU) required remediation of sediments contaminated with creosote and pentachlorophenol. In addition, the East Harbor operable unit sediments were contaminated with mercury.

The East Harbor operable unit was remediated with a 3- to 6-foot layer of clean sediment dredged from the Snohomish River navigation project and placed over an approximately 54-acre area of contaminated sediments in water depths of 40 to 60 feet (Sumeri 1996). Monitoring of the capping project was completed in 1995 and 1997 (EPA 1997b). The West Harbor operable unit was remediated using a combination of thin and thick layer capping, dredging with nearshore fill and upland landfilling, and chemical treatment (Verduin et al. 1998). Monitoring of the West Harbor operable unit is ongoing.

# REGIONAL PARTNERSHIP OPPORTUNITIES

The sediment remediation alternatives evaluation presented in this SMP for the seven listed sites, identified two of the sites as high priority (Duwamish/ Diagonal and King Street) and three as medium priority (Hanford, Lander, and Denny Way). Two additional sites (Chelan and Brandon) were identified as lower priority sites. The following discussion focuses on the potential for King County to develop cooperative projects for the cleanup of these sites.

Cleanup of sediments at the Duwamish/Diagonal CSO/SD is currently proceeding as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program (EBDRP). Funding for this sediment cleanup project was previously allocated through the EBDRP. A portion of the sediment cleanup work at the Denny Way CSO site is currently proceeding at the request of Ecology and WADNR in coordination with King County's Denny Way/Lake Union CSO control project.

While sediment cleanup at both the Duwamish/Diagonal and Denny Way sites is currently proceeding under existing arrangements that include major participation by King County, there do not appear to be reasonable further opportunities for an expanded County role within the context of this SMP. Therefore, both the Duwamish/Diagonal and Denny Way sites were assumed for this analysis to provide a low potential for further cooperative involvement by King County.

Of the two lowest-priority sites, only the Chelan Avenue site area appears at this time to have the potential and opportunity for cooperative cleanup, primarily within the context of maintenance dredging or improvement of the West Waterway by the COE. These opportunities are discussed further in a later section.

Thus, from the seven listed sediment sites investigated for the SMP, there are four sites that emerge as projects with the potential to support a cooperative or demonstration project approach for cleanup: King Street, Hanford Street, Lander Street, and the Chelan Avenue. The cooperative opportunities that exist for these projects are discussed in the following sections of this plan.

## EB27 (near King Street CSO)

As described above, long-term redevelopment plans for an expanded Colman Dock ferry terminal in the immediate vicinity of the King Street CSO and South Washington Street SD outfalls are currently being developed and evaluated as part of the ongoing South Downtown Waterfront Master Development Plan and EIS. The plan and EIS are being developed by Washington State Ferries, in coordination with the Port of Seattle and City of Seattle. Conceptual alternatives being considered include construction of new auto ferry slips positioned offshore (near the outer harbor line) and slightly north of the

existing slips. An expanded passenger-only ferry terminal, potentially including a cruise ship terminal, may be located within the existing Pier 48 area immediately offshore of the existing CSO and SD outfalls. Under this scenario, expanded ferry operations would be located within the existing CSO and/or SD footprint (Figure 2).

Development of a cooperative agreement between those entities involved may address the interests of all concerned. There are however, a number of issues that would need to be investigated. Sediment remediation at this site would need to take into account the potential impact of propeller scour given the level of development proposed. Preliminary evaluations of propeller scour within the site area and at other locations along the central Seattle Waterfront were performed by the EBDRP (Ecology 1995). The screening-level modeling considered worst-case vessel operating characteristics, and thus provided an initial, conservative assessment of potential propeller-wash scour and possible sediment cap armoring requirements. More detailed propeller-wash modeling, using more typical operating assumptions may need to be performed prior to redevelopment and/or sediment cleanup.

Benefits to cooperative parties would be primarily in the form of financial savings resulting from shared costs of sediment cleanup and disposal. The plan for site redevelopment places the incentive for cleanup in the hands of those entities seeking to move the project quickly forward. Participation and involvement by cooperative parties would be considered a key element in achieving this goal. Currently the King County schedule for implementing CSO control at King Street is 2026.

## EB8 and EB7 (near Hanford and Lander Street CSOs)

The footprints of the Hanford and Lander CSOs (Figure 2) extend into the navigation channel of the East Waterway. An opportunity exists for the County to work with the Port of Seattle and the COE to accomplish cleanup of this site.

Over the last several years, the Port and COE have focused regional navigation improvement efforts on the East Waterway, which is a critical element of the Port's *Container Terminal Development Plan* (Port of Seattle 1991). Stage I of the East Waterway project, resulting in the dredging of key approach channels and berthing areas near Harbor Island to a depth of 51 feet mean lower low water (MLLW), is expected to be completed in 2000. Stage II of the project, which will include dredging of most of the rest of the East Waterway, including nearly all of the Hanford and Lander Street CSO footprints, is currently in the design phase. Because of the substantial overlap between these projects, Stage II of the East Waterway navigation improvement project is a significant cooperative project opportunity.

Benefits to cooperative parties would be in the form of financial savings resulting from shared costs of sediment cleanup and disposal. Because the COE and Port are moving ahead with Stage II of their navigation improvement project, cooperative parties have the opportunity to work in conjunction with them on removal and disposal that will occur in

and adjacent to the Hanford and Lander Street CSO footprints. Currently the King County schedule for implementing CSO control at Hanford Street and Lander Street is 2017 and 2019, respectively.

## EB13 (near Chelan Avenue CSO)

The Chelan CSO footprint stretches across the West Waterway of the Duwamish River (Figure 2) and lies within the federal channel boundary. Possible navigation improvement efforts (i.e., sediment removal) by the COE and Port could include sediment areas potentially affected by the Chelan CSO.

For the past 20 years, the COE and the Port have been considering deepening and widening this area of the Duwamish River, along with other areas of the federal channel. The final feasibility report and environmental impact statement for these proposed actions were completed in January 1983. Thereafter, navigation improvements of the waterways were recommended to Congress. The Seattle District of the COE initiated preconstruction engineering and design studies in October 1984 following receipt of congressional funding. Congress in PL 99-662 authorized construction of the project; however, preconstruction engineering and design were deferred in 1986 at the request of the Port of Seattle, the local sponsor. Although the West Waterway deepening and widening project represents an opportunity for a cooperative project at the Chelan CSO site, plans for this project are currently on hold.

Potential benefits to cooperative parties would be similar to those described above for the Hanford and Lander Street sites.

## Other Cooperative Project Opportunities

Because other entities are also dealing with similar issues and projects involving contaminated sediments and habitat restoration within Elliott Bay and the Duwamish River, other cooperative project and funding opportunities may be available with other jurisdictions. Some of these potential project opportunities are discussed below.

### Seattle Waterfront

Sediments at various locations along the Seattle waterfront are known or suspected to be contaminated (Turvey 1999 personal communication). Some of these sites include areas in and around the Seattle Aquarium (Pier 59–61), the Edgewater Inn (Pier 67), and the Unocal site at the north end of the waterfront. Should redevelopment or other activities occur at these or similar locations that would warrant the initiation of sediment cleanup, the opportunity may exist to develop a larger cooperative effort that would include a

partnership with those entities involved, and which could include the City of Seattle and/or interested private parties.

### Duwamish River

As a result of a petition from the National Oceanic and Aeronautic Administration (NOAA), the EPA recently completed an extensive sediment sampling and chemical characterization effort on the Duwamish River. Over 300 sediment samples were collected during 1998, from the river mouth up to the turning basin at river mile 6.2, and a data report was released in April 1999 (Bennett 1999 personal communication). The data results will be used to evaluate if contaminated sediments in specific areas of the estuary, or the entire estuary reach, merits listing as a National Priorities List (NPL) site. If a listing occurs, EPA could oversee and direct cleanup at the site(s) or defer this role to Ecology. EPA has indicated that the Regional Decision Team (RDT) will likely make a decision in September 1999 as to the status of the Duwamish River based on the sampling conducted (Bennett 1999 personal communication).

Prior to making a decision regarding listing of the Duwamish River, EPA and the RDT will evaluate the actions currently being taken by those entities involved in cleaning up known, existing problems and will use this information to determine whether listing is warranted. EPA has stated that it is looking to see solid commitments for cleanup from those parties involved, rather than vague plans or ideas. The expectation is that contaminated sediment areas in the river will be prioritized based upon the data analysis but that the cleanup approach needs to be unified among those entities involved in the cleanup.

King County CSO sites in the Duwamish (i.e., Duwamish/Diagonal and Brandon) will potentially be affected if the NPL listing should occur. Some entities are currently moving ahead on the cleanup of various contaminated areas in the Duwamish (e.g., Boeing is proceeding with sediment removal and upland disposal of sediments from the area off of its Plant #2 located south of Slip 4). The development of a cooperative cleanup program however, among the larger entities involved (i.e., Boeing, Port of Seattle, City of Seattle, and King County), would appear to have merit. King County staff are currently meeting with staff from Boeing, City of Seattle, Port of Seattle, and Ecology to design a coordinated effort for sediment management issues in the Duwamish River and Elliott Bay. No formal commitments have been made to participate in this effort on a long-term basis.

Within the Duwamish River, various projects may warrant consideration as cooperative ventures. These projects could be done in conjunction with the projects noted above and applying funding opportunities described in the following sections. These involve projects/proposals that are currently being explored by others and include: Slip 4 confined aquatic disposal facility (CAD) and habitat creation; and Slip 27 nearshore confined disposal facility (CDF). These projects are described in Appendix D as options for dealing with the disposal of contaminated sediments, should removal be selected as a preferred alternative.

The Slip 4 CAD facility would provide needed sediment disposal capacity for the local land owner (Crowley) and others, and would concurrently provide for remediation of some of the most contaminated sediments in the Duwamish River. Filling and capping of the contaminated sediments with clean materials would create critically needed intertidal mudflat habitat which is now nearly absent in the Duwamish River. Such habitat would provide highly desirable feeding and rearing habitat for fish. At this point in time there are no plans in place for a Slip 4 facility.

The Slip 27 CDF facility is currently being evaluated by the COE and Port of Seattle East Waterway deepening project EIS. Filling of the slip with contaminated sediments and creation of a nearshore CDF would require substantial habitat mitigation elsewhere within the estuary to compensate for the filling of subtidal and intertidal habitat. The schedule for this project is not currently defined. However, the Port is under increasing pressure from its container terminal tenants to provide terminal improvements that would be accomplished by the Slip 27 CDF facility.

Potential benefits to cooperative parties that may result from participation in these cooperative ventures include:

- Availability and use of relatively low cost multi-user disposal sites (MUDS) for contaminated sediments
- Integration of habitat restoration and salmon recovery efforts with sediment cleanup
- Facilitation of overall TMDL and/or Superfund deferral efforts.

## Water Resources Development Act Funding Opportunities

In addition to direct cooperation with the Port of Seattle for navigation improvement projects, as described above, there is also federal Water Resources Development Act (WRDA) funding authorities that are potentially available to assist in the implementation of the SMP. Consistent with the overall mission of the COE and with the intent of the current WRDA authority as amended by Congress, federal funding assistance is potentially available for general navigation features (Section 101; e.g., Duwamish River navigation channel maintenance) and for a range of environmental improvement projects (Section 201 through 210). These are discussed in more detail in Appendix E.
The cooperative projects presented here offer a number of opportunities to move forward with cleanup at several of the listed sediment sites. The potential for cooperative cleanup, opportunities available, potential partners, and funding availability are summarized in Table 3 in order of their recommended feasibility and/or apparent viability.

## Table 3. Cooperative Projects Matrix.

| Site | Potential for Cooperative Cleanup | Cooperative Opportunities | Potential Partners | Possible Funding Sources |
|---|---|---|---|---|
| EB 27 (near King Street CSO) | High | Long-term redevelopment plans are currently being developed for an expanded Colman Dock Ferry Terminal within the existing Pier 48 area as part of the South Downtown Waterfront Master Development Plan. Washington State Ferries and the Port of Seattle recently initiated a sediment cleanup study of the site as part of this larger planning effort. Cleanup decisions are currently scheduled for spring and summer, 2000. | Washington State Ferries (WSF)<br>Port of Seattle<br>City of Seattle<br>King County | WSF and/or the Port may decide to perform some or all of the required sediment cleanup as part of site redevelopment. King County could potentially assume CSO control and long-term monitoring responsibilities as part of an overall cooperative implementation agreement. |
| EB 8 (near Hanford Street CSO) | High | The Port of Seattle and Corps of Engineers are currently performing planning studies for dredging and confined disposal of sediments at this site as part of the East Waterway Stage II navigation improvement project. Sediment sampling has been completed. Dredging and disposal decisions may occur in late 1999. | Port of Seattle<br>Corps of Engineers<br>King County | U.S. Army Corps of Engineers may perform dredging; King County and the Port could potentially share disposal costs. |
| EB 7 (near Lander Street CSO) | High | The Port of Seattle and Corps of Engineers are currently performing planning studies for dredging and confined disposal of sediments at this site as part of the East Waterway Stage II navigation improvement project. Sediment sampling has been completed. Dredging and disposal decisions may occur in late 1999. | Port of Seattle<br>Corps of Engineers<br>King County | U.S. Army Corps of Engineers may perform dredging; King County and the Port could potentially share disposal costs. |
| EB 13 (near Chelan Avenue CSO) | High | No cleanup studies have been completed at this site, although data have been collected by King County and others on the extent of sediment contamination, some of which extends into the federal navigation channel.<br>The U.S. Army Corps of Engineers may conduct dredging of the channel area of the site if the action is performed as part of routine channel maintenance, and if a suitable sediment disposal location is identified. | Corps of Engineers<br>Port of Seattle (local sponsor)<br>King County | U.S. Army Corps of Engineers may conduct dredging if performed as part of channel maintenance; disposal costs are uncertain. |
| DR 31 (near Duwamish/ Diagonal CSO) | Low | A sediment cleanup study of this site has been completed as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program (EBDRP). However, cleanup implementation activities are currently stalled due to a lack of planning funds.<br>In addition, the U.S. Army Corps of Engineers may perform dredging of the channel area of the site if the action is performed as part of routine channel maintenance, and if a suitable sediment disposal location is identified.<br>EPA is currently considering adding the Duwamish/Diagonal site, along with other areas of the Duwamish Estuary, to the National Priorities List (NPL; or Superfund). | Elliott Bay/ Duwamish Restoration Program<br>U.S. Army Corps of Engineers and Port of Seattle (local sponsor)<br>City of Seattle<br>King County | As part of a NRDA settlement agreement, King County and the City of Seattle previously allocated and committed resources to EBDRP for the cleanup of this site.<br>Funding of U.S. Corps of Engineers dredging activities could occur under existing Water Resources Development Act (WRDA) authorities, and would require Congressional appropriations and participation of the local sponsor (Port of Seattle). |
| EB 26 (near Denny Way CSO) | Low | King County recently completed a cleanup study of the site as part of the Denny Way CSO Control Project. Cleanup of portions of the site are currently proceeding under this separate program. | King County | King County previously committed resources to perform cleanup of a portion of the site through the King County's Denny Way CSO Control Project. |
| DR 32 (near Brandon Street CSO) | Low | No cooperative opportunities identified. The available data suggests highly localized sediment contamination at this site, not extending into the federal navigation channel.<br>EPA is currently considering adding the Brandon Street site, along with other areas of the Duwamish Estuary, to the National Priorities List (NPL; or Superfund). | King County | No source identified |

# SEDIMENT MANAGEMENT PLAN RECOMMENDATIONS

This section presents a description of programmatic sediment cleanup alternatives that may be applied to some or all of the listed sediment sites. Based on the results of the comparison of sediment remedial technologies presented above, five different sediment remediation alternatives were considered for use at the SMP sites. Preliminary costs estimates were developed for each alternative. These cost estimates considered the full range of prospective costs associated with cleanup, including studies (e.g., filling data gaps), engineering, construction, monitoring, land easements/encumbrances, and mitigation. Based on King County staff review of technical feasibility, implementability, and costs, a preferred remediation alternative is identified for planning level evaluations.

Final decisions about the preferred cleanup option to be used at each site can be made only after further study and preparation of a detailed cleanup study report for each site. The preferred cleanup action must be approved first by Ecology and/or EPA and then by other regulatory agencies during the permitting process.

## Sediment Management Plan Programmatic Alternatives

The readily available sediment site characterization data discussed above were also reviewed in the context of potential cleanup options in order to determine the general scope of practicable remediation alternatives that could be applied to some or all of the seven listed sediment sites. The initial development of sediment remediation options in this case focused on the more practicable technologies identified from a preliminary review of technical feasibility, implementability, and cost (Appendix B). The more practicable sediment remedial technologies identified from this preliminary assessment included source control/natural recovery (potentially including detailed risk assessment); capping; and dredging with confined disposal. This section presents the initial assembly and analysis of programmatic sediment cleanup alternatives that may be applied to some or all of the listed sediment sites.

For the purposes of this initial programmatic assessment, five sediment remediation alternatives were considered for each of the SMP sites:

- Alternative 1—No action
- Alternative 2—Source control/natural recovery with detailed risk assessment
- Alternative 3—Capping of contaminated sediments
- Alternative 4—Low range sediment removal and confined disposal with capping
- Alternative 5—High range sediment removal and confined disposal.

Each of these alternatives is briefly described below.

### Alternative 1—No Action

Under this option, no agencies or businesses would actively pursue any further sediment investigation or cleanup actions at one or more of the seven listed sediment sites. Depending upon future developments within the SMP area, a time may come when PRPs may be required to initiate cleanup actions at one or more of these sites as part of a formal enforcement order under the state Model Toxics Control Act (MTCA)/SMS or the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund). Alternatively, the PRPs may be sued by a third party for cost recovery under either of these laws. However, no such enforcement or cost recovery actions have been initiated to date. Under this alternative, PRPs would simply wait until such time as an action may be brought against them to compel their further involvement. Options for participation would be evaluated at that time.

### Alternative 2—Source Control/Natural Recovery with Detailed Risk Assessment

This alternative would focus on defining whether active sediment cleanup is necessary at any of the seven listed sediment sites, through the use of detailed contaminant transport modeling and/or ecological and human health risk assessment. Based on the preliminary recontamination and natural recovery modeling performed for this SMP, these more detailed technical evaluations may demonstrate that biological effects criteria would be achieved within the next 10 years through a combination of existing source controls and natural recovery processes. An explicit objective of pursuing this alternative may be to obtain a formal determination from Ecology and/or EPA (e.g., in the form of a Cleanup Action Plan) that active remediation at one or more of the seven sites is impracticable within the meaning of MTCA/SMS/CERCLA. Long-term monitoring would be required to demonstrate the success of natural recovery. In the event that Ecology/EPA may not concur with this determination, or if monitoring data indicate that cleanup standards are not being achieved, options for further involvement would be evaluated at that time.

### Alternative 3—Capping of Contaminated Sediments

This option would focus on near-term construction of sediment caps at one or more of the seven listed sediment sites to achieve compliance with state cleanup criteria. The caps would be constructed to a thickness of 1 to 3 feet using proven methods, and may require armoring and/or habitat layers in some cases to ensure long-term performance. The potential for sediment recontamination of the caps would be addressed by contaminant transport modeling ranging from relatively simple updates of nearfield (PLUMES) modeling to reflect expected future CSO controls to more complex contaminant transport modeling (see Appendix A). Depending on the results of the modeling, there may be a need to delineate a sediment impact zone (SIZ) in the immediate outfall discharge area. An explicit objective of pursuing this alternative may be to obtain a formal determination from Ecology/EPA that no further cleanup actions are required under MTCA/SMS/CERCLA. However, landowner concurrence would likely also be required to achieve this objective. If the caps would encumber federal navigation channels or

other harbor areas, landowner concurrence may be difficult, potentially requiring the payment of a significant easement fee. Landowner considerations within the SMP project area are discussed in more detail below.

## Alternative 4—Low Range Removal and Confined Disposal with Capping

The overall objective of this alternative is to rapidly achieve state cleanup criteria at one or more of the seven listed sediment sites while maintaining existing and prospective navigation channels, minimizing dredging and disposal of contaminated sediment, and maximizing the areal extent and diversity of intertidal aquatic habitat by using caps and potentially available confined disposal facilities. Contaminated sediments (exceeding SQS criteria) that are located within existing federal navigation channels or are otherwise targeted for near-term navigation or development dredging would be removed under this alternative. Although the action level for sediment removal under this alternative could potentially range from SQS to CSL criteria, the available data suggest that sediments within this range (i.e., between SQS and CSL criteria) would not likely be suitable for unconfined open-water disposal. Thus, residual liabilities associated with confined disposal of these navigation dredging materials may remain if the action level is set too high. For these reasons, the action level assumed for this alternative was conservatively set at the SQS level. Preliminary areas and volumes of sediment contamination at each site are summarized in Figure 2 and Table 4.

**Table 4. Summary of Sediment Site Areas and Depths**

| Sediment Site | Total Site Area in acres | | Estimated Sediment Thickness (ft) |
|---|---|---|---|
| | Above SQS | Above CSL | |
| **Higher Priority Sites:** | | | |
| EB31 (near Duwamish/Diagonal SD/CSO) | 8 | 5 | 6 |
| EB27 (near King Street CSO and South Washington Street SD) | 20 | 15 | 8 |
| **Medium Priority Sites:** | | | |
| EB5 (near Hanford Street CSO) | 15 | 9 | 8 |
| EB7 (near Lander Street CSO) | 6 | 1 | 8 |
| EB26 (near Denny Way CSO) | 5 | 0[a] | 6 |
| **Lower Priority Sites:** | | | |
| EB13 (near Chelan Avenue CSO) | 4 | 0.3 | 6 |
| DR32 (near Brandon Street CSO) | 1 | 0 | 6 |
| **SUBTOTAL** | **59** | **30** | |

[a]Assumes inshore areas above CSL will be dredged in accordance with permit agreement.

As presented in Figure 5 and Table 5, sediment removal under Alternative 4 would likely occur primarily within the Hanford Street CSO footprint (190,000 cubic yards), and secondarily within the footprints of the Lander Street CSO (50,000 cubic yards), Duwamish/Diagonal CSO/SD (20,000 cubic yards), and Chelan Avenue sites (20,000 cubic yards). All of these removal footprints occur within the Duwamish River or East Waterway federal navigation channels, or otherwise within adjacent areas of the forthcoming East Waterway navigation improvement projects (Stage I and II; target removal depth of 51 feet MLLW). The removal volume associated with the Hanford and Lander Street CSO footprints (240,000 cubic yards) already appears to be targeted by the Port of Seattle for Stage II dredging and disposal. This volume is also slightly more than half of the total volume of Stage II sediments estimated to be unsuitable for open-water disposal (460,000 cubic yards), and thus requiring containment. Based on a preliminary review of existing information, capping of all other sediment site areas could be performed in a manner that would be consistent with current site development and land use plans, though easements may be required.

This initial programmatic assessment considered a short list of representative sediment disposal sites that have previously been considered in other regional cleanup evaluations. The following list of reports contain relevant disposal site evaluations that were included as part of this review:

- *Technical Appendix B-1: Aquatic Cleanup Feasibility Study, Southwest Harbor Cleanup and Redevelopment Project, Draft Environmental Impact Statement* (Parametrix 1994)

- *Final Remedial Design Investigation Data Report for the Lockheed Shipyard No. 1 Sediment Operable Unit* (Hartman Consulting 1999)

- *Puget Sound Confined Disposal Site Study: Programmatic NEPA/SEPA Environmental Impact Statement*, preliminary draft (U.S. COE and Ecology 1998)

- Unpublished design memoranda on file at Anchor Environmental.

Based on the available disposal site reviews, one of the most promising sediment disposal facilities for Alternative 4 is the Slip 27 nearshore confined disposal facility (CDF) alternative currently being evaluated in the COE and Port of Seattle East Waterway deepening project EIS. A nearshore CDF constructed at this location in the East Waterway (Figure 5) could convert intertidal and subtidal areas into upland property. Dredged sediments would be transported to the CDF site typically by barge, and placed within a constructed berm to an elevation such that the sediments confined at the site would remain saturated. Keeping the contaminated sediments saturated reduces the contaminants' mobility, thus enhancing the protectiveness of the disposal site. The sediments would then be covered with a layer of clean material, filling in the site to surrounding upland elevations for subsequent use as marine industrial land.

Missing Figure 5

Plan View of Alternative 4
Low Range Removal

## Table 5. Summary of Remedial Alternative Actions

| CSO Sediment Site | Sediment Remediation Alternative Actions | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 Low Removal | | Alternative 5 High Removal | |
| | No Action | Natural Recovery | Capping (acres) | Capping (acres) | Removal (cubic yards) | Capping (acres) | Removal (cubic yards) |
| **Higher-Priority Sites** | | | | | | | |
| DR31 (near Duwamish/Diagonal SD/CSO) | X | X | 5 – 8 | 5 | 20,000 | 0 | 70,000 |
| EB27 (near King Street CSO and South Washington SD) | X | X | 15 – 20 | 15 – 20 | 0 | 7 – 11 | 110,000 |
| **Medium-Priority Sites** | | | | | | | |
| EB5 (near Hanford Street CSO) | X | X | 9 – 15 | 0 | 190,000 | 0 | 190,000 |
| EB7 (near Lander Street CSO) | X | X | 1 – 6 | 0 | 50,000 | 0 | 50,000 |
| EB26 (near Denny Way CSO) | X | X | 0 – 4 | 0 – 4 | 0 | 0 | 40,000 |
| **Lower-Priority Sites** | | | | | | | |
| EB13 (near Chelan Avenue CSO) | X | X | 0.3 – 4 | 0.2 – 2 | 20,000 | 0 | 40,000 |
| DR32 (near Brandon Street CSO) | X | X | 0 – 1 | 0 – 1 | 0 | 0 | 10,000 |
| **SUBTOTAL** | | | **31 – 61** | **20 – 37** | **280,000** | **7 – 11** | **500,000** |
| **Possible Disposal Sites** | | | | | | | |
| Port of Seattle: Slip 27 nearshore fill | | | | | 260,000 | | 260,000 |
| Option A—Crowley: Slip 4 confined aquatic disposal (& habitat) | | | | | 20,000 | | – |
| Option B—Multi-user disposal site: Elliott Bay confined aquatic disposal | | | | | 280,000 | | 500,000 |
| Option C—Roosevelt Landfill (or equivalent) | | | | | 280,000 | | 500,000 |

The Slip 27 nearshore CDF alternative has an estimated capacity of approximately 460,000 cubic yards, incorporating prospective disposal site improvements. The Port of Seattle owns the upland and aquatic areas surrounding Slip 27, while the subtidal area consists of City of Seattle right-of-way. The land area created by the CDF has been identified as needed for expansion of a container handling area by connecting Terminals 25 and 30 in the Port of Seattle's *Container Terminal Development Plan* (Port of Seattle 1991). Creating a nearshore CDF would therefore be consistent with upland development plans. However, a nearshore CDF constructed at this location would require substantial habitat mitigation for the filling of aquatic lands. Other Port properties within the Duwamish River potentially are available to provide habitat restoration opportunities.

Under Alternative 4, and pending confirmation by the Port of available capacity, all or part of the total estimated volume of sediments removed as part of the site remediation (280,000 cubic yards) may be disposable at Slip 27, representing an increase in disposal volumes up to 10 percent above the Port's current Stage II proposal. The Port is presently working through applicable environmental review processes to evaluate the Slip 27 nearshore fill facility as part of its Stage 2 navigation improvement of the East Waterway. Under this alternative, cooperative parties could potentially negotiate with the Port to achieve multiple objectives within the SMP area, including sediment cleanup, disposal, redevelopment, and habitat mitigation/restoration. However, if the Slip 27 fill alternative is not accepted by the regulatory agencies, or if additional capacity is needed, there are several additional options (with progressively increasing costs) that may be considered, including the following:

- **Alternative 4, Option A—Slip 4 supplement.** One option to consider is a supplement to the Slip 27 nearshore CDF proposal to include additional disposal and habitat mitigation and/or restoration by constructing a relatively small confined aquatic disposal facility (CAD) at Slip 4 in the upper Duwamish River (Figure 5). The Slip 4 CAD facility could also provide needed sediment disposal capacity for the local land owner (Crowley), and would concurrently accomplish remediation of some of the most contaminated sediments in the Duwamish River (the regional PCB hotspot; NOAA 1998). Equally important is that the Slip 4 contaminated sediments would be covered with a layer of clean material and the subtidal area raised to intertidal conditions to provide highly productive mudflat habitat. Because of its location, the Slip 4 CAD would provide critical feeding and rearing habitat for important fisheries resources, including endangered juvenile Chinook salmon outmigrants from the Green River.

- **Alternative 4, Option B—**Multi-user disposal site**.** Another option is to dispose of the Alternative 4 sediments in a possible regional multi-user disposal site (MUDS) located in Elliott Bay or elsewhere in Puget Sound. The COE and Ecology are currently completing a programmatic SEPA/NEPA EIS, with WADNR and EPA as cooperating agencies, that evaluates the potential environmental impacts from a wide range of regional sediment MUDS alternatives. Once the programmatic EIS is completed, one or more embayments in Puget Sound will be selected for a site-specific EIS, which will evaluate the environmental impacts of implementing one or

more MUDS alternatives at a specific location. At this point in time, there is no guarantee that Elliott Bay will be chosen for one of the initial site-specific EISs.

The draft EIS states that the most logical location for the first MUDS site would be central Puget Sound, because of the proximity of high volumes of contaminated sediment. Potential MUDS locations have been identified within Elliott Bay, including the Lockheed nearshore aquatic area (concurrently remediating this site and creating valuable intertidal and subtidal aquatic habitat), and several deep-water sites (150- to 200-foot depths) in the middle of the bay (see Figure 5). All of these lands are owned at least in part by the state and managed by WADNR. The MUDS locations may also overlap with the Puget Sound Dredged Disposal Analysis (PSDDA) boundary and perimeter lines, and may be difficult to construct. Nevertheless, the MUDS program may provide a suitable disposal alternative for consideration.

- **Alternative 4, Option C—Roosevelt or Columbia Ridge Landfills.** Although characterized by higher costs, a final option that could be considered for the disposal of sediments under Alternative 4 is upland landfilling. To dispose of dredged sediments in an upland site, the sediments would generally require dewatering for the facility's acceptance. Because of its approximately 3 million ton per year capacity with 35 years of capacity remaining, the Roosevelt Landfill, located approximately 210 miles southeast of Seattle in Goldendale, Washington (Klickitat County), is the upland landfill most often considered for this purpose. The Regional Disposal Company manages the landfill and operates a rail transport station at Third and Lander streets in Seattle. Dewatered sediments can be loaded onto containers and transported by truck to the rail transport station, where the containers can be loaded onto rail cars and transported to the landfill. An alternative to the Roosevelt Landfill is the Columbia Ridge Landfill and Recycling Center located in Arlington, Oregon, approximately 255 miles south of Seattle and 140 miles east of Portland. Both facilities charge similar tipping fees.

The primary elements of the Alternative 4 action, including the various disposal options, are summarized in Table 5. Sediment capping would be used (as generally described in Alternative 3 above) in those areas of the CSO sediment site footprint that are not located within the federal navigation channels, or within adjacent areas of the East Waterway Stage I and II navigation improvement project. Nevertheless, if the caps encumber these harbor areas, land-owner concurrence may require the payment of an easement fee (see below). The potential for sediment recontamination of the capping and dredging areas would also need to be addressed through contaminant transport modeling and/or sediment impact zone determinations (see Alternative 3 discussion above).

### Alternative 5 – High Range Removal and Confined Disposal

In contrast to the other alternatives, the overall objective of Alternative 5 is to rapidly achieve state cleanup criteria at one or more of the listed sediment sites, allowing for

unencumbered future navigation deepening of the navigation channels. Unlike Alternative 4, minimizing dredging and disposal volumes is not a primary objective of Alternative 5. In this case, all contaminated sediments (exceeding SQS criteria) that are located within designated harbor areas would be removed and disposed of in a regional containment facility. Although the action level for sediment removal under this alternative could potentially range from SQS to CSL criteria, the action level assumed for this alternative was conservatively set at the SQS level, consistent with the Alternative 4 discussion above.

As summarized in Figure 6 and Table 5, sediment removal under Alternative 5 could occur at all listed sediment sites, including Hanford Street (190,000 cubic yards), King Street (110,000 cubic yards), Denny Way (40,000 cubic yards), Duwamish/Diagonal (70,000 cubic yards), Lander Street (50,000 cubic yards), Chelan Avenue (40,000 cubic yards), and Brandon Street (10,000 cubic yards). The only areas that would be capped are those nearshore locations within the King Street CSO and/or South Washington Street SD footprints that are not located on state-owned aquatic lands (7 to 11 acres). The Port of Seattle currently owns these lands in fee.

As discussed above, this initial programmatic assessment considered a short list of representative sediment disposal sites that have previously been considered in other regional cleanup evaluations. Since one of the most promising sediment disposal facilities is the Port of Seattle's Slip 27 nearshore CDF alternative in the East Waterway, this CDF may also be used in Alternative 5. However, the total estimated volume of sediments removed as part of site remediation (500,000 cubic yards) would exceed the Slip 27 disposal capacity by approximately 200,000 cubic yards, even when supplemented with Slip 4 (see Option A of Alternative 4 above). Therefore, under this alternative, cooperative parties would either partner with the MUDS program to obtain the additional disposal capacity, or use relatively expensive upland disposal facilities.

The primary elements of the Alternative 5 action, including the various disposal options, are summarized in Table 5. The potential for sediment recontamination of the capping and dredging areas would also need to be addressed through contaminant transport modeling and/or sediment impact zone determinations (see Alternative 3 discussion above).

## Preliminary Cost Estimates

A preliminary cost estimate was developed for each of the remedial alternatives described above. The cost estimates considered the full range of prospective costs associated with cleanup, including studies (e.g., filling data gaps), engineering, construction, monitoring, land easements/encumbrances, and mitigation. All costs were estimated based on a

Missing Figure 6

Plan View of Alternative 5
High Range Removal

review of similar recent remedial design or construction projects within the Puget Sound region (e.g., Elliott Bay/Duwamish River, Eagle Harbor, Sitcum Waterway, Thea Foss Waterway, Hylebos Waterway, Bellingham Bay), using procedures consistent with relevant agency guidance (e.g., EPA 1994). The following items were included in the preliminary cost estimates:

- Contaminant transport modeling (see Appendix A)
- Risk assessments (human health and ecological assessments similar to those performed as a part of the WQA; Parametrix and King County 1998)
- Remedial investigations/feasibility studies (consistent with MTCA and SMS requirements)
- Cleanup action plans and consent decrees (including attorneys fees)
- Remedial design and engineering (including detailed engineering studies as may be required, final permitting, and plans and specifications documents)
- Mobilization/demobilization (generally estimated at 5 percent of construction costs)
- Remedial construction (capping, dredging, and disposal, including habitat and property mitigation)
- Construction monitoring/management (generally estimated at 10 percent of construction costs)
- Site acquisition and easement (including encumbrance fees; see below)
- Long-term monitoring
- Contingency (assumed at 30 percent of the cost subtotal).

The preliminary cost estimates developed for all seven listed sites combined are summarized in Table 6. For in-water options (i.e., excluding upland landfill disposal), the estimated total costs for all seven sites under the various cleanup alternatives range from approximately $26 to $36 million. If upland disposal becomes necessary, the upper-bound cost estimate could approach $75 million.

It is apparent from the Table 6 summary that site acquisition and/or easement costs may be a significant component of the overall cleanup costs, particularly for those alternatives that leave contaminated sediments in-place, and also depending on land owner and operator requirements. The long-term costs of property easements for sediment containment (*in situ* and at prospective disposal sites), particularly on state-owned aquatic lands and sediments that occur throughout the SMP area, are difficult to estimate and can vary widely depending on specific circumstances. Property owners and managers, including WADNR and the Port, may charge for long-term easements on their land in those cases where the cleanup or disposal action would reduce the value of the land to the owner.

## Table 6. Summary of Planning-Level Remedial Alternative Cost Estimates

| Cost Item | Sediment Remediation Alternatives | | | | |
|---|---|---|---|---|---|
| | **Alternative 1 No Action** | **Alternative 2 Natural Recovery** | **Alternative 3 Capping** | **Alternative 4 Low Removal** | **Alternative 5 High Removal** |
| 1. Contaminant Transport Modeling | $0 | $500,000 | $100,000 | $100,000 | $100,000 |
| 2. Detailed Risk Assessments | $0 | $1,000,000 | $0 | $0 | $0 |
| 3. Remedial Investigation/Feasibility Studies | $0 | $1,000,000 | $500,000 | $1,000,000 | $1,000,000 |
| 4. Cleanup Action Plans/Consent Decrees | $0 | $400,000 | $400,000 | $200,000 | $200,000 |
| 5. Remedial Design/Engineering | $0 | $0 | $400,000 | $1,500,000 | $2,000,000 |
| 6. Mobilization/Demobilization | $0 | $0 | $200,000 | $700,000 | $700,000 |
| 7. Construction of Sediment Caps | $0 | $0 | $3,000,000 | $2,000,000 | $500,000 |
| 8. Sediment Dredging | $0 | $0 | $0 | $1,000,000 | $2,000,000 |
| 9. Confined Disposal and Mitigation: | | | | | |
| a. Slip 27 CDF and/or Slip 4 CAD Option | $0 | $0 | $0 | $9,000,000 | $9,000,000 |
| b. MUDS Option (cost increment) | $0 | $0 | $0 | $2,000,000 | $10,000,000 |
| c. Upland Landfill Option (cost increment) [(a)] | $0 | $0 | $0 | ($20,000,000)[(a)] | ($40,000,000)[(a)] |
| 10. Construction Monitoring/Management | $0 | $0 | $300,000 | $1,000,000 | $2,000,000 |
| 11. Land Encumbrances/Easements [(b)] | $0 | $15,000,000 | $15,000,000 | $6,000,000 | $0 |
| 12. Long-term Monitoring | $0 | $2,000,000 | $1,000,000 | $500,000 | $200,000 |
| 13. Contingency (30%) | $0 | $6,000,000 | $6,000,000 | $7,000,000 | $8,000,000 |
| **TOTAL ESTIMATED COST [(a)]** | **$0** | **$26,000,000** | **$27,000,000** | **$32,000,000** | **$36,000,000** |
| **Cost-Sharing Opportunities** | none | none | small (0-20%) | large (50%+) | medium (20-50%) |

Notes:
[(a)] Incremental costs associated with the unlikely upland landfill disposal option are not included in the total estimated costs.
[(b)] Estimated based on preliminary land valuation concepts (see text).

On a case-by-case basis, the various fees and costs could be reduced or waived if the project(s) meet the interests of the land owners and makes them whole. In the case of the state, these land owner interests are generally set forth in the WADNR land management regulations and public trust doctrine (see below). Other property would likely make similar land owner interest determinations.

## Aquatic Land Management Laws and Public Trust Doctrine

Following a finding of the state legislature that *"This (1984) legislature finds that state-owned aquatic land is a finite natural resource of great value and irreplaceable public heritage"* (RCW 79.90.450), state-owned aquatic lands and sediments must be managed in accordance with constitutional and statutory requirements, while striving to provide a balance of varied public benefits for all citizens of the state, including the following objectives (RCW 79.90.455):

- Encouraging direct public use and access
- Fostering water-dependent uses
- Ensuring environmental protection
- Utilizing renewable resources
- Generating revenue in a manner consistent with these benefits (economics).

Consistent with these objectives, WADNR strives to manage state-owned aquatic lands to maximize overall public benefits, also recognizing the finding of the state legislature that dredged material "disposal sites are essential to the commerce and well being of the citizens of the State of Washington" (RCW 79.90.550). Although specific decision criteria for disposal site selection have not yet been developed for Elliott Bay, in making its public interest determination, WADNR assesses whether the action is clearly in the long-term interest of the public and how the cleanup and/or disposal action fits into the vision for the entire bay. Investments in navigation and commerce along harbor areas and waterways will be maintained to provide for economic growth and to avoid development elsewhere. Finally, the full costs will be evaluated as part of WADNR's public interest determination, including habitat restoration.

Because of the complexities of land owner interest determinations, it is difficult to estimate the long-term costs of property easements for leaving contaminated sediments in place or contained within disposal facilities, including state-owned aquatic lands and sediments. Nevertheless, since these costs can become very large (as at the Thea Foss Waterway CAD site in Tacoma), it is important to consider their potential ramifications early in the process. Accordingly, based on comparable regional land values, and considering recent WADNR policy developments, a preliminary easement cost of $15 per square foot is assumed for contamination left in federal navigation channels, and a cost of $5 per square foot is assumed for contamination left on other state-owned aquatic lands.

## Recommendation Summary

The recommendations generated in the development of this SMP are based upon several assumptions, which are summarized below, followed by the site-specific and general recommendations for sediment management at the seven listed sites.

### Key Assumptions

- **Ecology and/or EPA will ultimately require active sediment remediation in those site areas that exceed SMS cleanup screening level (CSL) chemical or biological criteria**. In previous sediment cleanup decisions within the SMP area, Ecology and EPA have tended to direct their sediment cleanup efforts to areas that exceed the CSL, based on its evaluation of site-specific sediment recontamination and practicability considerations, among other factors (e.g., see Ecology 1995; Hart Crowser 1997). Under the SMS, Ecology selects a site-specific cleanup level ranging between the SQS and CSL, with the selection based on environmental protection, implementability, and practicability considerations, among other factors.

- **The Elliott Bay/Duwamish Restoration Program has sufficient funding to complete its projects, and specifically to implement planned sediment cleanup actions at the Duwamish/Diagonal site**. Even though work is currently stalled due to a lack of planning funds, cleanup efforts are expected to resume in 1999 when the court that issued the original NRDA consent decree allocates additional funds.

- **The Port of Seattle will be successful in its efforts to receive regulatory approvals to develop the least costly disposal option for contaminated sediments, i.e., to place Stage II sediments that are unsuitable for open-water disposal in Slip 27 on the East Waterway, or in a similarly cost-effective disposal site**. The Port is presently working through applicable environmental review processes to evaluate the Slip 27 nearshore fill facility as part of its Stage II navigation improvement of the East Waterway. If these lower-cost disposal options are not available, then costs would increase significantly to use upland disposal sites.

### Site-Specific Project Recommendations

The preliminary planning recommendation derived from the SMP analysis for the priority sediment sites is for King County and other cooperative parties to support implementation of limited removal and confined disposal of contaminated sediments present in federal navigation channels and prospective harbor improvement areas. This selection was made following a detailed evaluation of the technical feasibility, implementability, and costs of the five viable alternatives presented above. Based on the programmatic evaluation performed for this SMP, selection of the limited removal alternative would likely be fully consistent with Ecology's Sediment Management Standards guidelines, and would also be consistent with recent sediment cleanup decisions in the region. It is the most appropriate alternative given the type, extent, and

severity of contamination at the listed sites. Nevertheless, Ecology (or EPA under Superfund) retains the authority for final cleanup decisions.

Contaminated sediments (exceeding SQS criteria) that are located within existing federal navigation channels or are otherwise targeted for a near-term navigation or development dredging would be removed and disposed of in either a nearshore confined disposal facility (CDF), a multi-user disposal site (MUDS), or an upland disposal facility. The remaining sediments would be contained below a thin- or thick-layer cap, with the final cap thickness dependent on site-specific remedial design.

One of the more promising sediment disposal options within the SMP area is the Slip 27 nearshore confined disposal facility (CDF) alternative currently being evaluated in the COE and Port of Seattle EIS for the East Waterway deepening project. The Slip 27 nearshore CDF alternative has an estimated capacity of approximately 460,000 cubic yards, incorporating prospective disposal site improvements. This capacity is sufficient to contain all or most of the planned Stage II sediments to be dredged within the Lander Street and Hanford Street CSO site footprints. The Port of Seattle owns the upland and aquatic areas surrounding Slip 27, while the subtidal area consists of City of Seattle right-of-way. The Port is presently working through applicable environmental review processes to evaluate the Slip 27 nearshore fill facility as part of its Stage II navigation improvement of the East Waterway. Under this alternative, cooperative parties could negotiate with the Port to achieve multiple objectives within the SMP area including sediment cleanup, disposal, redevelopment, and habitat mitigation/restoration. However, if the Slip 27 fill alternative is not accepted by the regulatory agencies, there are several additional disposal options (confined disposal facility constructed at Slip 4; potential regional multi-user disposal site (MUDS) located in Elliott Bay or elsewhere in Puget Sound; and upland landfilling) that are possible, but at increasing costs.

Capping of all sediment site cleanup areas that are not dredged could be performed in a manner that would be consistent with current site development and land use plans, though easements may be required. However, if the caps encumber these harbor areas, land owner concurrence may require the payment of an easement fee (see preliminary cost estimates above).

The potential for sediment recontamination of the dredged areas and caps would need to be addressed by contaminant transport modeling ranging from relatively simple updates of nearfield (PLUMES) modeling to reflect expected future CSO controls, to more complex contaminant transport modeling that would also evaluate SD discharges (see Appendix A). Depending on the results of the modeling, there may be a need to delineate a sediment impact zone in the immediate outfall discharge area.

Detailed descriptions of the specific remediation technologies to be used at each of the seven listed sites are presented below. Table 7 provides a summary of costs associated with the recommended alternative. Table 8 presents a summary matrix for the preferred alternative identified in this planning level assessment.

## Table 7. Summary of Planning-Level Costs Associated with the Recommended Remedial Alternative

| Cost Item | Alternative 4 - Limited Removal with Cost-Effective In-Water Disposal | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Duw/Diag | King | Hanford | Lander | Denny | Chelan | Brandon | **TOTAL** |
| 1. Transport Modeling/Phthtalate Studies | $150,000 | $150,000 | $100,000 | $50,000 | $50,000 | $50,000 | $50,000 | $600,000 |
| 2. Detailed Risk Assessments | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 3. Remedial Investigation/Feasibility Studies | $0 | $100,000 | $100,000 | $100,000 | $0 | $100,000 | $50,000 | $450,000 |
| 4. General Planning, CAPs & Consent Decrees | $250,000 | $100,000 | $250,000 | $150,000 | $50,000 | $150,000 | $50,000 | $1,000,000 |
| 5. Remedial Design/Engineering | $80,000 | $80,000 | $580,000 | $150,000 | $20,000 | $70,000 | $5,000 | $1,000,000 |
| 6. Mobilization/Demobilization | $50,000 | $0 | $480,000 | $120,000 | $0 | $50,000 | $0 | $700,000 |
| 7. Construction of Sediment Caps | $300,000 | $1,100,000 | $0 | $0 | $310,000 | $100,000 | $60,000 | $1,900,000 |
| 8. Sediment Dredging | $70,000 | $0 | $680,000 | $180,000 | $0 | $70,000 | $0 | $1,000,000 |
| 9. Confined Disposal and Mitigation: | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| a. Slip 27 CDF and/or Slip 4 CAD Option | $600,000 | $0 | $6,500,000 | $1,700,000 | $0 | $700,000 | $0 | $9,500,000 |
| b. MUDS Option (cost increment) | $100,000 | $0 | $1,400,000 | $400,000 | $0 | $100,000 | $0 | $600,000 |
| c. Upland Landfill Option (cost increment) [(a)] | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 10. Construction Monitoring/Management | $70,000 | $0 | $700,000 | $200,000 | $0 | $70,000 | $0 | $1,000,000 |
| 11. Land Encumbrances/Easements [(b)] | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 12. Long-term Monitoring | $100,000 | $150,000 | $100,000 | $100,000 | $100,000 | $100,000 | $50,000 | $700,000 |
| 13. Contingency (30%) | $530,000 | $520,000 | $3,100,000 | $850,000 | $160,000 | $460,000 | $60,000 | $5,700,000 |
| **TOTAL ESTIMATED COST [(a)]** | $2,300,000 | $2,200,000 | $13,000,000 | $4,000,000 | $700,000 | $2,000,000 | $300,000 | $24,000,000 |

NOTES:
(a) Incremental costs associated with the unlikely upland landfill disposal option are not included in the total estimated costs.
(b) Estimated based on preliminary land valuation concepts (see text).

## Table 8. Sediment Management Matrix

| Site | Cooperative Cleanup Opportunities | Potential Partners | Possible Funding Sources | Recommended Remedial Action | **Total SMP Cost Estimate** (including planning, construction, and cooperative partner contributions) | Recommended SMP Implementation Action |
|---|---|---|---|---|---|---|
| **High-Priority Cleanup Sites:**<br><br>DR 31 (near Duwamish/ Diagonal CSO) | A sediment cleanup study of this site has been completed as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program (EBDRP). However, cleanup implementation activities are currently stalled due to a lack of planning funds.<br>In addition, the U.S. Army Corps of Engineers may perform dredging of the channel area of the site, if the action is performed as part of routine channel maintenance, and if a suitable sediment disposal location is identified.<br>EPA is currently considering adding the Duwamish/Diagonal site, along with other areas of the Duwamish River, to the National Priorities List (Superfund). | Elliott Bay/ Duwamish Restoration Program<br>U.S. Army Corps of Engineers and Port of Seattle (local sponsor)<br>City of Seattle<br>King County | As part of a Natural Resource Damage Assessment settlement agreement, King County and the City of Seattle previously allocated and committed resources to the Elliott Bay/Duwamish Restoration Program for cleanup of this site.<br>Funding of U.S. Army Corps of Engineers dredging activities could occur under existing Water Resources Development Act authorities, and would require Congressional appropriations and participation of the local sponsor (Port of Seattle). | Continuation of site cleanup as part of the existing Elliott Bay/Duwamish Restoration Program.<br>Cooperative involvement of the U.S. Army Corps of Engineers could be pursued by the Elliott Bay/Duwamish Restoration Program and/or the Port of Seattle. | $0 | None |
| EB 27 (near King Street CSO) | Long-term redevelopment plans are currently being developed for an expanded Colman Dock ferry terminal within the existing Pier 48 area, as part of the South Downtown Waterfront Master Development Plan. Washington State Ferries and the Port of Seattle recently initiated a sediment cleanup study of the site as part of this larger planning effort. Cleanup decisions are currently scheduled for spring and summer of 2000. | Washington State Ferries (WSF)<br>Port of Seattle<br>City of Seattle<br>King County | Washington State Ferries and/or the Port of Seattle may decide to perform some or all of the required sediment cleanup as part of site redevelopment. King County could potentially accelerate CSO control and long-term monitoring as part of an overall cooperative implementation agreement. | Capping of approximately 15–19 acres of contaminated sediments at the site with a 1- to 3-foot sand capping layer (thickness to be determined during final design). | $2.2 million (excluding possible land encumbrance fees from Washington Department of Natural Resources and/or Port of Seattle) | Begin cooperative discussions with Washington State Ferries and Port of Seattle.<br>Perform further evaluation and/or modeling of potential recontamination from existing CSO discharges to determine whether CSO control should be accelerated. |
| **Medium-Priority Cleanup Sites:**<br><br>EB8 (near Hanford Street CSO) | The Port of Seattle and Corps of Engineers are currently performing planning studies for dredging and confined disposal of sediments at this site as part of the East Waterway Stage II navigation improvement project. Sediment sampling has been completed. Dredging and disposal decisions may occur in late 1999. | Port of Seattle<br>U.S. Army Corps of Engineers<br>King County | The U.S. Army Corps of Engineers may perform dredging; King County and the Port of Seattle could potentially share disposal costs. | Removal and confined aquatic disposal of 190,000 cubic yards of contaminated sediments. | $13 million (assuming the availability of a relatively low-cost confined aquatic disposal site) | Contact Port of Seattle regarding the current status of Stage II.<br>Perform further evaluation and/or modeling of potential recontamination from existing CSO discharges to determine whether CSO control should be accelerated. |
| EB7 (near Lander Street CSO) | | | | Removal and confined aquatic disposal of 50,000 cubic yards of contaminated sediments. | $3.7 million (assuming the availability of a relatively low-cost confined aquatic disposal site) | |
| EB 26 (near Denny Way CSO) | King County recently completed a cleanup study of the site as part of the Denny Way CSO control project. Cleanup of portions of the site is currently proceeding under this separate program. | King County | As part of the year 2000 capital budget process, King County will consider a separate capital project request for remediation of inshore contaminated sites (areas A and B) for 2004 (i.e., after Denny Way CSO has been controlled). | Consider remediation of all contaminated areas after CSO control in 2003. | $0.7 million (excluding possible land encumbrance fees from Washington Department of Natural Resources) | Submit budget request to complete all sediment remediation after CSO project construction. |
| **Low-Priority Cleanup Sites:**<br><br>EB13 (near Chelan Avenue CSO) | No cleanup studies have been completed at this site, although data have been collected by King County and others on the extent of sediment contamination, some of which extends into the federal navigation channel.<br>The U.S. Army Corps of Engineers may conduct dredging of the channel area of the site if the action is performed as part of routine channel maintenance, and if a suitable sediment disposal location is identified. | U.S. Army Corps of Engineers<br>Port of Seattle (local sponsor)<br>King County | The U.S. Army Corps of Engineers may conduct dredging if dredging is performed as part of channel maintenance; disposal costs are uncertain. | Removal and confined aquatic disposal of 20,000 cubic yards of contaminated sediments. Cap approximately 2 acres of contaminated sediments at the site with a 1- to 3-foot sand capping layer (thickness to be determined during final design). | $2.0 million (excluding possible land encumbrance fees from Port of Seattle) | No action at this time |
| DR32 (near Brandon Street CSO) | No cooperative opportunities have been identified. The available data suggest highly localized sediment contamination at this site, not extending into the federal navigation channel.<br>EPA is currently considering adding the Brandon Street site, along with other areas of the Duwamish River, to the National Priorities List (Superfund). | King County | No source identified | Capping of approximately 1 acre of contaminated sediments at the site with a 1- to 3-foot sand capping layer (thickness to be determined during final design). | $0.3 million (excluding possible land encumbrance fees from Port of Seattle) | No action at this time |

- **DR31 (near Duwamish/Diagonal CSO/SD)** — King County and the City of Seattle have previously allocated and committed resources to perform cleanup of this site through a National Resource Damage Assessment settlement agreement. Although cleanup is underway as an independent cleanup action under the direction of the Elliott Bay/Duwamish Restoration Program, the request for additional funds to complete planning is still pending. Construction funds are adequate to complete the prospective sediment remediation (i.e., capping with limited dredging), thus no additional costs are included in the SMP cost estimate (Tables 7 and 8).

  Cleanup actions at this site should continue under the Elliott Bay/Duwamish Restoration Program. However, King County and the City of Seattle may want to consider providing part of the planning funds to move the project forward to completion. Another consideration is that cleanup boundaries, remediation methods, and costs have not yet been finalized.

- **EB27 (near King Street CSO and South Washington SD)**— King County should enter into discussions with Washington State Ferries, the Port of Seattle, and City of Seattle regarding cooperative project opportunities for sediment cleanup at this site, related to long-term redevelopment plans for an expanded Colman Dock ferry terminal at Pier 48 and the South Downtown Waterfront Master Development Plan. The planning-level cleanup remedy for the site involves capping approximately 15 to 19 acres of contaminated sediment with a 1- to 3-foot sand layer designed to protect against propeller wash. Washington State Ferries or the Port of Seattle may decide to perform some or all of the required sediment cleanup as part of site redevelopment. Long-term monitoring in the sediment remediation area will be required to verify the effectiveness of remedial measures. A nearfield sediment recontamination assessment, if performed, could be used to evaluate further control options and develop management recommendations. Based on the results of this study, the cooperating parties should negotiate responsibilities for providing long-term monitoring as part of an overall cooperative implementation agreement. The total estimated cost of sediment remediation at this site is approximately $2.2 million.

  **EB8 and EB7 (near Hanford Street and Lander Street CSOs)** — In consideration of the Port's navigation improvement plans for the East Waterway, the recommended cleanup plan involves dredging and confined aquatic disposal of 190,000 cubic yards of contaminated sediments at the Hanford Street CSO and 50,000 cubic yards at the Lander Street CSO. The COE, in cooperation with the Port, plans to perform dredging of the area as part of navigation improvements. Final cost allocations have not been determined. Potentially cost-effective disposal options for the contaminated sediments include a nearshore CDF constructed at Slip 27 or a MUDS in Puget Sound. Because of the removal action and pending verification of suitable source controls, long-term monitoring may not be necessary within the Hanford Street and Lander Street area, except as may be necessary to assess potential sediment recontamination. However, monitoring at the disposal site(s) will be necessary.

Cooperative parties should contact the Port of Seattle regarding potential cooperative opportunities as part of the Port's Stage II navigation improvement project. A nearfield sediment recontamination assessment, if performed, could be used to evaluate further control options and develop management recommendations. Based on the results of this study, the cooperating parties should negotiate responsibilities for providing long-term monitoring as part of an overall cooperative implementation agreement. The total estimated cost of sediment remediation at this site (including both the Hanford and Lander footprints) is approximately $17 million.

**EB26 (near Denny Way CSO) —** King County is conducting cleanup and remediation of a portion of this site as part of an aquatic lands easement agreement from the WADNR. Denny Way is King County's largest CSO, and it is recommended that the County consider completing all of the various components simultaneously to obtain timely resolution and closure at the site. Control to one untreated overflow per year with discharge of treated effluent will be achieved by 2003. A nearfield sediment contamination model, if developed, could be used to determine the recontamination potential from the one untreated overflow per year and the discharge of treated effluent.

Therefore, King County should consider remediating all areas of contamination soon after construction is completed. (Cleanup at the site is continuing under direction of the state Model Toxics Control Act.) The total estimated cost of sediment remediation at this site is approximately $700,000.

- **EB13 and DR32 (near Chelan Avenue and Brandon Street CSOs)** — These sites currently have low priority for cleanup. The total estimated cost of sediment remediation is approximately $2 million at Chelan and $300,000 at Brandon.

## General Recommendations

- **Maintain cooperative project involvement in Elliott Bay and the Duwamish River and support TMDL design team.** All of the sediment sites located near King County CSO outfalls reflect contamination from a variety of sources. The role of current sources needs to be better defined to develop appropriate corrective approaches. The County should develop partnerships with other entities to pursue corrective measures. King County is currently participating with Ecology and other design team agencies in initiating a coordinated approach to contaminated sediment issues and the development of total maximum daily loads (TMDLs) within the CSO sediment site area. The findings of the design team should be incorporated into future phases of the SMP. The TMDL process is focusing on the reduction of pollutants to receiving waters that currently exceed water or sediment quality standards. Specifically, the TMDL project has identified contaminated sediments in the Duwamish River and Elliott Bay as one of the highest-priority work elements. Cooperative project involvement by King County is scheduled to occur through December 2000.

- **Develop model for potential sediment recontamination from existing CSO and SD sources.** Results from the screening-level recontamination modeling analysis (presented in the Task 900 technical memorandum) indicate that, given current discharge levels, there is a potential for localized recontamination of sediments near some or all of the CSO outfalls following completion of a cleanup action. Ongoing SD discharges to these same areas may be associated with similar or greater risks of recontamination. The primary chemical of potential recontamination concern is bis(2-ethylhexyl)phthalate (see below), which has numerous sources within the basin. However, because the screening-level modeling performed to date has used a number of conservative simplifying assumptions, more detailed near-field modeling studies are recommended to confirm whether the potential for recontamination currently exists, particularly at the higher-priority sites (e.g., near Duwamish/Diagonal and King Street). The modeling should incorporate expected future CSO controls. Other entities with point or non-point source discharges could also use such a model. Model development could be completed within 7 to 12 months, at an estimated total cost of approximately $250,000.

- **Perform further evaluation of phthalates and other chemicals of concern for potential sediment recontamination from existing CSO and SD sources.** It is known that phthalates are used in a wide range of residential, commercial, and industrial applications; however, the source of phthalates to regional CSOs and SDs is largely unknown. Therefore, it is difficult to determine the best methods to control their entry into the system. Further studies of the source, fate, and toxicity of bis(2-ethylhexyl)phthalate within regional CSO and SD basins near the listed sediment sites should be initiated. Such studies could be used to determine the level of CSO and SD controls necessary to prevent future sediment recontamination. The phthalate study could be completed within 12 months, at an estimated total cost of approximately $250,000.

- **Negotiate timing of CSO control versus sediment remediation with Ecology.** Based on results of the recontamination modeling and phthalate control studies outlined above, it should be possible to determine the extent of ongoing sediment recontamination near each CSO site, given the current Regional Wastewater Services Plan source control schedule. Currently the extent of recontamination appears to be highly localized, although this condition would be refined with the new modeling and phthalate studies. Following completion of the studies, King County could negotiate with Ecology the appropriate timing of site-specific sediment cleanup actions and the need for further CSO source controls at one or more of the sites. Important considerations in this determination would include the magnitude and extent of historical sediment contamination addressed by cleanup versus ongoing recontamination sources, among other factors. Negotiations with Ecology are currently scheduled to occur in late 1999 through mid-2000.

## Path Forward

The recommended programmatic sediment remediation alternative(s) described above are based on a general evaluation of feasibility, implementability, and costs of alternative

cleanup strategies, also considering cooperative project opportunities that have a significant potential benefit to cooperating parties.

### Significant Information or Data Gaps Pertaining to Management Decisions

As discussed above, a critical factor dictating the feasibility of any form of sediment cleanup at the listed sites is the degree to which ongoing contaminant sources are effectively controlled. One possible trigger (although not the only one) signifying that source control is complete is flow reduction meeting the criterion of one untreated overflow event per year. The only SMP site that is currently scheduled to meet this flow reduction criterion in the near term (i.e., 2003) is Denny Way (King County 1999).

Alternatively, there may be other means of determining whether or not discharges from a given CSO or SD are effectively controlled. These alternative approaches, which could be performed as a component of Tier 2 SMP activities, include:

- Perform refined contaminant transport modeling to evaluate whether existing source controls are already adequate to prevent sediment recontamination, or to more precisely delineate the extent of recontamination in the immediate vicinity of the CSO and SD outfall(s). As described in Appendix A, a combination of nearfield and farfield models is recommended for this purpose. The level of detail and refinement to existing King County models would be dependent on the resolution to which the contamination needs to be modeled, and on the results of initial screening-level analyses. Successive model refinements, if required, could support improved resolution to better define the extent of potential sediment recontamination.

- Conduct a phthalate study that includes a review of source, fate, and sediment toxicity characteristics within the immediate vicinity of the outfall(s), to determine with more certainty whether contaminant accumulations in these areas pose a risk to the environment. For example, sediment samples collected at the Duwamish/Diagonal CSO/SD site that contained elevated (above CSL) bis(2-ethylhexyl)phthalate concentrations did not exhibit adverse effects in confirmatory bioassay tests (King County 1997). Similar results and evaluations have also been reported elsewhere in Puget Sound. These data provide evidence that bis(2-ethylhexyl)phthalate may pose a lower risk to sediment-dwelling infauna than indicated based on a simple comparison with SMS chemical criteria. This observation, if substantiated based on a more detailed review, may have important ramifications to the recontamination assessment.

In the event that a decision may be reached to move forward with formal (e.g., MTCA) cleanup planning at one or more SMP listed site, it will likely be necessary to perform a SMS sediment cleanup study. However, with the exception of source control determinations described above, considerable data are already available for most, if not all, of the SMP sites to complete the necessary cleanup studies. Further, forthcoming sampling data and cleanup studies will soon be available that will provide considerable additional information pertinent to the cleanup studies. These efforts are described below.

- As part of Stage II navigation improvement planning for the East Waterway, the COE recently collected 86 composite sediment cores from the greater Hanford and Lander CSO site area, and submitted the samples for detailed chemical and biological analyses following PSDDA guidelines. Sediment chemistry, bioassay, and bioaccumulation analyses were conducted on most of the surface composite samples collected, and also on subsurface samples. These determinations, which are expected to greatly improve the characterization of sediment contaminants and disposal requirements within the Stage II area, are expected to be available by summer 1999.
- WSDOT and the Port of Seattle will soon be collecting and analyzing additional sediment samples (including confirmatory bioassays as appropriate) at the King Street CSO site to complete the site characterization and to support an evaluation of combined sediment cleanup and redevelopment alternatives. The EIS and Cleanup Action Plan are currently scheduled to be completed in mid-2000, when they will be provided for public review.

Thus, the additional sediment sampling data and cleanup evaluations available from these other efforts will allow more expedited and efficient execution of the sediment cleanup studies, should they be determined to be necessary.

### Development of Cleanup and/or Cooperative Agreements

At this time, it is possible only to outline the general components of sediment cleanup agreements with Ecology/EPA or with cooperative partners. However, depending on specific circumstances, such components may include:

- Administrative framework (e.g., consent decrees)
- Site ownership and land easement/encumbrance agreements
- Design responsibilities
- Site permitting framework
- Mitigation requirements and responsibilities
- Cost allocation (e.g., payment components and alternatives, etc.)
- Short- and long-term liabilities (e.g., for disposers, constructors, land owners, those with operation and maintenance responsibilities), including resolution of cleanup liabilities
- Operation and maintenance responsibilities and contingency plans
- Institutional controls (including possible future site modifications).

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