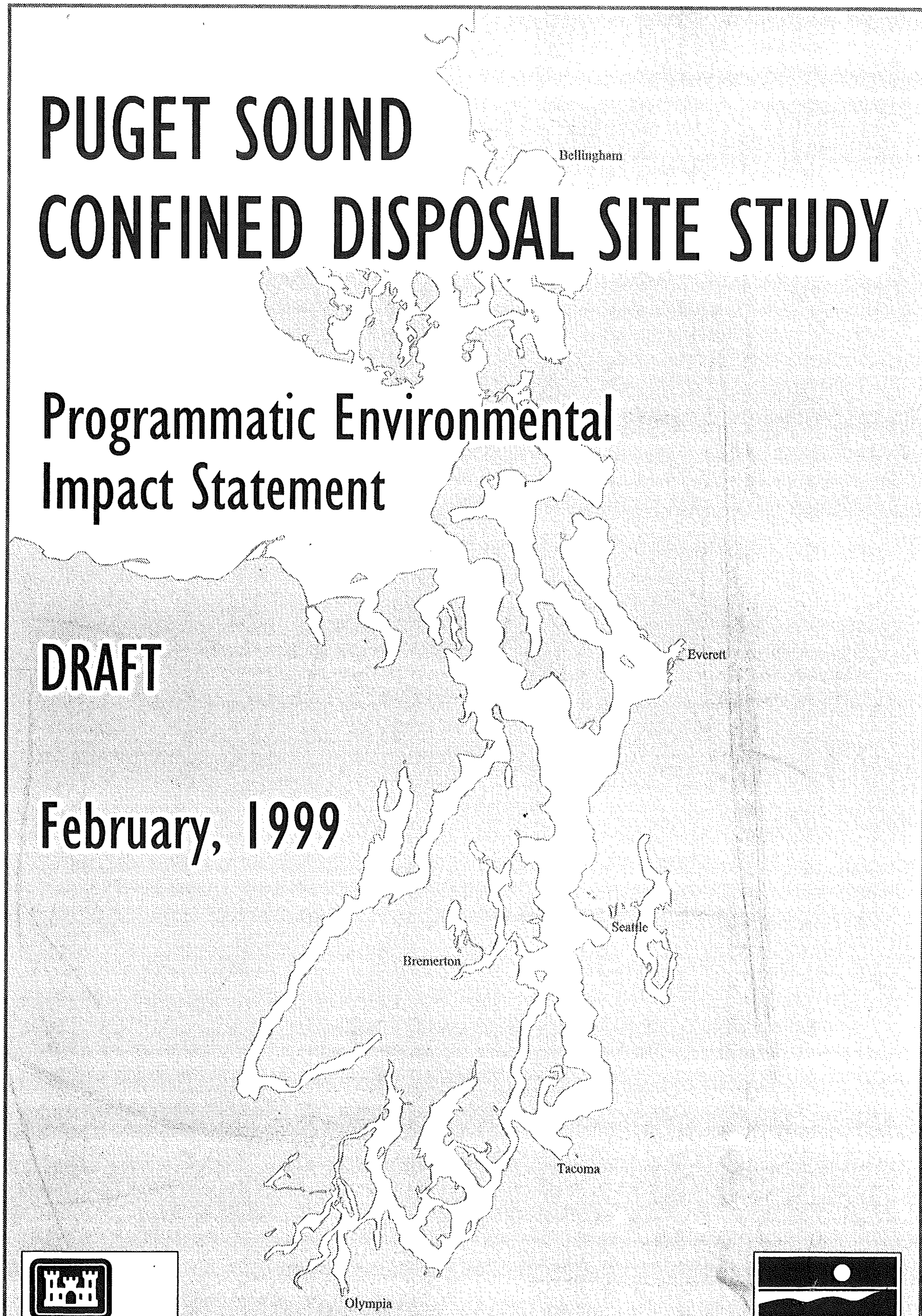
PUGET SOUND CONFINED DISPOSAL SITE STUDY

Programmatic Environmental Impact Statement

DRAFT

February, 1999



US Army Corps of Engineers
Seattle District

WASHINGTON STATE DEPARTMENT OF Natural Resources

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Pub. No. 99-09-900

US Army Corps of Engineers
Seattle District

Washington State Department of Ecology

Washington State Department of Natural Resources

February 19, 1999

RE: Draft Programmatic NEPA/SEPA EIS for the Puget Sound Confined Disposal Study

Dear Interested Party:

The enclosed draft Programmatic NEPA/SEPA EIS for the Puget Sound Confined Disposal Study has been prepared in compliance with the National Environmental Policy Act (NEPA) (40 CFR Parts 1500-1508), and the State Environmental Policy Act (SEPA) (RCW 43.21C). The NEPA lead agency is the U.S. Army Corps of Engineers. SEPA lead agency status is shared by the Washington State Department of Ecology and the Washington State Department of Natural Resources.

This draft Programmatic EIS (PEIS) was prepared as a key component of the Puget Sound Confined Disposal Study and is intended to facilitate development of any site-specific confined disposal EIS that might follow. The site-specific EIS could use the PEIS document through "tiering" or "phasing", incorporating relevant aspects of the PEIS by reference and focusing on site-specific issues and impacts. The site-specific EIS would include application of the siting process and selection of candidate sites, site-specific design and impact analyses, and selection of a preferred candidate site(s).

From 6 to 14 million cy of contaminated dredged material from Puget Sound will require confined disposal over the next 15 years. Seven different alternatives for addressing this need are described and evaluated in this draft PEIS: no action, disposal in solid waste landfills, and several types (e.g., in-water, nearshore and upland) of constructed sediment disposal facilities. There is no preferred alternative at this time. All the constructed alternatives and the solid waste landfill alternative are feasible from an engineering perspective and provide long-term confinement. Costs vary substantially among alternatives, with significant economies of scale for larger facilities. The alternatives also have different environmental advantages, disadvantages, and risks.

The draft PEIS evaluation provides initial environmental review and cost analysis of available alternatives. An array of issues concerning the natural and built environments are considered. Key environmental advantages and disadvantages among the alternatives concern habitat loss, changes in upland and aquatic land use, siting difficulty, sediment rehandling requirements and potential short-term environmental exposure, monitoring needs, and aesthetic impacts. Timing, liability, public perception, regulatory issues, and management options are also discussed. The PEIS does not speculate about how the Puget Sound Confined Disposal Study might be affected by state and federal policies on disposal of contaminated sediment that are still under development, and it does not address the proprietary issues related to the use of state-owned aquatic lands, their valuation, nor issues of funding related to cleanup costs.

A 45-day comment period is being provided for reviewers to comment on the draft PEIS. Written comments should be addressed to Dr. Stephen Martin, U.S. Army Corps of Engineers, P.O. Box 3755, Seattle, WA 98134-3755, by April 5, 1999. Lack of response by agencies or members of the public within the comment period is construed as a lack of objection to the contents of the draft PEIS. Comments should be concise, specific, and cross referenced with document format. All comments received will be addressed in the final PEIS.

Three informational workshops and two public hearings will be held during the 45-day review period for the draft PEIS to provide opportunities for comments and questions. The informational workshops will provide briefings on the projects, while the public hearings will receive verbal comments. First, a draft PEIS informational workshop is scheduled for March 16, 1999, from 5:30 to 6:45 PM at the Federal Center South, 4735 E. Marginal Way, Seattle, followed by a public hearing from 7:00 to 9:30 PM at the same location. Another informational workshop is scheduled for March 18, 1999, from 5:30 to 6:45 PM at the Tacoma Main Library, Olympic Room, 1102 Tacoma Avenue South, Tacoma. The third informational workshop will be held on March 23, 1999 from 5:30 to 6:45 PM at the Howard Johnson Plaza Hotel, 5640 Kitsap Way, Bremerton, followed by a public hearing from 7:00 to 9:30 PM at the same location. Written comments on the draft PEIS may be submitted at any of these workshops or hearings; oral comments will be accepted only at the public hearings.

A limited number of copies of the draft PEIS will be available to public agencies, organized citizens groups, and private citizens at no charge. Requests should be made by calling Dr. Stephen Martin, (206) 764-3631. If numerous requests are received after copy supplies have been exhausted, additional copies will be printed and will be available for a nominal fee to the public. The public may also examine review copies which have been distributed to the regional libraries listed in Chapter 12 of this document. In addition, the executive summary of the draft PEIS is available for viewing on Ecology's web site: <http://www.wa.gov/ecology/sea/smu/sediment/MUDS.htm>.

Further information on the PEIS may be obtained by contacting Dr. Stephen Martin, U.S. Army Corps of Engineers, (206) 764-3631; Mr. Tom Gries, Washington Department of Ecology, (360) 407-7536; and/or Mr. Tim Goodman, Washington Department of Natural Resources, (360) 902-1057.

Following receipt of public comments, a final PEIS will be prepared and issued which will include responses to comments received during the 45-day public comment period.

Sincerely,

Dr. Stephen Martin	Mr. David Bradley	Mr. Paul Silver
U.S. Army Corps of Engineers	Washington Dept. of Ecology	Dept. of Natural Resources

PUGET SOUND CONFINED DISPOSAL SITE STUDY
PROGRAMMATIC NEPA/SEPA
ENVIRONMENTAL IMPACT STATEMENT

DRAFT

February 1999

United States Army Corps of Engineers, Seattle District (NEPA)
Washington Department of Ecology (SEPA)
Washington Department of Natural Resources (SEPA)

NEPA COVER SHEET/SEPA FACT SHEET

Project Title:	Puget Sound Confined Disposal Site Study Draft Programmatic NEPA/SEPA Environmental Impact Statement
Nature and Location of Proposal:	The goal of the study is to find environmentally sound solutions to the lack of confined disposal capacity for contaminated sediments from Puget Sound, Washington. This draft PEIS evaluates the environmental impacts of developing one or more multiuser confined disposal facilities for contaminated sediments. The seven alternatives considered include 1) no action, 2) contained aquatic disposal and level bottom capping, 3) nearshore confined disposal, 4) upland confined disposal, 5) solid waste landfill disposal, 6) multiuser access to large privately-developed CDFs, and 7) combinations of alternatives. No preferred alternative is recommended at this time. The study area encompasses the entire upland Puget Sound basin from the Canadian border to 35 miles south of Olympia and eastward to the Cascade range foothills, and all of Puget Sound and waters north to the Canadian border.
Lead Agencies:	U.S. Army Corps of Engineers, Seattle District (NEPA) Washington Department of Ecology (SEPA) Washington Department of Natural Resources (SEPA)
Other Sponsors and Cooperating Agencies:	Puget Sound Water Quality Action Team U.S. Environmental Protection Agency, Region 10 Washington Public Ports Association
Responsible Officials:	Col. James. M. Rigsby, Seattle District, U.S. Army Corps of Engineers Mr. David Bradley, Washington Department of Ecology Mr. Paul Silver, Washington Department of Natural Resources

Contacts for Further Information:

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Address Comments to:

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Licenses, Permits, and Other Required Approvals:

No licenses are required as no specific action is proposed in this PEIS. Any future site-specific study would include site evaluation, facility design, and additional environmental review. Numerous permits and approvals are required for site-specific disposal facilities.

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Washington Department of Ecology
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Washington Department of Natural Resources
Puget Sound Water Quality Action Team
U.S. Environmental Protection Agency
Washington Public Ports Association
U.S. Fish and Wildlife Service
Document Review

Internet Web Site: Information about the study and the PEIS in particular, including the Executive Summary of the PEIS, graphics, current hearing schedules and information, is available on the Washington Department of Ecology web site at http://www.wa.gov/ecology/sea/smu/sediment/MUDS.htm

Date Draft PEIS Issued: February 19, 1999

Date Draft PEIS Comments Due: April 5, 1999

Dates and Locations of Informational Workshops and Public Hearings:

Three informational workshops and two public hearings will be held during the review period for the draft PEIS to provide opportunities for written or verbal comments. The informational workshops will provide briefings on the study, while the public hearings will satisfy both NEPA and SEPA requirements. Written comments on the draft programmatic EIS may be presented at any of these workshops or hearings. Oral comments must be presented at the public hearings.

- March 16, 1999
  Seattle Federal Center South, Galaxy Room
  4735 E. Marginal Way, Seattle
  Informational Workshop 5:30 to 6:45 PM,
  NEPA/SEPA Public Hearing 7:00 to 9:30 PM.
- March 18, 1999
  Tacoma Main Library, Olympic Room
  1102 Tacoma Avenue South, Tacoma
  Informational Workshop 5:30 to 6:45 PM.
- March 23, 1999
  Howard Johnson Plaza Hotel
  5640 Kitsap Way, Bremerton
  Informational Workshop 5:30 to 6:45 PM,
  SEPA Public Hearing 7:00 to 9:30 PM.

For more specific information on these workshops, hearings and their locations, please call Mr. David Sale at (206) 937-6092 or Dr. Stephen Martin at (206) 764-3631.

Date of Final Action:

No specific action is proposed by the U.S. Army Corps of Engineers, Washington Department of Ecology, and Washington Department of Natural Resources at this time.

Subsequent Environmental Review:

Further environmental review will take place if the study continues to the site-specific phase. This review could include preparation of a site-specific EIS. The timing of any further review is not known.

Location of Draft PEIS Copies:

A limited number of copies of the draft PEIS will be available to public agencies, organized citizens groups, and private citizens at no charge. Requests to receive copies of the PEIS should be made by calling Dr. Stephen Martin, (206) 764-3631. If numerous requests are received after copy supplies have been exhausted, additional copies will be printed and will be available for a nominal fee. This draft PEIS has also been widely distributed throughout City, County, and University Library systems for easy access by the public. Refer to Chapter 12 of the document for a listing of these libraries. Requests to review PEIS supporting documents should also be made to Dr. Stephen Martin at the address and phone number listed above.

DISCLOSURE STATEMENT

REFERENCE: Council on Environmental Quality NEPA Implementing Regulations (40 CFR 1506.5) require the execution of a disclosure statement by the contractor specifying that they have no financial or other interest in the outcome of the project.

STRIPLIN ENVIRONMENTAL ASSOCIATES, INC., with associated firms, is preparing the major input to the Seattle District U.S. Army Corps of Engineers' Environmental Impact Statement pursuant to the National Environmental Policy Act and the State Environmental Policy Act.

We certify that we are preparing this input in conformance with guidance and participation of the U.S. Army Corps of Engineers and Washington Department of Ecology in the role of an independent third party contractor.

We further certify that Striplin Environmental Associates, Inc. and its subcontractors have no financial or other interest in the outcome of this project.

Betsy Striplin
Betsy Striplin
President
Striplin Environmental Associates, Inc.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMARY

This Programmatic Environmental Impact Statement (PEIS) has been prepared for the Puget Sound Confined Disposal Site Study, an interagency effort led by the U.S. Army Corps of Engineers (Corps) and the Washington Departments of Ecology (Ecology) and Natural Resources (DNR). Other participating state and federal agencies and organizations include Puget Sound Water Quality Action Team (PSWQAT), Washington Public Ports Association, and Region 10 of the U.S. Environmental Protection Agency (EPA).

The objective of this PEIS is to provide a broad initial environmental review and cost analysis of major alternatives for the confined disposal of contaminated sediments dredged from Puget Sound, Washington. Pending the outcome of this evaluation of disposal alternatives, a site-specific EIS in support of a specific confined disposal alternative may be pursued in that region of Puget Sound that might benefit most from such an effort. The long-term goal of this effort is to address the regional need for confined disposal of contaminated sediments that require dredging and disposal. The alternatives evaluated at a programmatic level include the following:

- No action
- Disposal in constructed confined aquatic, nearshore, or upland multiuser disposal sites (presented as three individual alternatives, one for each disposal environment)
- Disposal in existing solid waste landfills
- Multiuser disposal in large, privately-developed, confined disposal projects
- Combinations of alternatives.

AUTHORITY AND JURISDICTION

This PEIS was prepared pursuant to the National Environmental Policy Act (NEPA) and the Washington State Environmental Policy Act (SEPA) to support federal, state, and local decision making in regards to the confined disposal of contaminated sediments. The Corps, Seattle District, is the NEPA lead agency for this project, and Ecology and DNR are the co-lead SEPA agencies.

The Corps has regulatory authority over many activities affecting the waters of the United States. This authority is derived from both Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act (1977). A Section 10 permit is required for dredging operations of any kind whether for navigation or environmental cleanup. A Section 404 permit is required for discharges of dredged or fill material into waters of the U.S. including wetlands. This includes upland disposal environments when there is return flow (e.g., runoff) to the waters of the U.S.

For any federally permitted project that requires a Section 10/404 permit, Ecology has authority through Section 401 of the Clean Water Act to issue a water quality certification. A Section 401 certification is a precondition to receiving a Section 404 permit and is designed to ensure that the proposed action does not violate any applicable federal and state water quality criteria.

The dredging and confined disposal of contaminated sediments in Puget Sound also would need to comply with other state and local laws and regulations. In addition to the other agency study members (EPA, DNR, and PSWQAT), participating agencies and groups that might have authority over activities described in this PEIS, depending on the disposal alternative and geographic location, include the following:

- U.S. Department of the Interior, Fish and Wildlife Service
- U.S. Department of Commerce, NOAA, National Marine Fisheries Service
- Washington Department of Fish and Wildlife
- City and county governments
- Native American Tribes
- Local health departments

PURPOSE AND NEED

The dredging of sediments from shipping channels and berths to maintain or deepen navigable water depths, from waterfront development and habitat restoration projects, and from aquatic site cleanup projects, results in a need to safely handle and dispose of dredged material that is unsuitable for unconfined, open-water disposal. These contaminated sediments require confined disposal to eliminate or minimize the risk of short- and long-term contaminant release to the environment.

To date in Puget Sound, dredging and disposal of contaminated sediments have been done on a project-by-project basis. The contaminated sediment dredging and disposal process can be time-consuming, expensive, uncertain, and often controversial for dredging proponents, regulators, and the public. Efforts to clean up contaminated sediments have also been hindered by the lack of viable confined disposal options and the time required to obtain project approval from permitting agencies. Thus, the overall goal of the Puget Sound Confined Disposal Site Study is to find environmentally sound and affordable solutions for the confined disposal of contaminated sediments.

Based on existing information, the volume of contaminated sediment in Puget Sound that will require confined disposal over the next 15 years, is projected to be between about 6 and 14 million cubic yards (cy). Subtracting the volume of sediment that will likely be cleaned up before a multiuser site could become available, from 4 to 10 million cy of contaminated dredged material from Puget Sound will require confined disposal. These estimates include sediment from contaminated site cleanup projects, navigation and maintenance dredging, waterfront development, and habitat restoration projects.

The majority of the contaminated sediments are located in Puget Sound's south-central urban/industrial embayments. Considering all existing sites, about 44% of the contaminated sediment volume is located in the Elliott Bay/Seattle/Lake Washington area (including the Ship Canal and Lake Union). Another 21% is located in the Sinclair Inlet/Bremerton area and 20% is found in Commencement Bay. About 10% is in the Bellingham Bay region and the remaining relatively minor volumes are found in Port Gardner (4%) and Budd Inlet (1%). Because the Sinclair Inlet area is geographically close to the Elliott Bay region, about two-thirds of Puget Sound's contaminated sediments are situated in this central Puget Sound area. This is the region with the greatest contaminated sediment disposal need and the logical focus for a site-specific confined disposal EIS.

As existing contaminated areas (which can be sources of contamination to adjacent areas) are cleaned up and as improved source control efforts continue to be implemented throughout Puget Sound, it is reasonable to assume that the input of contaminants to Puget Sound will decrease over the study's planning horizon. Natural processes such as sedimentation (burial) and chemical and biological degradation should also reduce contaminant levels in surface sediments over time. Consequently, a long-term decrease in contaminated sediment disposal needs may be observed as the contaminated volumes identified above are addressed. Alternatively, delays in on-going cleanup actions and/or the adoption of more restrictive sediment cleanup standards could increase long-term contaminated sediment disposal needs.

ALTERNATIVES

Seven alternatives (including no-action) for the confined disposal of contaminated sediments from Puget Sound were identified by the study team. The major features of each alternative are described below. The constructed alternatives for multiuser disposal sites (MUDS), [level bottom capping and contained aquatic disposal, nearshore and upland confined disposal facilities (CDF)s] and the use of existing solid waste landfills are defined in the PEIS in sufficient detail to allow evaluation and comparison of their potential environmental impacts and cost elements. Much of this detail was based on information provided by the Corps' Waterways Experiment Station for this study (Palermo et al. 1998a).

To allow evaluation of the constructed alternatives in this programmatic EIS, it was necessary to make assumptions about the design, shape, layout, capacity, and operational life of each alternative. For each constructed alternative, a conceptual design was developed and both 500,000-cy and 2,000,000-cy facilities were considered. Also, each facility was assumed to be operational (i.e., accept contaminated dredged material) for a 10-year period. It is important to note, however, that other realistic design and operational options exist. For example, a MUDS could have more than a 2,000,000-cy capacity and be in operation for more than 10 years. So while this PEIS presents and evaluates plausible scenarios for a Puget Sound MUDS, other reasonable scenarios could emerge during site-specific efforts.

No-action

Under the no-action alternative, no multiuser disposal site would be established. Contaminated sediment cleanup and dredged material disposal would continue as it is currently done. Confined disposal facilities would be developed by individual users on a project-by-project basis, some contaminated dredged material would likely be disposed in existing landfills, and some contaminated sediments would be left in-place and exposed to the environment until remedial action or dredging was required. These actions would likely be conducted under the existing framework of regulations and options. In addition, changes to existing policies or regulations might be pursued (i.e., even in the absence of additional confined disposal studies) to facilitate contaminated sediment disposal or cleanup. Examples of such changes are discussed briefly under the no-action alternative.

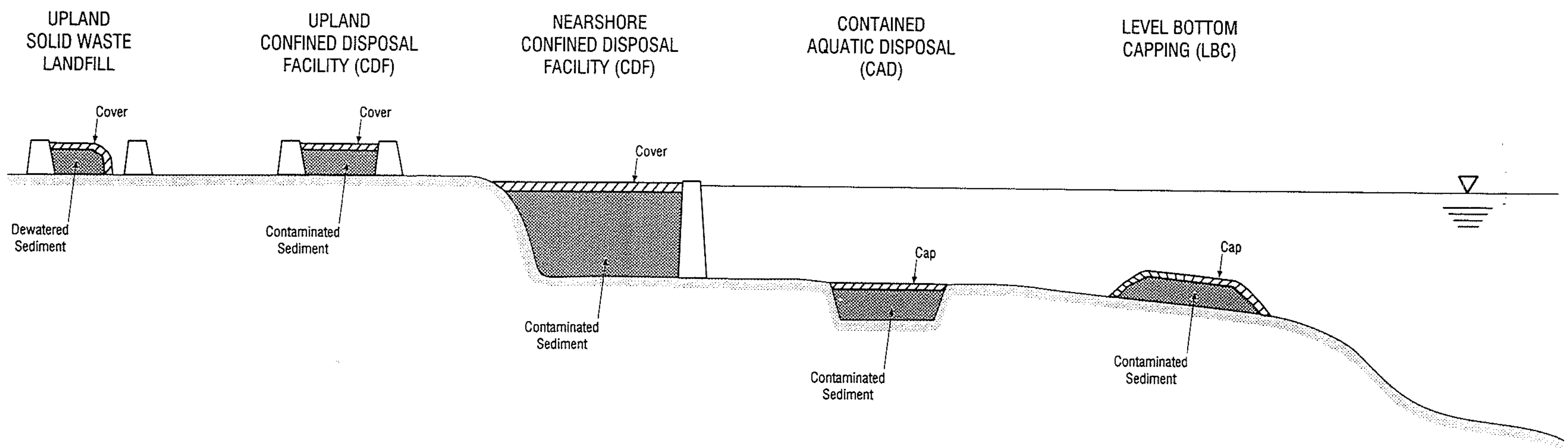
The following three alternatives are considered the main constructed alternatives because they include disposing of contaminated sediments in a constructed confined disposal facility (Figure S-1). For environmental impact evaluation, feasibility, and costing purposes, it is assumed that each constructed facility would have a 10-year operational life and both 500,000- and 2,000,000-cy capacity sites are considered.

Level Bottom Capping (LBC) and Contained Aquatic Disposal (CAD)

LBC and CAD are two types of underwater sediment disposal that are discussed as one alternative because they have similar features and potential environmental impacts. LBC is the placement of contaminated material in a mound on an existing flat or very gently sloping natural bottom and covering the mound with clean sediments. The cap isolates the marine environment from the contaminated material and minimizes the potential for contaminant migration. Biological communities recolonize these areas following final cap placement.

CAD is similar to LBC but includes some form of lateral confinement (e.g., placement in natural or excavated bottom depressions or behind berms) to minimize spread of the materials on the bottom (see Figure S-1). CAD is generally used where the bottom conditions (e.g., slopes) require lateral control measures to limit the spread of the contaminated sediments.

Both LBC and CAD include dredging of contaminated sediments from one or more locations, transportation to the disposal site, and accurate placement of the contaminated materials at the site. LBC sites have been successfully constructed on relatively flat bottoms (0-1%) in depths up to about 200 ft (Wiley 1995, SAIC 1998). CAD sites are generally constructed in water depths less than or equal to 100 ft, but can be constructed in areas with slopes up to 6%. Given the relatively steep slopes that are characteristic of



SOURCE: Based on Palermo et al. 1998a

Figure S-1	Conceptual Illustration of Confined Disposal Alternatives	MUDS Draft PEIS	
		Feb 99	MPEIS Figure S-1.xar

the shallower depths in much of Puget Sound, the CAD option was considered a more likely aquatic disposal scenario and was therefore developed as the aquatic alternative conceptual design in this PEIS. However, this does not preclude consideration of a LBC design as part of future site-specific confined disposal efforts if suitable site conditions exist.

The dredging, disposal, and monitoring technologies associated with LBC/CAD facilities are well-established. The effectiveness of an LBC/CAD facility in avoiding or minimizing environmental risks is a function of appropriate site location, design and construction, technology and operational controls, and effective short- and long-term monitoring and site closure. Two successful CAD projects have been completed in Puget Sound. In others areas of the U.S. and throughout the world, numerous effective CAD and LBC sites have been constructed.

For this PEIS, the conceptual design for this alternative consists of series of CAD pits that are excavated, backfilled with contaminated sediments, and capped with clean sediments (one CAD pit per year over the 10-year operational life). Cost estimates for disposal at the conceptual CAD site described in this PEIS range from $13/cy to $17/cy (exclusive of dredging and transport costs to the CAD site and land acquisition costs).

Nearshore Confined Disposal Facility

Nearshore confined disposal is the placement of contaminated dredged material at a site constructed partially or completely in water adjacent to shore, where the dredged material is contained by a dike or berm (see Figure S-1). Nearshore sites use the shoreline as part of the containment structure, with in-water dikes constructed out from the shoreline to complete the enclosure. Once the contaminated material filling the diked area reaches a specified elevation, it is capped with clean material. The clean capping material raises the elevation to just below or at dike level. The nearshore sites can be finished to grade to allow beneficial reuse or development of the created uplands after completion. Alternatively, they can be finished to grade in the intertidal zone to create intertidal or shallow subtidal habitat.

The construction, dredging, disposal, and monitoring technologies associated with nearshore disposal facilities are well-established. Three nearshore CDFs for contaminated sediments have been successfully constructed in Puget Sound in recent years. The effectiveness of a nearshore site in minimizing environmental risks is a function of appropriate site location, design and construction, operational controls, and effective long-term monitoring and site closure. The three Puget Sound CDFs, initially constructed in water, have become useful upland areas (e.g., container terminals) following final capping and closure.

The disposal cost estimates for nearshore CDF conceptual design described in this PEIS range from \$27/cy to \$44/cy (exclusive of dredging and barge transport costs to the CDF).

Upland Confined Disposal Facility (including a Dewatering Facility)

The upland CDF alternative is the placement of contaminated sediments within a diked confinement structure. The contaminated sediments are covered with clean material to allow beneficial reuse after completion (see Figure S-1). Upland CDFs are designed to retain dredged sediment solids while providing acceptable suspended solids and/or contaminant concentrations in effluent for discharge to receiving waters. All dredged material at upland CDFs is placed above the water table.

Although there are currently no upland CDFs for contaminated sediments in the Puget Sound area, nationally, upland CDFs are one of the most common dredged material disposal methods. Upland CDFs are found throughout much of the country and are extensively used in the Atlantic and Gulf Coast regions of the U.S.

The technologies associated with constructing and disposing of sediments in an upland CDF are similar to solid waste landfill technologies (see below). In this PEIS, it was assumed that water content of the dredged sediments for disposal at both the upland CDF and solid waste landfill alternatives is reduced before disposal to minimize water management requirements at the facilities. The upland conceptual design includes dewatering of the contaminated sediments at a separate rehandling facility that is accessed from the water before transport and final placement at the upland CDF.

The dewatering facility is comprised of multiple cells where material can be actively disposed of, left for dewatering, rehandled for transport to the upland disposal site, or used to store excess sediments. Individual cells are lined or paved to control leachate infiltration into the groundwater, depending on regulatory requirements and the level of sediment contamination. Dikes of compacted soil or concrete provide the outside walls and separate the dewatering facility into individual cells. All water within the dewatering operations area is collected and treated to meet state and local water quality requirements before discharge back to surface waters.

The estimated costs for disposal at an upland CDF, including dewatering at specially established rehandling facilities, range from \$47 to \$63/cy (exclusive of dredging and transport costs to the dewatering facility).

Disposal in Existing Solid Waste Landfills

The solid waste landfill alternative is the placement of contaminated sediments within an existing upland solid waste landfill. Solid waste landfills in the state of Washington are regulated primarily by the Minimum Functional Standards For Solid Waste Handling

(WAC 173-304), Criteria For Municipal Solid Waste Landfills (WAC 173-351), and the Resource Conservation and Recovery Act (RCRA) (Subtitle D). These regulations were established by state and federal governments to ensure protection of human health and the environment.

Sediments must be dewatered prior to transport to a landfill because of the water content in dredged material. Dewatering requires rehandling of the contaminated sediments at a facility that is accessed from the water and is typically included and permitted as part of a project dredging plan. Under this alternative, dewatering is done at a specially-constructed nearshore multiuser dewatering facility, as described in the upland CDF alternative.

The technologies for disposing of contaminated sediments in an existing solid waste landfill are well-established. The dewatered sediments are placed in lined containers for transport by truck or rail to a landfill. At the landfill, sediments are placed in an active cell for disposal or, if appropriate, used as daily cover material for other waste materials.

Private and public landfills currently operating in Washington and Oregon have accepted contaminated sediments for disposal. The two largest operating private landfills in the region are Roosevelt landfill in southern Washington, operated by the Regional Disposal Company of Rabanco, and Columbia Ridge landfill in northern Oregon, operated by Waste Management, Inc. In western Washington, county governments operate solid waste landfills for disposal of material generated within their jurisdictions. While many of these sites can accept dewatered contaminated sediments, the capacity of these landfills is limited. Because of the difficulty in siting new landfills near metropolitan areas, most Puget Sound basin jurisdictions are reluctant to accept a large volume of unanticipated material such as contaminated sediments.

The cost estimates for disposal at a solid waste landfill range from $48 to $65/cy. These estimates include dewatering, transport, and disposal at current landfill disposal costs for large quantities of material (i.e., 500,000- and 2,000,000-cy), but are exclusive of dredging and transport costs to the dewatering facility.

Multiuser Access to Privately-Developed Confined Disposal Projects

This alternative calls for access to larger confined disposal projects by users other than the project proponent. Project proponents have been reluctant to provide multiuser access to their disposal projects because of the following concerns:

- Extended time frames for site development and closure
- Lost capacity for their own disposal projects
- Inherited liability of accepting contaminated sediments from other parties.

The environmental issues associated with multiuser access to a confined disposal project would be the same as for a multiuser facility of the same type (e.g., nearshore or upland). Some differences between the multiuser disposal alternatives and this alternative would be how long the site would be open for disposal to accommodate multiple users, how the liability would be managed for multiple parties, and how the site would be managed and operated. These issues would need to be addressed as part of a project- and site-specific environmental review.

Combination of Alternatives

A combination of two or more of the alternatives previously described is also an alternative. This alternative could be a hybrid composed of any of the action-based alternatives. For example, a CAD facility could be located adjacent to a nearshore CDF, or a location including both a nearshore and upland CDF could be developed. Siting and capacity criteria are critical elements in determining the feasibility of the combination alternative. Because a combination alternative would not be identified until after completion of the PEIS and initiation of the site-specific site selection process, the combination alternative is not directly evaluated in this PEIS. However, the environmental consequences and cost of any potential combination alternative can be assumed to be a composite of the consequences and costs of the individual alternatives.

IMPACTS AND MITIGATION

Table S-1 summarizes the potential impacts, mitigation, and unavoidable adverse impacts of each of the major alternatives. Impacts are associated with contaminant pathways and potential biological receptors. Mitigation involves controlling or minimizing the opportunities for contaminant release to the environment through effective siting, site design, technology and operational controls, site monitoring and management, and effective closure practices. Because the constructed alternatives involve the irretrievable commitment of aquatic, nearshore, and upland land resources to a sediment containment function, the siting process and decisions made during site-specific efforts will be critical in avoiding or minimizing significant impacts.

CONCLUSIONS

With the completion of this PEIS, the Puget Sound Confined Disposal Study will be at a critical decision point. The following issues will need to be addressed by the study team:

1) Based on the anticipated confined sediment disposal need, should the study team pursue one or more of the alternatives for Puget Sound and move forward with a site-specific confined disposal study in a selected region(s)?

Table S-1. Summary of Environmental Impacts by Alternative.

Alternative	Potential Impact	Mitigation	Unavoidable Adverse Impacts
No Action	- Proliferation of smaller and more confined disposal sites - Inefficiency in sediment evaluation, site design, and permitting process - Possible legal actions to protect aquatic life and endangered species	- Existing regulatory mechanisms for cleanup (e.g., CERCLA, SMS) - Individual project mitigation requirements of federal, state, and local entitities	- Delays in cleaning up contaminated sites and some maintenance dredging projects - Long-term exposure of contaminated surface sediments and continued harm to aquatic life and other biota
Contained Aquatic Disposal			
CAD Cell Excavation and Contaminated Sediment Placement	- Short-term exposure of biota to suspended solids, reduced dissolved oxygen (DO), dissolved contaminants, and particulate contaminants - Short-term aesthetic impact - Dispersal of contaminants - Long-term biological uptake by benthos, fish, and humans - Temporal loss of subtidal habitat - Destruction of sedentary benthos and displacement of mobile fauna	- Mechanically dredged, bottom-dumped material, and operational controls; use downpipe (tremie) placement, if needed - Water quality (WQ) monitoring to ensure compliance with appropriate water quality standards (WQS) and modify placement technique as needed - Avoid heavy public use areas in siting - Site in low energy areas, monitor accurate placement, tidal current windows - Place interim caps within 4 weeks of disposal, final cap of 3+ feet - Monitor bioaccumulation of shellfish and demersal fish in area - Avoid high resource areas in siting - Exclude critical or priority habitat areas in siting, monitor benthic recovery on cap - Pre-excavation benthic habitat assessment and, if needed, off-site mitigation - Compliance with dredging and disposal closure periods	- Minor amounts of sediment will settle outside of CAD cell
Cap Placement	- Short-term exposure of biota to suspended solids and reduced DO	- WQ monitoring to ensure compliance with appropriate WQS - Compliance with dredging closure periods	- None
Long-term Containment	- Cap erosion or disturbance and release of contaminants	- Site in low energy areas, adhere to land use restrictions (e.g., no anchor zone) - Effective cap design, placement, and verification - Long-term monitoring and cap replenishment, as needed	- Foreclosure of future use (e.g., navigation deepening)
Nearshore Confined Disposal Facility			
Site Preparation and CDF Construction	- Short-term exposure of biota to suspended solids and reduced DO - Loss of intertidal and shallow subtidal habitat and displacement of fauna - Long-term aesthetic impacts	- Runoff controls - WQ monitoring to ensure compliance with appropriate WQS - Pre-construction habitat assessment and habitat mitigation - Siting excludes critical or priority habitat and high value resource use areas - Siting preference for industrial/commercial area or contaminated sites	- Loss of nearshore habitat

Table S-1. Summary of Environmental Impacts by Alternative.

Alternative	Potential Impact	Mitigation	Unavoidable Adverse Impacts
Contaminated Sediment Placement and Redistribution	- Exposure of biota to contaminants in runoff/effluent discharge, leachate, seepage through dike, and air emissions (volatilization)	- Effective CDF siting, design, modeling, monitoring, and management - Ensure adequate dilution, determine and maintain effective fill rate - WQ monitoring to ensure compliance with appropriate WQS - Air quality monitoring to ensure compliance with standards - Maintain ponded water above sediments - Discourage access through fencing, cover, noise blasts - Periodic placement of interim caps, if warranted - Operational controls	- Uptake by foraging birds (gulls, waterfowl) - Long-term biological uptake by plants, birds, and mammals
Cap Placement	- Dispersal of contaminants	- Effective cap design, placement, and monitoring	- None
Long-term Confinement	- Mass release of contaminants due to catastrophic failure (e.g., major seismic event)	- Effective siting design, construction, monitoring, and management contingency plans	- Localized aesthetic impacts (e.g., noise, odor, view) - Minor long-term release of contaminants in effluent and seepage
Upland Dewatering Facility and Confined Disposal Facility			
Site Preparation and CDF Construction	- Short-term exposure of biota to suspended solids and sedimentation of streams - Loss of upland habitat	- Sedimentation ponds and runoff controls - WQ monitoring to ensure compliance with appropriate WQS - Avoid construction during storm events - Siting excludes critical habitat, wetlands, parks, preserves - Perform pre-construction habitat assessment - Siting excludes residential areas and recreational areas	- None
Dewatering and Disposal at Upland CDF	- Exposure of biota to contaminants in runoff/effluent from dewatering leachate at CDF - Volatilization from sediments - Contaminated dust dispersal - Long-term biological uptake by plants, birds, and mammals	- Collection and filtration of runoff/effluent - WQ monitoring to ensure compliance with appropriate WQS - Siting and design meets landfill minimum functional standards - Avoid sole-source aquifers; include CDF liners, leachate collection and treatment system, monitoring wells - Place interim covers, as needed, erect wind barriers - Compliance with air quality standards - Spray dust suppressant, as needed - Fencing, sound blasts, interim covers, as needed	- None

Table S-1. Summary of Environmental Impacts by Alternative.

Alternative	Potential Impact	Mitigation	Unavoidable Adverse Impacts
Long-term Confinement at Upland CDF	- Exposure of biota to dissolved contaminants and particulate contaminants - Groundwater contamination - Mass release of contaminants due to catastrophic failure (e.g., major seismic event)	- Monitor integrity of final cover - Siting and design; avoid sole-source aquifers - Monitor groundwater and develop contingency plan - Contingency plans	- Localized aesthetic impacts (e.g., noise, odor, view) - Some leachate leakage inevitable
Disposal in Existing Solid Waste Landfills			
Dewatering and Overland Transport by Truck or Rail	- Exposure of biota to contaminants in runoff/effluent from dewatering - Volatilization from sediments - Contaminated dust dispersal - Spills/release during transport	- Collection and filtration of runoff/effluent - WQ monitoring to ensure compliance with appropriate WQS - Cover as needed and erect wind barriers to ensure compliance with air quality standards - Use lined rail cars or truck beds	- None
Long-term Confinement at Existing Landfill	- Exposure of biota to dissolved contaminants and particulate contaminants - Groundwater contamination - Mass release of contaminants due to catastrophic failure (e.g., major seismic event)	- Facility meets Minimum Functional Standards for Solid Waste Handling (WAC 173-304) - Siting and design; avoid sole-source aquifers - Contingency plans	- Localized aesthetic impacts (e.g., noise, odor, view)
Multiuser Access to CDF	- Impacts, mitigation, and unavoidable adverse impacts would be consistent with those at a multiuser CDF (nearshore or upland)		
Combination of Alternatives	- Impacts, mitigation, and unavoidable adverse impacts would be dependent on project and site specific combination		

2) Based on existing dredging and disposal technology and regional and national experience in handling contaminated sediments and designing confined disposal facilities, which of the alternatives described in this PEIS are practicable?

In order to move forward with a preferred alternative or subset of alternatives, the advantages and disadvantages of each must be considered in a broader context that combines environmental impacts, cost, irretrievable commitments of public resources, ability to meet regional disposal needs, timing issues, policy and liability concerns, and public acceptability. Table S-2 summarizes some of the broader advantages, disadvantages, and areas of uncertainty for each alternative based on the information presented in this PEIS.

Table S-2. The Advantages and Disadvantages of Each Alternative.

Alternative	Potential Advantages	Potential Disadvantages	Uncertainty/Controversy
No Action	Less dredging and disturbance of contaminated sediments	Stalled cleanups/contaminated sediments remain exposed Only large entities address problem Potential proliferation of CDFs	Whether policy/regulatory solutions can address disadvantages
LBC/CAD	Effective containment Minimal rehandling Sediments remain saturated, anaerobic Few aesthetic impacts Relatively low cost	Some contaminant release during placement Siting may be difficult due to Puget Sound slopes/depths Requires highly coordinated and relatively costly monitoring/management Forecloses some future aquatic land use	Siting Use of State-owned Aquatic Land Tribal fishing rights Public acceptability
Nearshore CDF	Effective containment Sediments remain saturated, anaerobic Can provide public access, habitat as part of design Commercial/industrial land use following closure Use of contaminated sediment site for MUDS	Loss of nearshore aquatic habitat Uncontrolled pathway (bird/animal foraging) prior to final closure Aesthetic impacts (view, odor, noise) on shoreline Forecloses some future nearshore land use Relatively high cost	Siting Permitting/mitigation requirements Use of State-owned Aquatic Land Tribal fishing rights
Upland CDF	Effective containment No aquatic land or aquatic habitat impacts Potential abandoned property use Commercial or recreational land use following closure	Multiple rehandling and release opportunities Sediments dried and aerated (contaminants potentially mobilized) Aesthetic impacts (view, odor, noise) Siting of CDF and dewatering facility difficult due to real estate constraints Relatively high cost	Siting Public acceptability Permitting/mitigation requirements
Existing Landfills	Effective containment No aquatic land or aquatic habitat impacts Use of existing permitted facility No CDF design/permitting issues	Multiple rehandling and release opportunities Sediments dried and aerated (contaminants potentially mobilized) Uses disposal capacity targeted for municipal wastes Relatively high cost	Dewatering provided or project-by-project Exporting contaminants to other regions
Multiuser Access	Effective containment Proponent constructs, designs, and manages CDF	Timing relative to regional need Liability management	Project specific
Combinations	Effective containment Project specific Most flexible solution	Project specific Increased capacity	Project specific

READER'S GUIDE TO THE PEIS

This brief summary of the contents and organization of the Puget Sound Confined Disposal Site Study PEIS is provided to assist the reader in locating information contained in the report. The main text of the PEIS is contained in Sections 1 through 6, with supporting information provided in Sections 7 through 11. There are five appendices that present supplementary information related to various aspects of the Puget Sound Confined Disposal Site Study.

***Section 1*, Purpose and Need**. Introductory information describing the Puget Sound Confined Disposal Site Study and its purpose, background and previous studies, as well as the objectives of this PEIS, are described in this section. In addition, the need for the Puget Sound Confined Disposal Site Study is assessed by providing current estimates of the volumes of contaminated sediments requiring confined disposal.

***Section 2*, Alternatives**. This section describes the seven alternatives for contaminated sediment disposal evaluated in the PEIS, including the no-action alternative. Principal design features and feasibility of the constructed disposal facility alternatives are described.

***Section 3*, Affected Environment**. General descriptions of the existing environment that would be affected by the alternatives are provided in this section.

***Section 4*, Environmental Consequences**. This section describes the general environmental consequences of implementing of each of the seven alternatives. Mitigation to reduce these consequences, as well as unavoidable adverse impacts, are also discussed.

***Section 5*, Probable Irreversible and Irretrievable Commitment of Resources**
This section identifies significant commitments of natural resources that are irretrievable and irreversible based on information provided in Section 4.

***Section 6*, Coordination with Other Programs and Applicable Laws and Regulations**
This section provides a summary of the coordination efforts that have been conducted by the Corps with government agencies, tribes, and the public. This is followed by a brief discussion of the laws and regulations that apply to the MUDS project.

Sections 7 through 12. Supporting information to the main text is provided in these sections:

- Section 7 - References
- Section 8 - Index
- Section 9 - Acronyms and Abbreviations

- Section 10 - Glossary
- Section 11 - List of Preparers
- Section 12 - Distribution List for PEIS.

***Appendix A*, Initial Site Screening**. This appendix presents the results of the initial regional screening process for identifying potential aquatic, nearshore, and upland areas that may be suitable for construction of confined disposal facilities. *This appendix is only an initial screening; additional screening and rigorous evaluation of any selected sites would be conducted during site-specific studies.*

***Appendix B*, Siting Process and Criteria**. A recommended siting process, including a preliminary list of general and site-specific siting criteria for aquatic, nearshore and upland confined disposal facilities, is provided in this appendix. The list of siting criteria would be finalized as part of site-specific studies.

***Appendix C*, Conceptual Plans and Cost Estimates for Upland, Aquatic, and Nearshore Options**. Detailed information on the conceptual designs and costs for the aquatic, nearshore and upland confined disposal facilities alternatives summarized in Section 2 is presented in detail in this appendix.

***Appendix D*, Institutional Studies**. This appendix summarizes two previous studies conducted to 1) examine the role(s) of various federal and state agencies and private sector entities in planning, operating, managing, and closing a MUDS facility (including costs and liability management) and 2) develop and analyze general institutional options for managing multiuser disposal facilities.

***Appendix E*, Public Participation and Outreach**. A brief summary of the activities and tasks that will be conducted to contact, inform, involve and educate the public on the Puget Sound Confined Disposal Study are presented in this appendix.

1.0 PURPOSE AND NEED

1.1 STUDY PURPOSE

The dredging of sediments from Puget Sound, Washington shipping channels and berths to maintain or deepen navigable water depths, from waterfront development and habitat restoration projects, and from aquatic site cleanup projects results in a need to safely handle and dispose of the dredged material. The Puget Sound Dredged Disposal Analysis (PSDDA) program, implemented in 1989, established dredged material evaluation procedures and disposal sites for dredged material determined by the PSDDA testing program to be suitable for unconfined, open-water disposal (PSDDA 1988, 1989). However, some sediments from dredging, development, habitat restoration projects, and aquatic cleanup sites are not suited for unconfined disposal at a PSDDA site due to elevated levels of contaminants. If dredged, these sediments require disposal in a confined setting to eliminate or minimize the risk of short- and long-term contaminant release to the environment.

Dredging and disposal of Puget Sound contaminated sediments historically has been done on a project-by-project basis. In some cases, contaminated sediments have been transported many miles from the point of origin and disposed at existing landfills. In other cases, dredging proponents such as the ports of Seattle, Tacoma and Everett have constructed nearshore disposal sites that isolate contaminated sediments from the environment and in the process create usable uplands such as marine terminals. However, due to the high cost of siting and constructing an upland or nearshore site, the additional cost of required habitat mitigation, the time required to secure permits, and the general uncertainty associated with these projects, several proponents have concluded that the costs of contaminated sediment disposal outweigh the benefits of dredging the unsuitable material and have redesigned, delayed, or abandoned projects. Similarly, the high costs and the anticipated length of time needed to get permit approvals have also discouraged voluntary cleanup efforts. These concerns and issues are recognized and shared by local, state, and federal permitting agencies.

The contaminated sediment cleanup process is sometimes time-consuming, often expensive, and usually controversial for dredging proponents, regulators, and the public. Efforts to clean up contaminated sediments have been hindered by the lack of cost-effective, confined disposal options and perhaps the time required to obtain project approval from local, state, and federal permitting agencies. Uncertainty about the liability of sharing potential disposal sites between multiple users has also stalled cleanup efforts.

The overall goal of the Puget Sound Confined Disposal Site Study is to find environmentally sound and practicable solutions to the lack of confined disposal capacity for contaminated sediments. In the absence of such solutions, contaminated sediments will remain in contact with marine life and continue to affect the health of Puget Sound's invertebrate and fish populations. Over the past 20 years, numerous studies have documented the relationship between contaminants in sediments and measurable biological effects (e.g., lesions, tumors) to benthic invertebrates and bottom fish in the Sound's industrial and urban waterways (e.g., Becker et al. 1987; Landahl et al. 1997; Malins et al. 1980, 1982, 1984, 1985; McCain et al. 1983, Myers et al. 1990, 1995a, 1995b, 1998; Stein et al. 1992). The development of viable, regional disposal options for contaminated sediments is a crucial step in reducing these effects.

This National Environmental Policy Act (NEPA)/Washington State Environmental Policy Act (SEPA) Programmatic Environmental Impact Statement (PEIS) has been prepared as part of the Puget Sound Confined Disposal Site Study (Corps 1997a), an interagency effort coordinated by the U.S. Army Corps of Engineers (Corps) and the Washington Department of Ecology (Ecology). Other participating state and federal agencies include the Washington Department of Natural Resources (DNR), the Washington Public Ports Association (WPPA), the Puget Sound Water Quality Action Team (PSWQAT) and Region 10 of the U.S. Environmental Protection Agency (EPA).

The purpose of the PEIS is to evaluate the environmental and economic impacts of various alternatives for addressing the regional contaminated sediment disposal problem. These alternatives include the following:

- No action
- Disposal in constructed confined aquatic, nearshore, or upland multiuser disposal sites (MUDS)
- Disposal in existing solid waste landfills
- Multiuser disposal in large, privately-developed, confined disposal facilities (CDFs)
- Combinations of alternatives.

Due to the volume and distribution of contaminated sediments in Puget Sound, it is unlikely that the regional demand for confined disposal capacity can be met by a single constructed MUDS facility. In addition to the programmatic evaluation of disposal alternatives, this PEIS identifies geographic areas of interest for possible future project-level efforts (Appendix A), outlines a MUDS siting process, and proposes a preliminary set of siting criteria for aquatic, nearshore, and upland multiuser disposal sites (Appendix B).

1.2 NEPA/SEPA STUDY PROCESS

The intent of NEPA is to ensure that environmental considerations are evaluated early in the planning phase before critical decisions are made. The process is intended to help public officials make decisions that are based on an understanding of environmental consequences, and to take actions that protect, restore, and enhance the environment. Washington State's SEPA is modeled after NEPA. As with NEPA, the intent of SEPA is to ensure that environmental values are considered by state and local officials when making their planning decisions.

An Environmental Impact Statement (EIS) prepared under NEPA and SEPA may be either programmatic or project-specific. One purpose of a programmatic, or non-project, EIS is to provide a broad initial environmental review of a program or action to expedite the review process for possible future site-specific projects. Subsequent project-specific EIS(s) can use the programmatic EIS through "tiering" or "phasing" by incorporating and referencing the relevant aspects of the programmatic EIS. Future projects are then able to focus on site-specific issues and impacts.

1.3 PROGRAM BACKGROUND

Preparation of this PEIS is the current phase of a long-term, interagency effort to establish multiuser disposal capacity for contaminated sediments in Puget Sound. Figure 1-1 is a timeline of the major elements that have been conducted as part of this effort. Since 1987, several technical and policy initiatives have focused on management and disposal of dredged material and contaminated sediments. These initiatives are summarized below.

The 1987 *Puget Sound Water Quality Management Plan* (*Puget Sound Management Plan*) (PSWQA 1987), identified the need to study the feasibility and potential demand for multiuser confined disposal sites in Puget Sound. The goal of the *Puget Sound Management Plan* is to reduce and ultimately eliminate adverse effects on biological resources and human health from sediment contamination in Puget Sound by reducing or eliminating discharges of toxic contaminants and by capping, treating, or removing contaminated sediments. The *Puget Sound Management Plan* has nine elements related to contaminated sediments (S-1 through S-9). The Puget Sound Confined Disposal Study and this PEIS is an outgrowth of the work initially completed under Element S-6 of the *Puget Sound Management Plan*, the multiuser confined disposal study.

In 1989, the joint federal/state PSDDA program was implemented. PSDDA established multiuser disposal sites for sediments determined to be suitable for unconfined, open-water disposal based on PSDDA-developed dredged material evaluation procedures. The PSDDA program also produced management plans for each disposal site. The PSDDA program created a workable solution for effectively disposing of dredged material determined to be suitable for unconfined disposal from regional projects. However, it did not address disposal of dredged material that was found to be unsuitable for unconfined disposal based on PSDDA chemical and/or biological sediment testing data.

The PSDDA approach potentially provides a viable interagency framework for managing contaminated dredged sediments in the region. The management plan clearly defines agency (Corps, EPA, Ecology, DNR, and local shoreline jurisdictions) roles and responsibilities that include both individual and cooperative actions consistent with underlying federal, state, county, and municipal authorities (PSDDA 1988, 1989). The plan requires an annual program review that provides the public with an opportunity to review and comment on the program's status (including dredged material evaluation procedures and disposal site monitoring). The continuing success of

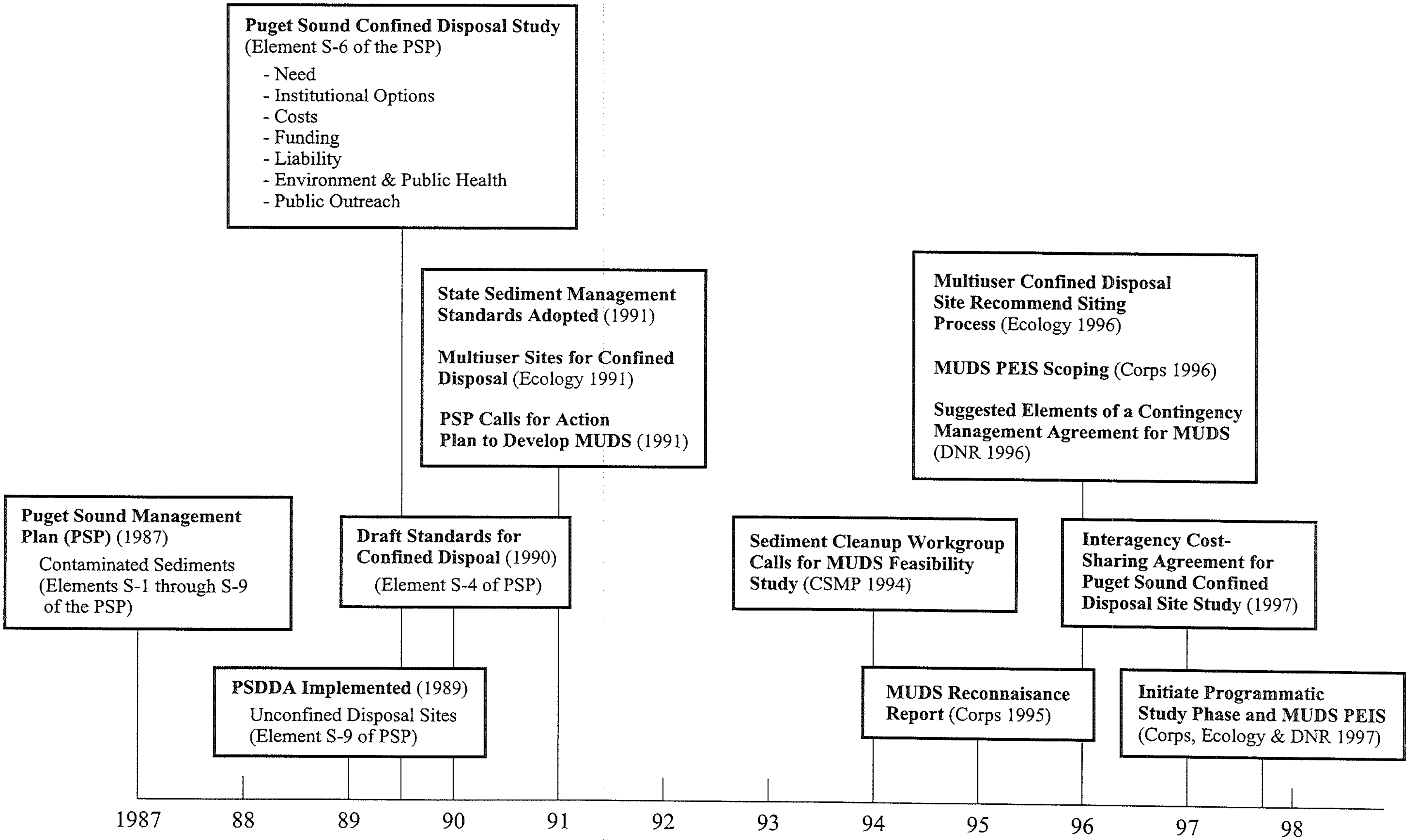


Figure 1-1 Timeline of Major Efforts Leading to the Puget Sound Confined Disposal Site Study PEIS. (Responsible agencies and year of completion are shown in parentheses.)

MUDS Draft PEIS	
Feb 99	MPEIS Figure 1-01.xar

the PSDDA program, now 10 years old, is a reflection of PSDDA agencies' policy support, resource commitment, and technical accountability.[1]

Following PSDDA implementation, federal and state agencies addressed Elements S-4 and Element S-6 of the *Puget Sound Management Plan*. Element S-4 called for the development of confined disposal standards for contaminated sediments in Puget Sound. Ecology (1990a) issued draft documentation which discussed potential sediment evaluation procedures, alternative dredging and disposal techniques, and general disposal site design and monitoring requirements. However, the S-4 standards or guidelines have not been promulgated and remain in draft form.

Element S-6 efforts included preliminary studies to determine the utility and viability of establishing one or more multiuser disposal sites for contaminated sediments. Results of these studies were documented in a series of seven reports examining issues associated with a multiuser disposal site program: 1) need (PTI Environmental Services 1989); 2) institutional options (Fernandes Associates and PTI Environmental Services 1989); 3) costs (Gersham, Brickner & Bratton 1989a); 4) funding mechanisms (CCAinc 1989); 5) liability and management (PTI Environmental Services 1990); 6) environmental and public health (Gersham, Brickner & Bratton 1989b); and 7) public involvement/education (Hall & Associates 1989). Ecology (1991) summarized the finding of these efforts in a report entitled *Multiuser Sites for the Confined Disposal of Contaminated Sediments from Puget Sound.* This summary document concluded that multiuser disposal sites were both needed and viable, and recommended that an action plan be developed for managing and disposing of contaminated sediments. Based on these studies, both the 1991 and 1994 editions of the *Puget Sound Management Plan* called for an action plan to develop of one or more multiuser disposal sites for contaminated sediments.

In 1991, the State of Washington adopted the Sediment Management Standards (SMS). The intent of these standards is to reduce and eventually eliminate adverse effects to the aquatic biological community and the health risk to humans from sediment contamination. The SMS are the basis for managing and reducing pollutant discharges to the aquatic environment, and they provide an evaluation framework and decision process for the identification and cleanup of contaminated sediments.

In May 1994, a group of federal and state agencies signed an interagency agreement for a Cooperative Sediment Management Program (CSMP). The participating agencies included the PSDDA agencies (Ecology, DNR, the Seattle District Corps and EPA Region 10) and PSWQA (now referred to as PSWQAT). The agreement established a coordinated and cooperative program to address many of the pressing concerns of sediment management in Puget Sound. An interagency and stakeholder group, the Sediment Cleanup Work Group, was formed to evaluate and recommend ways to expedite sediment cleanup. The work group issued its final report in December 1994. One of the report's recommendations was to evaluate the feasibility of a MUDS facility.

[1] The PSDDA framework is part of the regional Dredged Material Management Program (DMMP). The DMMP defines dredged material evaluation procedures for coastal Washington regions (e.g., Grays Harbor and Willapa Bay) and the lower Columbia River that are consistent with the approach developed in the PSDDA program for Puget Sound.

In August 1995, the five state and federal agencies responded to the Sediment Cleanup Work Group's recommendations by issuing the *Sediment Cleanup Strategy: An Interagency Overview* (DNR et al. 1995). The agencies identified three goals in this document: 1) provide a new interagency cleanup program to support project decisions through joint policy and technical guideline development, 2) undertake a demonstration project, and 3) create flexible and creative models of State and non-State funding for cleanup. These three goals are being pursued independently, but also in concert with the Puget Sound Confined Disposal Site Study.

In October 1995, the Corps, in cooperation with Ecology, DNR, PSWQAT, EPA, and WPPA drafted the Puget Sound Confined Disposal Site Study Reconnaissance Report (Corps 1997b). Based on a review of regional needs and the federal interest in maintaining navigable waterways, this report recommended proceeding with a cost-shared feasibility study for establishing confined multiuser disposal capacity for contaminated dredged material from Puget Sound. As evidence of agency commitment to this program, the study sponsors initiated three feasibility phase studies during this reconnaissance. Ecology and EPA funded a study that reviewed siting approaches used in a variety of sensitive projects and recommended a siting process for locating suitable and acceptable MUDS for contaminated sediments (PTI and EnviroIssues 1996). This study forms the basis for the siting approach and criteria contained in Appendices A and B of this PEIS. DNR funded a study that investigated liability and contingency management options in developing a MUDS (Marten and Brown 1996); this work forms the basis for the institutional options discussion presented in Appendix D. The Corps led the interagency scoping of this joint NEPA/SEPA PEIS, which resulted in a scoping document identifying the process to be followed in preparing the PEIS and the alternatives to be considered (Striplin Environmental Associates and Parametrix 1996). Section 6.1.1 provides additional details on PEIS scoping.

In 1997, the Corps re-issued the 1995 reconnaissance report, which provided the basis for the cost-sharing agreement between the Corps and non-federal project sponsors signed in July 1997. This agreement initiated the feasibility phase of the Puget Sound Confined Disposal Site Study and the preparation of this PEIS as its first major element. The non-federal co-sponsors of the feasibility study include Ecology, DNR, and PSWQAT. The WPPA and EPA Region 10 signed the agreement as cooperating agencies.

1.4 OBJECTIVES

This NEPA/SEPA PEIS examines the potential environmental impacts and costs associated with different alternatives for the confined disposal of contaminated sediments, and estimates the volume and geographic distribution of those sediments in Puget Sound. Specific objectives of this PEIS include:

- Assess the need for one or more MUDS for contaminated sediments in Puget Sound by estimating the volume, distribution, and cleanup status of contaminated sediments in the region

- Develop planning-level conceptual designs for alternative approaches to the safe disposal of contaminated dredged sediments from multiple sources in Puget Sound
- Provide a programmatic review of the potential environmental impacts and relative costs associated with each of these alternatives
- Identify general upland, nearshore, and aquatic areas throughout the Puget Sound region where a MUDS can be located based on a preliminary screening of existing physical, biological, and land use features, and identify additional site screening criteria to be used in site-specific studies.
- Recommend a siting process for site-specific MUDS studies and a set of preliminary siting criteria for all MUDS
- Identify general elements of contingency management agreement studies
- Recommend elements of a public participation strategy needed for successfully siting a MUDS facility

Provided the programmatic phase concludes that further action is warranted, a site-specific effort will be initiated to evaluate the potential environmental impacts of site-specific alternatives for a selected geographic area of interest in Puget Sound. The site-specific EIS will focus on site-specific disposal options, impacts, policy and regulatory issues, and incorporate by reference the relevant findings of this PEIS.

Finally, it is important to note that this PEIS does not address potential alternative remedies to dredging and confined sediment disposal (e.g., in-place capping and natural recovery), cleanup priorities, or site-specific environmental, land use, and stakeholder concerns. Further, the PEIS discusses sediment quality evaluation procedures and cleanup levels only as needed to address potential environmental impacts and concerns. As warranted, these important issues will be addressed in future, site-specific MUDS efforts or site-specific cleanup studies (see Section 1.6).

1.5 ASSESSMENT OF CONFINED SEDIMENT DISPOSAL NEED

The need to continue the Puget Sound Confined Disposal Site Study beyond the programmatic phase will be determined, in part, by the predicted volume of contaminated sediments in Puget Sound requiring confined disposal. In 1990, Ecology estimated that between 5 and 12 million cubic yards (cy) of contaminated sediments would, if dredged, require confined disposal between 1989 and 2000. Between 1989 and 1998, the actual volume of sediments that were dredged and disposed of in a confined facility was only about 2,000,000 cy. The discrepancy between the volume predicted to require confined disposal and the actual volume dredged and disposed of over this period reflects 1) delays in cleanup project [e.g., Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), MTCA] schedules because of complex technical, policy, and legal issues that require resolution between regulatory agencies and potentially responsible or liable parties before sites are actually cleaned up; 2) redesigned or abandoned dredging plans due to a lack of feasible disposal options for the material found to be unsuitable for PSDDA; and 3) selection of alternative remedies (i.e., in-place capping or natural recovery rather than dredging and disposal) as part of the remedial action.

1.5.1 Estimated Volumes of Contaminated Sediment Requiring Confined Disposal

Contaminated sediments in Puget Sound may be dredged as part of aquatic site cleanups, navigation and maintenance dredging, and waterfront development and restoration projects. The ports, waterfront industrial and commercial businesses, municipalities, the U.S. Navy, and the Corps (federal navigation projects) are responsible for the dredging. Historically, greater than 80 percent of the contaminated dredged material has come from an average of only five to six projects per year; with a large number of small projects contributing relatively minor amounts to the total contaminated dredged material volume (PTI 1989).

For this PEIS, historic and current information on site cleanup projects and estimated distribution and volumes of all known contaminated sediments was compiled in an effort to predict the confined disposal capacity needed in the Puget Sound region . Several data sources were used, including Ecology's contaminated site list, information on dredging projects compiled by the Corps [Dredged Analysis Information System (DAIS) database], and correspondence with the staff of Washington's ports, the Corps, Ecology, EPA, and the Navy. The results of this compilation are described below.

1.5.1.1 Contaminated Sediment Site Cleanups

Contaminated sediments may need to be removed and disposed in a confined facility as part of sediment cleanup projects. Based on Ecology's list of contaminated sediment sites in Puget Sound (Ecology 1996), and more recent information (Gries 1998, Friedman-Thomas 1997), Ecology and EPA site managers were contacted for information on the sediment cleanup status at these sites and the potential need for confined sediment disposal. Even though program and site-specific regulatory/legal issues would need to be addressed, for the purposes of this PEIS it was assumed that sediments from both state (MTCA) and federal (CERCLA) Superfund sites could be placed in a MUDS facility if one was available. Table 1-1 lists the contaminated sites, the cleanup authority, the planned remedial actions (if known), and the estimated volume of contaminated sediments likely to require confined disposal.

The unshaded rows in Table 1-1 show contaminated sediment sites for which a MUDS may be an option based on current project schedules (i.e., cleanup is not likely to occur before 2003, the earliest a constructed MUDS facility might be available for use). Estimates of the total volume of contaminated dredged material from these sites range from 1.8 to 7.7 million cy. The low estimate is based on an assumption that one-half of the contaminated area at each site will need to be dredged to a depth of 2 ft below mudline, on average, while the high estimate is based on an assumed average dredge depth of 4 ft across the entire contaminated area. While this volume range represents reasonable low and high estimates for needed MUDS capacity, uncertainty in these volumes comes from the following:

- It is likely that the true areal extent of contaminated sediments at most sites will change as additional testing, sediment characterization, and remedial design efforts are conducted.
- The estimates assume that contaminated areas will be dredged to a depth of 2 ft over one-half of the area or 4 ft over the entire area, respectively. In reality, the depth of contamination can

Table 1-1. Estimated Volumes of Contaminated Sediments at Puget Sound Sites.[1] (Shaded rows are projects likely to be remediated prior to establishment of a MUDS.)

Region/Site Name	Location	Cleanup Authority	Contaminated Area (sq.ft)[2]	Cleanup Method (NR = Natural Recovery)	Min. Estimated Dredge Volume (cubic yards)[3]	Max. Estimated Dredge Volume (cubic yards)[4]	Target Cleanup Date	Comment
BELLINGHAM BAY - BELLINGHAM								
Whatcom and I&J WW	Bellingham Bay	MTCA	4,250,000	Some Dredging/Rest Unknown	240,000	1,600,000	BBPP	Bellingham Bay Pilot Study
Georgia-Pacific Outfall	Bellingham Bay	NPDES	1,400,000	Unknown	part of above estimate		BBPP	Bellingham Bay Pilot Study
Harris Avenue Shipyard	Bellingham Bay	Not yet assigned	900,000	Unknown	part of above estimate		BBPP	Bellingham Bay Pilot Study
Intalco	Bellingham Bay	MTCA/NPDES?	2,097,000	Unknown	78,000	311,000	Unknown	
PORT GARDNER - EVERETT								
Mukilteo	Port Gardner	MTCA	1,074,000	Source Control/Unknown	40,000	159,000	Unknown	
Mill E/Koppers	Everett-Port Gardner	MTCA	2,000,000		–		–	No further action - delisted
North East Waterway	Everett	WPCA	581,000	Unknown	22,000	86,000	Unknown	
South Terminal	Everett	Not yet assigned	1,186,000	Unknown	44,000	176,000	Unknown	
South East Waterway	Everett	Not yet assigned	316,000	Unknown	12,000	47,000	Unknown	
Scott Paper Mill	Everett	Not yet assigned	Unknown	Unknown	Unknown	Unknown	Unknown	
ELLIOTT BAY/LAKE WASHINGTON - SEATTLE								
EB1 (Harbor Island)	Elliott Bay	CERCLA	519,000	Unknown	19,000	77,000	Unknown	
EB2 (Harbor Island)	Elliott Bay	CERCLA	397,000	Dredge/Nearshore fill/Cap	15,000	59,000	Unknown	
EB3 (Todd/Lockheed)	Elliott Bay	Partial CERCLA	3,353,000	Partial dredge/Cap/Disposal unknown	250,000	500,000	Unknown	
EB5 (Todd/Lockheed)	Elliott Bay	MTCA/CERCLA	859,000	Nearshore Fill	130,000	1,175,000	Unknown	
EB6 (Wykcoff West Seattle)	Elliott Bay	CERCLA	495,000	Unknown	18,000	73,000	Unknown	
EB7 (East Waterway)	Elliott Bay	MTCA	523,000	Unknown	460,000	460,000	Unknown	
EB8 (Harbor Island)	Elliott Bay	Partial CERCLA	1,649,000	Unknown	61,000	244,000	Unknown	
EB9 (East Waterway)	Elliott Bay	Not yet assigned	114,000	Unknown	part of EB7		Unknown	
EB10 (Harbor Island)	Elliott Bay	CERCLA	790,000	Unknown- No Further Action?	29,000	117,000	Unknown	
EB11 (Harbor Island)	Elliott Bay	CERCLA	286,000	Dredge/Landfill/Cap	11,000	42,000	Unknown	
EB12 (Harbor Island)	Elliott Bay	CERCLA	1,196,000	Unknown	44,000	177,000	Unknown	
EB13 (Harbor Island)	Elliott Bay	Not yet assigned	264,000	Unknown	10,000	39,000	Unknown	
EB17 (East Waterway)	Elliott Bay	Not yet assigned	823,000	Unknown	part of EB7		Unknown	
EB18 (Pier 48 - 52)	Elliott Bay	MTCA	676,720	Unknown	25,000	100,000	Unknown	
EB23 (Seacrest Park)	Elliott Bay	Not yet assigned	624,000	Unknown	23,000	92,000	Unknown	
EB26 (Denny Way)	Elliott Bay	WPCA	105,000	Unknown	4,000	72,000	Unknown	
EB27 (Pier 46 - 48)	Elliott Bay	WPCA	71,000	Unknown	3,000	11,000	Unknown	
EB28 (Colman Dock-Pier 58)	Elliott Bay	NRDA/ Not yet assigned	557,058	Unknown	21,000	83,000	Unknown	
DR29 (south of Harbor Island)	Duwamish River	Not yet assigned	1,220,000	Unknown	45,000	181,000	Unknown	
DR31 (Duwamish/Diagonal CS	Duwamish River	MTCA	109,000	Dredge/Upland Dispose/Backfill	4,000	16,000	Unknown	
DR32 (Brandon Street CSO)	Duwamish River	WPCA	66,000	Unknown	2,000	10,000	Unknown	
DR30 (PCBs)	Duwamish River	Not yet assigned	5,030,000	Unknown	186,000	745,000	Unknown	
Boeing Plant 2	Duwamish River	RCRA	1,000,000	Unknown	37,000	148,000	Unknown	
DR34 (Slip 3, MP&E)	Duwamish River	Not yet assigned	319,000	Unknown	12,000	47,000	Unknown	
DR36 (Duwamish Shipyard)	Duwamish River	Not yet assigned	90,000	Unknown	3,000	13,000	Unknown	
Salmon Bay	Ship Canal	Not yet assigned	Unknown-large	Unknown			Unknown	
Northlake Shipyard	Lake Union	MTCA	1,400,000	Dredge/dispose sandblast grit	52,000	207,000	Unknown	

Table 1-1. Estimated Volumes of Contaminated Sediments at Puget Sound Sites.[1] (Shaded rows are projects likely to be remediated prior to establishment of a MUDS.)

Region/Site Name	Location	Cleanup Authority	Contaminated Area (sq.ft)[2]	Cleanup Method (NR = Natural Recovery)	Min. Estimated Dredge Volume (cubic yards)[3]	Max. Estimated Dredge Volume (cubic yards)[4]	Target Cleanup Date	Comment
Lakepoint	Lake Union	MTCA	50,000	Unknown	2,000	7,000	Unknown	
Metro Lake Union	Lake Union	MTCA	500,000	Unknown	19,000	74,000	Unknown	
Gas Works Park	Lake Union	Not yet assigned	2,250,000	Unknown	83,000	333,000	Unknown	
Quendall-Baxter	Lake Washington	MTCA	Unknown	Dredge/Upland Disposal	83,000	83,000	3 years?	--
Port Quendall	Lake Washington	MTCA	588,000	Dredge/Nearshore Fill ?	22,000	87,000	Unknown	
SINCLAIR INLET - BREMERTON								
Eagle - East OU 1	Eagle Harbor	CERCLA	1,470,000	Cap/NR	--		Unknown	No dredging planned.
Eagle - East OU 2	Eagle Harbor	CERCLA	1,470,000	Cap/NR	--		Unknown	No dredging planned.
Manchester Annex	Central Puget Sound	CERCLA	300,000	Thin Layer Cap/Local Upland Fill minimal intertidal material	10,000	10,000	Unknown	Project specific disposal site
Jackson Park	Dyes Inlet	CERCLA/MTCA	7,363,000	Thin layer Capping	--		Unknown	No dredging planned.
Keyport - Liberty1	Liberty Bay	CERCLA	1,035,000	Unknown	--		Unknown	Status Unknown
Keyport - Liberty2	Liberty Bay	CERCLA	521,595	Unknown	--		Unknown	Status Unknown
Keyport - Tide Flats	Liberty Bay	CERCLA	1,175,000	NR/Monitoring	--		Unknown	No dredging planned.
Bremerton Evergreen Park	Bremerton	MTCA	100,000	Unknown	4,000	15,000	Unknown	
Sinclair East	Bremerton	CERCLA and MTCA	5,793,000	Dredge/Dispose/Cap	215,000	858,000	Unknown	
Sinclair West	Bremerton	CERCLA and MTCA	11,607,000	Dredge/Dispose/Cap	430,000	1,720,000	Unknown	
COMMENCEMENT BAY-TACOMA								
Lake Hancock	Unknown	MTCA	300,000	Unknown	45,000	45,000	Unknown	Accessibility to MUDS location?
Goose Lake	Mason County	MTCA	Unknown	NR	--		--	Accessibility to MUDS location?
CB1 - Asarco	Commencement Bay	CERCLA	8,928,000	Dredge/Upland Disposal/NR/Cap	160,000	260,000	Unknown	Most to be capped
CB2 - Thea Foss WW	Tideflats	CERCLA	4,486,000	Dredge/Disposal/NR/Cap	425,000	425,000	3-5 years	Project specific disposal site
CB3 - Hylebos WW	Tideflats	CERCLA	8,362,000	Dredge/Disposal/NR	400,000	1,200,000	3-5 years	Project specific disposal site
CB4 - Middle WW	Tideflats	CERCLA	561,000	Dredge/Disposal/NR	60,000	60,000	3-5 years	Project specific disposal site
BUDD INLET-OLYMPIA								
Midwest	Budd Inlet	Not yet assigned	703,000	Unknown	26,000	104,000	Unknown	
Cascade Pole	Budd Inlet	MTCA	380,000	Dredge/Upland Dispose/Cap	14,000	40,000	Unknown	
TOTAL VOLUMES (All Projects):					**3,898,000**	**12,388,000**		

NR = Natural Recovery
[1] Site list information from Ecology (1996) and Ecology "site tool" (Friedman-Thomas 1997).
[2] Areas are estimates; many sites have not been completely characterized.
[3] If no project-specifc volume available, estimate calculated by assuming a dredging depth of 2 feet across one-half of the contaminated area.
[4] If no project-specific volume available, estimate calculated by assuming a dredging depth of 4 feet across the entire contaminated area.

be quite variable at a given site, and could be less or more than these assumed minimum and maximum values.

- The estimates assume that at sites currently having no remediation plan some contaminated sediments will be removed for confined disposal. As demonstrated by completed and on-going remedial actions, remediation can include non-removal options such as in-place capping and natural recovery. Often, a combination of different actions is used to remediate a single site.
- Although all major urban embayments have been fairly well surveyed and the majority of contaminated sites have been identified, it is probable that the current list does not represent all contaminated sediments that are present in Puget Sound. As other areas are studied, additional contaminated sediment areas may be identified.
- Over the last 10 to 15 years, source control requirements have reduced the contaminant discharge loads throughout Puget Sound and surface sediment quality will improve in some areas as cleaner sediments are deposited over previously contaminated areas.
- Conversely, is also possible that in some areas ineffective source control, non-point source pollution, or accidental spills and releases of materials could create new contaminated sites or recontaminate sites that had been cleaned up.
- Sediment quality standards may be modified over time as warranted by new technical information. To date, most changes have resulted in less restrictive standards (higher numerical guidelines) that might reduce the volume of material requiring confined disposal. However, the adoption of stricter water quality and/or sediment criteria (e.g., human health criteria) could increase the volume of material requiring confinement.

The shaded rows in Table 1-1 list contaminated sediment cleanup projects that will not likely use a MUDS because they either already have or will develop project-specific disposal options prior to MUDS establishment (i.e., before 2003). Nonetheless, these projects are compiled here to fully address regional disposal needs (many of these projects were included in past MUDS needs assessments) and because some portion of this material could be disposed of at a MUDS if project delays occur. The total estimated volume of material requiring dredging and confined disposal from these projects ranges from about 2.1 to 4.6 million cy. Unlike the volume estimates in the unshaded rows of Table 1-1, these estimates are based on relatively detailed site evaluations and remedial design planning and are assumed to accurately bound the confined disposal volume need.

1.5.1.2 Navigation and Maintenance Dredging Projects

Navigation and maintenance dredging is conducted by the Corps and other federal and state agencies, local governments, ports, and the private sector, including marina owners, industries, and private developers. In Puget Sound, all sediments targeted for dredging and open-water disposal must be evaluated and issued a suitability determination under the PSDDA program as part of the federal and state permitting process.

Since the PSDDA program's inception in 1989, approximately 9.3 million cy of dredged material have been characterized. Of this total, 703,000 cy, or 7.6%, proved to be unsuitable for unconfined, open-water disposal at a PSDDA site (Fox 1997). This represents an average of about 80,000 cy that could be placed at a MUDS annually. For planning purposes, it was assumed that the volume of sediments from future dredging projects that will require confined disposal will continue to average about 80,000 cy annually. This is because, although the completion of on-going or planned cleanup projects and the implementation of improved source control should reduce contaminant inputs to the Sound, future dredging projects will likely encounter more contaminated material as proponents conduct PSDDA testing in more problematic areas (during the first 10 years of PSDDA implementation, the areas tested, in general, were believed to be relatively uncontaminated).

Over a 10-year planning horizon (2003 to 2013), this represents an additional 800,000 cy of material that will require confined disposal. Port expansion and maintenance dredging projects will likely account for about 50% of this total. Federal navigation channel maintenance dredging by the Corps will account for another 25%, and the remainder will be generated by all other navigation dredging proponents combined (e.g., private industry, marinas, and other government entities).

1.5.1.3 Waterfront Construction/Development and Habitat Restoration Projects

Waterfront construction projects, property transfer site assessments, and habitat restoration projects can encounter contaminated sediments that require confined disposal. These projects are not typically part of established cleanup or dredging projects and so represent an additional source of contaminated materials. Because dredging needs vary widely from project to project, it is difficult to assign an average annual volume of sediments that would arise from these activities. For planning purposes in the PEIS, these type of activities were estimated to generate 20,000 cy of material annually that requires confined disposal. Over the 10-year planning horizon (2003 to 2013), this represents an additional 200,000 cy of contaminated sediment.

1.5.1.4 Summary of Puget Sound Confined Disposal Need

Table 1-2 summarizes the predicted sediment volumes requiring confined disposal from on-going cleanup projects, identified contaminated sites, anticipated navigation and maintenance dredging projects, and waterfront development and habitat restoration projects over the 10-year planning horizon (2003 to 2013). The estimates have been rounded to the nearest 0.1 million cy. Also, an additional 1 million cy estimate has been included to account for: 1) contaminated sediment sites that may exist in Puget Sound but have not yet been identified; 2) sediments that might become contaminated or recontaminated due to accidental contaminant releases to the aquatic environment; and 3) the possible future adoption of stricter sediment quality standards (e.g., human health criteria) that could increase the volume of dredged material that fails to qualify for unconfined disposal.

These volume estimates are similar to those documented previously (PTI 1989). Through the year 2013, and accounting for the volume that will likely be cleaned up before a MUDS is available, from 4 to 10 million cy of contaminated sediments dredged from Puget Sound will require confined disposal.

Table 1-2. Predicted Volumes of Sediments in Puget Sound Requiring Confined Disposal Through the Year 2013.

Project Category	Projected Volume Range (cy)
On-going Cleanup Projects[1]	2.1 to 4.6 million
Other Contaminated Sites	1.8 to 7.7 million
Navigation and Maintenance Dredging	0.8 million
Waterfront Development/Habitat Projects	0.2 million
Contaminated Sediments Yet to be Identified[2]	1.0 million
Grand Total	**5.9 to 14.3 million**
Total Volume Likely Available for a MUDS	**3.9 to 9.7 million**

[1] Volumes likely to be cleaned up prior to MUDS establishment (i.e., 2003).

[2] Includes as yet undiscovered contaminated sites, recontaminated areas, and additional contaminated sediment volumes due to the adoption of stricter standards.

As existing contaminated areas are cleaned up (themselves a possible source of contamination to adjacent areas) and as improved source control efforts take effect throughout Puget Sound, it is reasonable to assume that the input of contaminants to Puget Sound will decrease over the project planning horizon. In addition, natural processes such as sedimentation (burial) and chemical and biological degradation should naturally reduce contaminant levels in some surface sediments. Therefore, although some as yet unknown contaminated sites may be identified and some recontamination may occur, a significant long-term (i.e., beyond 2013) decrease in contaminated sediment disposal needs is anticipated once the sediments identified here are addressed.

1.5.2 Distribution of Contaminated Sediments in Puget Sound

Table 1-3 lists the projected contaminated sediment volumes by region from all existing cleanup sites and from just those sites still likely to need remediation when a MUDS becomes available. The majority of the contaminated sediments are located in Puget Sound's south-central urban/industrial embayments. Considering all existing sites, about 44% of the contaminated sediment volume is located in the Elliott Bay/Seattle/Lake Washington area (including the Ship Canal and Lake Union). Another 21% is located in the Sinclair Inlet/Bremerton area and 20% is found in Commencement Bay. About 10% is in the Bellingham Bay region and the remaining relatively minor volumes are found in Port Gardner (4%) and Budd Inlet (1%). Because the Sinclair Inlet area is geographically close to the Elliott Bay region, about two-thirds of Puget Sound's contaminated sediments are situated in this central Puget Sound area. Considering only the volumes still likely to need remediation beyond 2003, the earliest date a MUDS could practically be established, the percentage regional distribution of material changes. Approximately 54% of this material is located in the Elliott Bay region, with another 34% situated in the nearby Sinclair Inlet region. Only relatively minor volumes are present in other regions (6% in Port Gardner, 4% in Bellingham Bay, and 2% in Budd Inlet).

The Corps (1997b) estimated a similar distribution for contaminated sediments from navigation and maintenance dredging projects, with two-thirds of the total situated in the central Puget Sound area (Elliott Bay and Sinclair Inlet areas combined). The remaining material was relatively evenly distributed among Commencement Bay (Tacoma), Port Gardner (Everett) and north and south Puget Sound. Based on PSDDA permits from the late 1980s, PTI (1989) also concluded that about two-thirds of the contaminated material identified in dredging projects was located in Elliott Bay and vicinity, and the remaining material was distributed among other areas of central, northern, and southern Puget Sound.

1.5.3 Range of Contamination in Puget Sound Sediments

The levels and type of contamination in dredged material from Puget Sound will ultimately determine both the volume of sediments requiring confined disposal and the specific design requirements for the confined disposal facilities. Unfortunately, most of the sediments that may be considered for MUDS disposal (see Table 1-1) have not yet been completely characterized,

Table 1-3. Regional Distribution of Contaminated Sediments from Puget Sound Cleanup Sites (see Table 1-1).

Region/Embayment	Projected Volume (cy)	Projected Volume Available for MUDS	Total (Range)	Percent of Total Likely Available for MUDS[1]
Bellingham Bay	0.3 to 1.9 million	0.08 - 0.3	8-15%	4%
Port Gardner/Everett	0.1 to 0.5 million	0.1 - 0.5	3-4%	6%
Elliott Bay/Lake Washington/Seattle	1.7 to 5.3 million	1.0 - 4.2	43-44%	54%
Sinclair Inlet/Bremerton	0.7 to 2.6 million	0.6 - 2.6	18-21%	34%
Commencement Bay	1.0 to 2.0 million	0	16-26%	0%
Budd Inlet/Olympia	0.04 to 0.1 million	0.04 - 0.1	~1%	2%

[1] Percentage of totals included in unshaded columns of Table 1-1.

nor have evaluation procedures and standards for confined disposal been developed.[2] As a result, a discussion of the range of contamination that may be placed at a MUDS must remain general at this time. *As part of future MUDS efforts, however, a program framework will need to be developed that thoroughly defines contaminated sediment evaluation procedures, confined disposal suitability criteria, and alternative site-specific design features. This framework will expand upon the concept level approaches used in this PEIS.*

It is known that sediments to be disposed at a MUDS will not be suitable for PSDDA open-water disposal and will not be classified as dangerous waste under WAC 173-303. Within these boundaries, there is a broad range of contamination levels that could be considered for MUDS disposal and this range of contamination could require a range of MUDS design features. Figure 1-2 illustrates this contamination range relative to Ecology's draft S-4 standards and the MUDS designs presented in this PEIS.

For the conceptual designs in this PEIS, it was assumed that the MUDS alternatives would accept material from the maximum PSDDA levels up to higher levels of contamination than those defined for the S-4 functional designs, but still well below levels that approach Dangerous Waste (Palermo et al. 1998). This is based on a presumption that most dredged material in Puget Sound requiring confined disposal is only slightly more contaminated than the maximum PSDDA levels (Ecology 1990a), (i.e. is at the low end of the contaminant range shown in Figure 1-2). As a general confirmation of this presumption, an examination of some existing sediment quality data from Puget Sound was conducted.

Contaminant levels in Puget Sound sediments were examined using Ecology's sediment quality database (SEDQUAL). SEDQUAL contains quality-assured data from numerous sediment investigations throughout Puget Sound. Based on a review of these data, most of the contaminated sediments in Puget Sound do appear to be near the low end of the possible contamination range (i.e., only slightly exceeding PSDDA limits). Table 1-4 summarizes statistics for all chemicals of concern detected in over two-thirds of the Puget Sound surface and subsurface sediment samples contained in SEDQUAL. This list of chemicals includes several metals and hydrocarbon compounds, a phthalate, and total polychlorinated biphenyls (PCBs). (Two-thirds was arbitrarily chosen as a cutoff to identify chemicals of concern which are widespread in Puget Sound samples.)

The left portion of Table 1-4 lists the number of samples, median (the middle value or midpoint when the data are arranged in order) and the 95th percentile concentration (95% of the values in the data set are below this concentration) for each chemical. For comparison purposes, the PSDDA maximum level (ML) is also included. With the exception of benzo(a)pyrene, the 95th percentile value for each chemical is less than the PSDDA ML. This indicates that the levels of most compounds in most Puget Sound samples are below or only slightly above the level that defines the high end of PSDDA suitability based on sediment chemistry. *This supports the view*

[2] Per element S-4 of the Puget Sound Plan, Ecology (1989, 1990a, 1990b) drafted confined disposal standards, but these have not been updated or formally adopted.

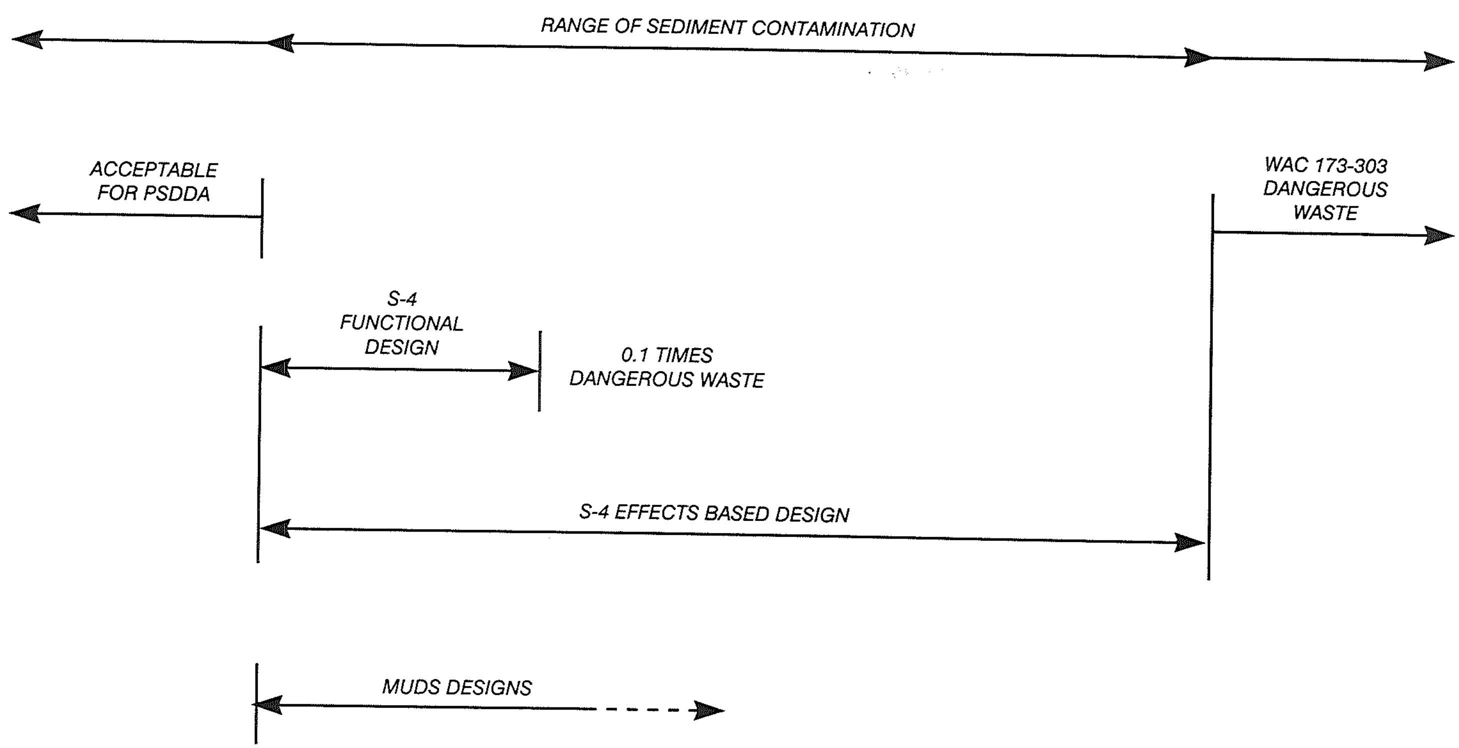


Figure 1-2 Range of Sediment Contamination Considered for MUDS Program. The general contamination levels assumed for the MUDS conceptual designs and the draft S-4 standards (Ecology 1990a) are indicated.

MUDS Draft PEIS | Feb 99 | MPEIS Figure 1-02.xar

Table 1-4. Summary Statistics for Chemicals Detected in Over Two-Thirds of Puget Sound Samples[1].

Chemical	All SEDQUAL Data Number of Samples	All SEDQUAL Data Median	All SEDQUAL Data 95th Percentile	PSDDA ML	Data ≥ 95th Percentile Number of Samples	Data ≥ 95th Percentile Median
Metals (mg/kg, dry weight)						
Antimony	1,801	2.2	56.0	200	91	126
Arsenic	3,498	11	102	700	177	404
Cadmium	2,896	0.7	6.5	14.0	148	7.9
Copper	3,814	53	439	1,300	192	1,025
Lead	3,779	38	486	1,200	189	1,070
Mercury	3,188	0.2	1.8	2.3	80	4.3
Nickel	3,189	30	71	370	166	102
Silver	2,229	0.4	3.6	8.4	112	5.9
Zinc	3,829	100	777	3,800	192	1,935
Organics (μg/kg, dry weight)						
Anthracene	2,550	130	3,180	13,000	127	8300
Fluorene	2,047	84	2,300	3,600	106	5850
Phenanthrene	2,823	260	6,000	21,000	138	15,500
Benzo(a)anthracene	2,545	230	4,800	5,100	127	9,300
Benzo(a)pyrene	2,584	240	4,000	3,600	131	6,824
Benzo(b)fluoranthene	1,149	540	6,271	9,900[2]	58	9,050
Benzo(k)fluoranthene	1,093	450	5,580	--	55	8,000
Benzo(g,h,i)perylene	1,826	150	2,274	3,200	92	3,850
Chrysene	2,834	342	6,400	21,000	142	11,000
Fluoranthene	3,021	440	9,900	30,000	153	23,000
Indeno(1,2,3-c,d)pyrene	2,106	150	2,200	4,400	103	3,900
Pyrene	3,028	490	10,264	16,000	152	20,000
Bis(2-ethylhexyl)phthalate	1,714	198	4,200	--	90	7,600
Total PCBs	1,156	95	1,500	3,100	56	3,180

[1] Sediment chemical data were downloaded from SEDQUAL for all of Puget Sound; only detected values were compiled.

[2] Guideline values apply to Total Benzo(b+k)fluoranthenes only.

that most of the material that would be considered for MUDS disposal exhibits low contamination levels relative to the broad potential range of sediment contamination illustrated in Figure 1-2.

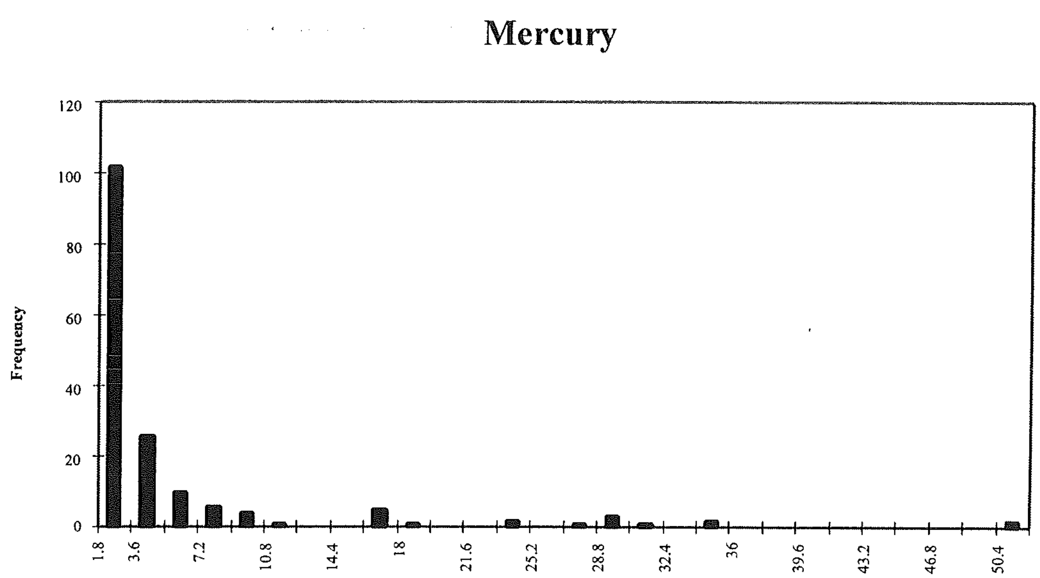
Because the SEDQUAL database contains samples from both uncontaminated areas and contaminated sites, however, the fact that the 95th percentile concentrations are less than the PSDDA MLs is possibly misleading as the material disposed at a MUDS would likely come from the high end of the SEDQUAL range (i.e., values approaching or exceeding the 95th percentile concentration). To explore this further, the number of samples and median for only those concentrations that exceed the 95th percentile concentration value are compiled on the right side of Table 1-4. In most cases (16 of the 23 chemicals), the 95th percentile median concentrations are still less than the PSDDA ML. For the other seven chemicals, the 95th percentile median concentrations are always less than twice the PSDDA ML.

To examine this graphically, histograms of the data greater than or equal to the 95th percentile for mercury and total PCBs are plotted in Figure 1-3 (the 95th percentile median concentration for these two chemicals exceeds the PSDDA ML). These plots show the frequency distribution of the most highly contaminated mercury and PCB samples in the SEDQUAL database. Consistent with the tabulated data, these plots illustrate that most of the measured concentrations are clustered near the 95th percentile value, while markedly higher values are scattered and few. *Again, this supports the inference that the majority of contaminated sediments in Puget Sound that will require confined disposal will very likely exhibit contamination levels close to the PSDDA MLs and well below levels that approach dangerous waste per WAC 173-303.*

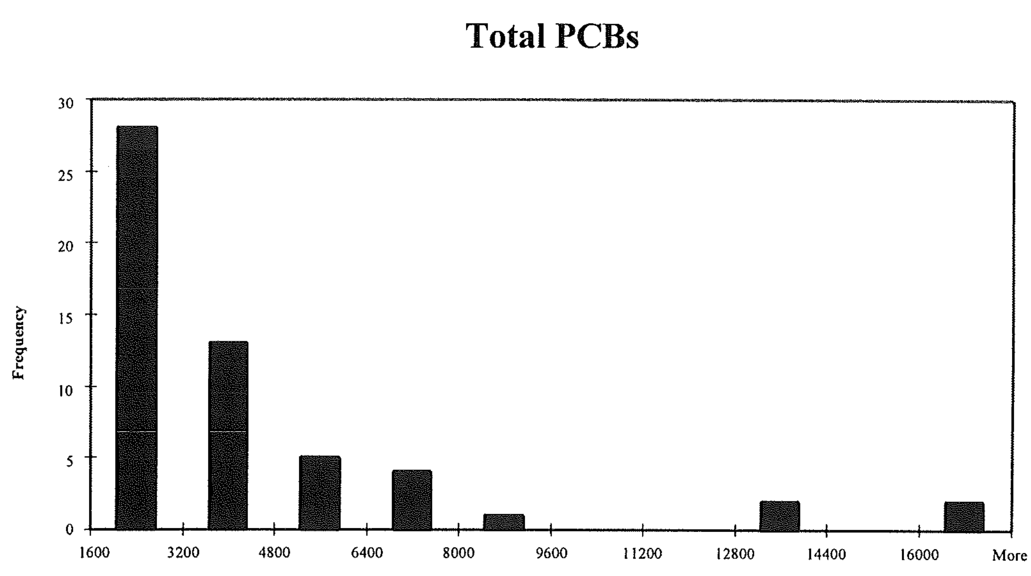
1.6 INSTITUTIONAL, PLANNING, AND REGULATORY NEEDS

This PEIS evaluates the impacts and practicability of several alternative confined disposal options for addressing the contaminated sediment disposal problem in Puget Sound. However, it is important to recognize that significant additional environmental review and technical studies will be needed if the establishment of a confined disposal facility is pursued. In addition to site-specific siting and design studies, the institutional and regulatory frameworks for siting, funding, permitting, operating, and closing a MUDS need to be established. Some progress in these areas has been made (Marten & Brown 1996, see Appendix D) and work is ongoing. Moreover, even absent pursuit of a MUDS facility, there are still significant institutional and management needs that could be addressed to improve the management of contaminated sediments in Puget Sound.

Table 1-5 lists the institutional and management needs associated with the Puget Sound Confined Disposal Study, whether or not a MUDS is built. Appendix D summarizes the range of contingency management and institutional options for a MUDS that have been defined previously (Marten and Brown 1996, Fernandes Associates and PTI 1989). If the site-specific phase of the Puget Sound Confined Disposal Study is conducted, institutional arrangements between the stakeholders in the study area will need to be defined. The specific arrangement (e.g., who owns or operates a MUDS) might vary depending on the region and range of



Mercury Concentrations in mg/kg, dry weight (≥ 95th Percentile, 1.8 mg/kg).



Total PCBs Concentrations (≥ 95th Percentile, 1,500 ug/kg). Concentrations greater than 16,000 µg/kg are plotted in the More category.

Figure 1-3 Frequency Distribution of Mercury (top) and PCBs (bottom) Values in SEDQUAL that are ≥ 95th Percentile Concentration	MUDS Draft PEIS February 1999 MPEIS Figure 1-03.xar

Table 1-5. Elements of the Puget Sound Confined Disposal Study

	Environmental Review	Technical Studies	Institutional and Planning Needs
Feasibility Phase	- Programmatic EIS - Alternatives evaluation - Identify GAIs - Recommend preliminary siting criteria and process - Select preferred conceptual alternative(s)	- Disposal options technical assessment (WES) - Preliminary siting criteria	- Establish study team and executive committee
Site-specific Phase (if regulatory solutions are pursued with or without a MUDS)	- Pursue regulatory solutions alternative; if selected, address conflicts and acknowledge need in existing regulations and guidance documents	- Define evaluation procedures for material failing PSDDA	- Define interagency process for managing contaminated sediments - Resolve agency mission and mandate conflicts (e.g., disposal and land use policies)

Site-Specific Phase (if a MUDS is to be established)	- Site-Specific EIS
	- Alternatives evaluation
	- Select preferred alternative(s)
		- Adopt siting criteria
		- Identify candidate sites
		
		- Define evaluation procedures and performance criteria
		- Conduct field/feasibility studies, as needed
			- Establish regional siting partnership
			- Finalize siting process
			
			- Develop institutional framework for managing MUDS
			- Manage risk and liability (Contingency Management Agreement)
			
			- Establish MUDS management plan(s)
			  - Establish agency roles and responsibilities
			  - Suitability determination process
			  - Site monitoring plan(s)
			  - Data management and review process

MUDS Design and Construction	- Obtain regulatory permits and land use authorizations	- Design and Build Facility	- Implement evaluation process - Conduct site monitoring and review

alternatives selected. Under most scenarios, it is likely that the following elements will need to be developed:

- Siting process that includes all stakeholders
- Institutional arrangements for disposal site management (i.e., establish roles and responsibilities to cover funding, permitting, site operation and management)
- Regulatory requirements and legislative actions, if needed
- Liability and contingency management plans
- Sediment evaluation procedures and disposal site performance standards
- Site management plans for operation, monitoring, and closure.

In order to conduct the programmatic environmental review, some of the following PEIS sections presume that these confined disposal program elements are in-place and effective.

2.0 ALTERNATIVES

Seven alternatives for addressing the contaminated sediment disposal problem in Puget Sound were identified during project scoping (see Section 6.1). This section describes the alternatives in sufficient detail to allow planning level evaluation and comparison of their environmental impacts and relative costs. The alternatives include:

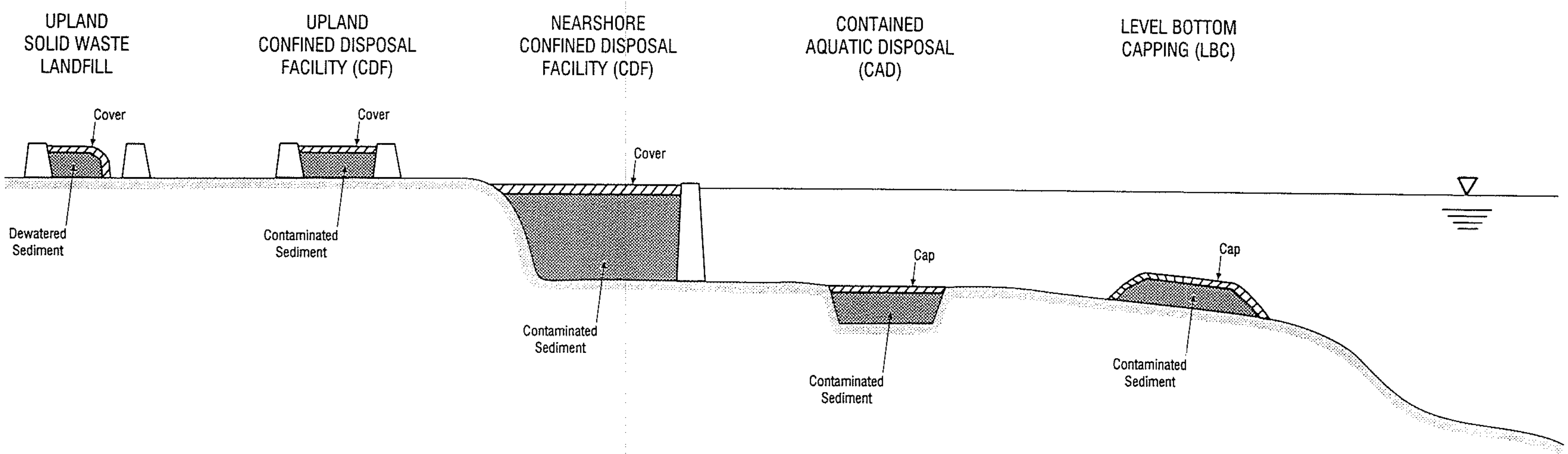
- No action
- Level bottom capping and contained aquatic disposal
- Nearshore confined disposal
- Upland confined disposal
- Solid waste landfills disposal
- Multiuser access to privately developed confined disposal projects
- Combinations of the above alternatives

For each constructed alternative (offshore, nearshore and upland confined disposal), conceptual designs were developed in this PEIS to allow more thorough and complete evaluation. In developing the conceptual designs, it was necessary to make assumptions about the design, shape, layout, capacity, and operational life of each facility. Basic assumptions common to all alternatives included capacity (500,000 cy and 2,000,000 cy) and operating period (10 years). Additional specific assumptions were made within each alternative. While the resulting alternatives presented in this PEIS are considered plausible scenarios for a Puget Sound MUDS, it is important to note that there may be many other realistic design and operational options that are not considered in this PEIS. If other feasible configurations are identified, they will be evaluated during site-specific efforts.

In the following sections, for each of the four basic types of confined disposal facilities (level bottom capping and contained aquatic disposal, nearshore, upland, and solid waste landfill), general design features are described first, followed by more specific conceptual design and cost estimates. The two types of aquatic disposal, level bottom capping and contained aquatic disposal, have similar characteristics and so are discussed as one alternative. A conceptual illustration of the confined alternatives is shown in Figure 2-1. Additional information on design elements, design development and evaluation, and performance standards for the constructed aquatic, nearshore, and upland alternatives is contained in Palermo et al. (1998a).

2.1 NO-ACTION ALTERNATIVE

For the no-action alternative, the potential environmental impacts from contaminated dredged material disposal are evaluated under the existing framework of regulations and options. No new MUDS would be established. Contaminated dredged material disposal



SOURCE: Based on Palermo et al. 1998a

Figure 2-1 Conceptual Illustration of Confined Disposal Alternatives

MUDS Draft PEIS
Feb 99
MPEIS Figure 2-1.xar

would continue as it is currently done: confined disposal facilities would be developed by individual users on a project-by-project basis and some contaminated dredged material would be transported to landfills.

Under current regulations, contaminated sediment dredging and disposal occurs as part of: 1) navigation or maintenance dredging projects; 2) contaminated sediment site cleanup; or 3) in-water construction and habitat restoration projects that require removal of contaminated sediments. Routine maintenance or navigation dredging projects, even if outside listed sediment cleanup sites, may encounter sediments that do not qualify for open-water disposal under DMMP. In cases where these sediments must be removed for navigation purposes, a suitable disposal option for the contaminated sediments must be identified. In some instances, the contaminated sediments are left in place and maintenance dredging is not conducted. Ports and many private dredging proponents may also encounter contaminated sediments during required DMMP sediment evaluation prior to maintenance dredging of slips or berths. Between 1988 and 1997, 25 proposed dredging projects reported sediments that failed PSDDA testing requirements for open-water disposal (Fox 1997). Approximately 24% of these sediments were disposed of at a private upland location or landfill; the remainder (76%) was left in place. Sediments were generally left in place because of the lack of cost-effective disposal alternatives, changes in plans, needs or budgets, or a combination of these factors.

Contaminated sediments may also be dredged as part of site cleanups. To date, regional contaminated sediment sites have been cleaned up primarily under CERCLA, MTCA, and the Clean Water Act (CWA). Voluntary cleanups are conducted under the SMS, and the SMS can also be enforced under MTCA or the Washington Water Pollution Control Act (WPCA). The following examples of recent or ongoing projects illustrate how contaminated sediment disposal is currently addressed and may be expected to be addressed in the future in the absence of a MUDS facility (i.e., under the no-action alternative):

- Commencement Bay Nearshore/Tideflats Superfund site in Tacoma, Washington is being remediated under CERCLA. According to CERCLA, different remedial alternatives must be evaluated using established criteria. At the Commencement Bay site, the Remedial Investigation and Feasibility Study was completed in 1989. The site was divided into separate problem areas for remedial design. One problem area, Sitcum Waterway, was remediated in 1994 by the Port of Tacoma. Contaminated sediments from Sitcum Waterway were dredged and placed in Milwaukee Waterway (creating a nearshore confined disposal facility) as part of a coincident port development project.

  At other Commencement Bay problem areas, including ASARCO, Hylebos Waterway and Thea Foss Waterway, preferred remedial action alternatives are being identified and evaluated independently for each area. At this time, alternatives include disposing of contaminated sediments at aquatic, nearshore or upland confined disposal sites. Different disposal sites are being considered for each problem area.

Because disposal options are developed for a single problem area by separate potentially responsible party (PRP) groups, alternative disposal site options are developed that meet only the needs of the individual area. For Hylebos Waterway, an initial 1994 inventory of 54 sites, plus 18 sites identified by the Commencement Bay Disposal Site Forum, were narrowed to 10 sites carried forward to a Preliminary Disposal Site Evaluation report (Hartman Consulting Corporation et al. 1997). Preferred disposal site selection and final remedial design is scheduled to begin in 1999.

- Cascade Pole, Olympia, Washington, is a contaminated site being remediated under MTCA. Contaminated intertidal sediments will be remediated in conjunction with remediation of the adjacent upland site. The remedial investigation was completed in 1992. No sediment remediation has yet occurred; active sediment remediation is targeted for 1999. Proposed alternatives include dredging with disposal on the upland part of the site (Pitts 1997).

- Piers 1 and 3 in Everett, Washington, is an example of a contaminated sediment site that was voluntarily remediated under Clean Water Act and SMS authority as part of a port development project. Under the Clean Water Act, disposal options are evaluated using established sediment testing procedures which predict potential impacts to the environment. The Port of Everett proposed dredging sediments to maintain existing berths as well as to create an additional berthing area. It was determined that some of the dredged sediments at Piers 1 and 3 were contaminated and required confined disposal. In addition, Ecology determined that contaminated sediments outside the maintenance dredging area also required cleanup under SMS. The Port of Everett dredged the contaminated sediments and disposed of the material in a nearshore confined disposal facility as part of an existing port development project. Initial testing of the dredged material began in 1992; construction of the nearshore confined disposal facility was completed in 1997 (Gregoire 1997).

- East Waterway, Seattle, Washington, is scheduled to be dredged in 2000 by the Corps as part of a federal dredging project and authorized by the 1996 Water Resources Development Act. Contaminated sediment not eligible for unconfined open-water disposal at a PSDDA site will require confined disposal. The Corps and the Port of Seattle are developing a joint federal and state NEPA/SEPA EIS to evaluate disposal site options, including contained aquatic disposal and nearshore confined disposal.

Currently, there is no formal regulatory policy, mechanism or forum to acknowledge the need and benefit of contaminated sediment disposal facilities in the Puget Sound region. Under the no-action alternative, i.e., in the absence of a site-specific MUDS effort, changes to the existing regulatory framework could be pursued to help ensure a coordinated, multi-jurisdictional approach and/or facilitate cost-effective, environmentally sound disposal solutions for contaminated sediments. Existing federal, state and local laws, regulations, and policies could be amended to acknowledge the need for and public benefits associated with contaminated sediment disposal. Regulatory changes could also address inconsistencies in the existing regulatory process, enable siting and construction of facilities by individual proponents, and ensure that the existing regulatory framework supports a coordinated, timely, consistent approach to regulatory review of disposal projects. Some examples of possible regulatory changes include:

- Addition of a statement to the Shoreline Management Act recognizing and promoting the need for confined disposal sites
- Amendment to the Growth Management Act to identify confined disposal sites as essential public facilities to make it easier to site these facilities
- Amending solid waste regulations to reflect permitting, management, siting and technical standards more pertinent to the handling and disposal of dredged material
- Development of a management framework (e.g., similar to the DMMP review process) for contaminated sediment project evaluation.

These types of regulatory changes could be implemented with or without development of a MUDS. While it is unlikely that such changes alone could solve the regional contaminant sediment disposal problem, they could possibly reduce the time and costs associated with individual contaminated sediment dredging and disposal projects.

2.2 LEVEL BOTTOM CAPPING AND CONTAINED AQUATIC DISPOSAL FACILITY ALTERNATIVES

2.2.1 Description

Level bottom capping (LBC) and contained aquatic disposal (CAD) are two types of underwater sediment disposal; these are discussed as one alternative because they have many similar features and environmental impacts. LBC is the placement of contaminated material in a mound on an existing flat or very gently sloping natural bottom and covering the mound with clean sediments (Figure 2-2). The cap is designed to isolate the marine environment from the contaminated material and minimize the potential for contaminant migration. Biological communities are reestablished following final cap placement. CAD is similar to LBC but includes some form of lateral confinement (e.g., placement in natural or excavated bottom depressions or behind berms) to minimize spread of the materials on the bottom (see Figure 2-2). CAD is generally used where the properties of the contaminated material or the bottom conditions (e.g., slopes) require lateral control measures to limit the spread of the contaminated sediments.

Both LBC and CAD include dredging of contaminated sediments from one or more locations, transportation to the disposal site, and accurate placement of the contaminated materials at the disposal facility. Both LBC and CAD projects are readily constructed in water depths of 100 ft or less, while successful LBC operations have been conducted as deep as 200 ft (SAIC 1998).

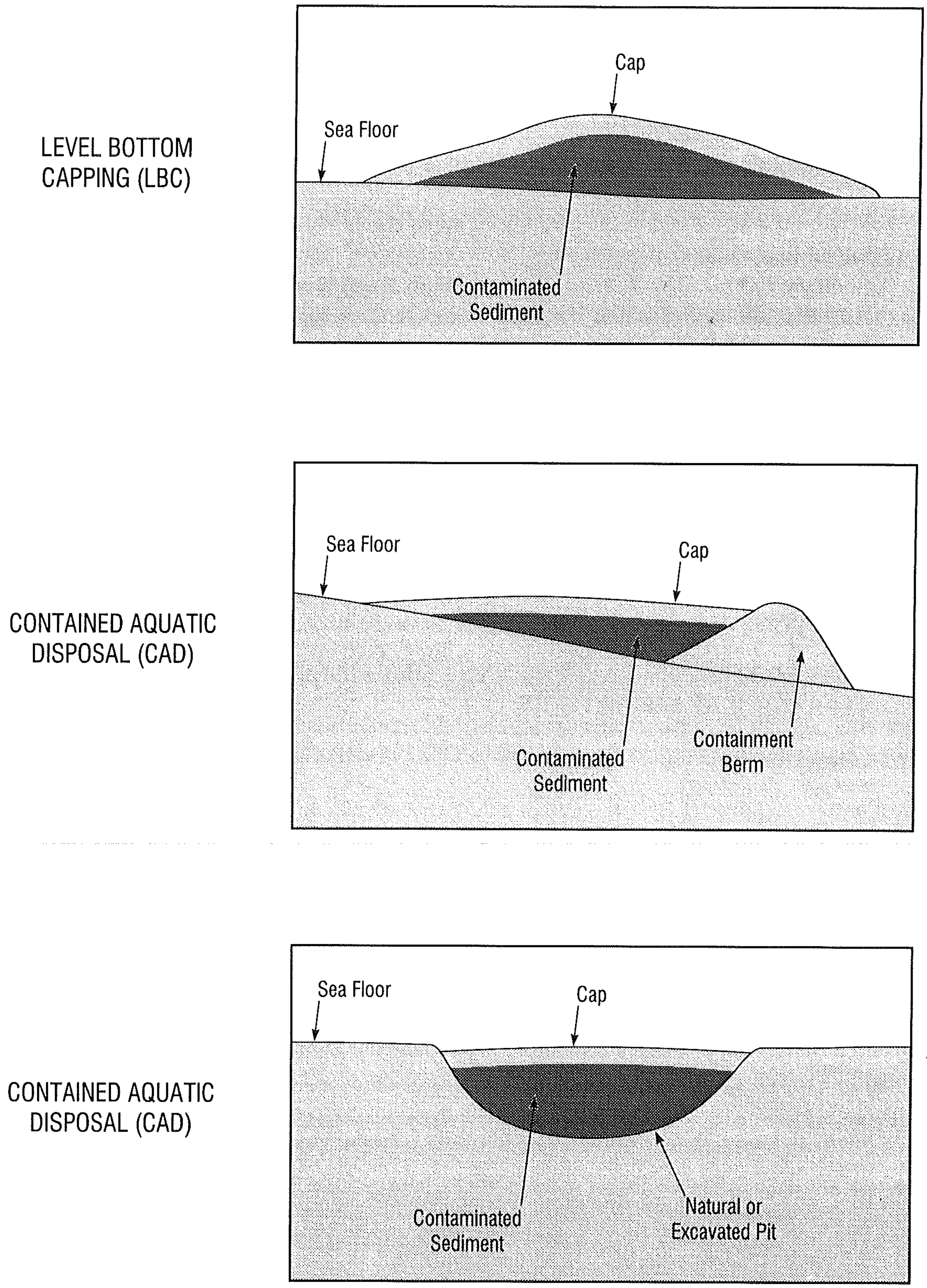


Figure 2-2 Illustration of Level Bottom Capping (LBC) and Contained Aquatic Disposal (CAD)

2.2.2 Contaminant Pathways

The following environmental pathways of concern are associated with the MUDS LBC/CAD alternative (Figure 2-3):

- Contaminant release to the water column and beyond the disposal site boundary during contaminated dredged material placement and subsequent uptake by water-column and benthic organisms before the material is capped
- Release of soluble contaminants in pore waters during consolidation following cap placement
- Re-exposure of the contaminated sediments over time by biological (i.e., bioturbation) or physical disturbance (e.g., erosion) of the cap and uptake by benthic organisms.

If the cap's long-term ability to isolate contaminants from the environment is compromised, marine organisms may be exposed to contaminants. The potential toxicity or bioaccumulation of contaminants in benthic organisms that contact the contaminated sediments or recolonize the compromised cap is a primary concern.

Control measures to minimize contaminant release via these pathways include site location characteristics, site design elements, dredging and disposal technologies, and operational procedures. The sections that follow summarize the technologies, operational methods, and constraints employed at existing LBC/CAD sites to address the environmental pathways of concern and to ensure that the project meets applicable regulatory standards. Preliminary siting considerations and criteria are included in Appendix B. Additional information on design elements and operational methods for controlling contaminant release are described in detail by Palermo et al. (1998a)

2.2.3 Regional Examples

Capping has been used in several navigation and contaminated sediment remediation projects in Puget Sound. In fact, much of the field experience gained in the U.S. for capping of contaminated sediments has been at sites in Puget Sound. The first actual CAD project executed in the U.S. was a demonstration project in the lower Duwamish River in Seattle. In 1984, dredged sediments containing metals and PCBs were placed in a depression in the West Waterway of the Duwamish River and covered with a clean sand cap. Another CAD project was conducted in Puget Sound in 1987 at the One Tree Island Marina in Olympia, WA. Contaminated material was dredged by clamshell, disposed of in a deep excavated pit, and capped with clean material. Other Puget Sound projects have involved in-place capping of contaminated sediments at Simpson Tacoma Kraft (Commencement Bay), Denny Way (Elliott Bay), and Seattle Ferry Terminal (Elliott Bay).

In other regions, LBC has been implemented on a routine basis in Long Island Sound (by the Corps New England District) and the Mud Dump Site in New York. Underwater

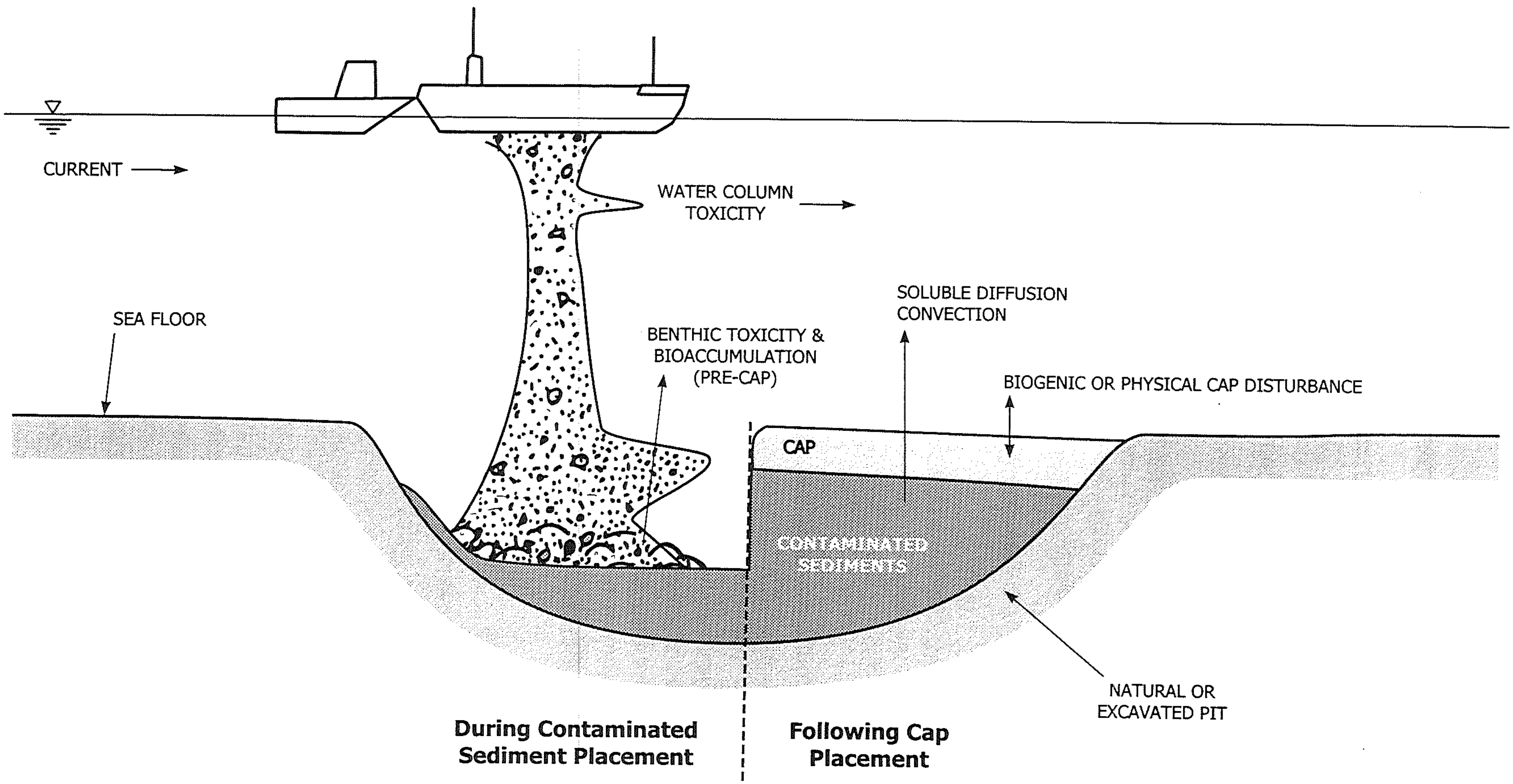


Figure 2-3 Migration Pathways for Contained Aquatic Disposal (CAD)	MUDS Draft PEIS	
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borrow pits (excavated as part of sand or gravel mining operations or excavated solely for CAD) have been used for CAD facilities in Hong Kong, Boston, Los Angeles, and Portland, Oregon. In Hong Kong, the East Sha Chau marine borrow pits created by sand dredging are being used for placement of sediments deemed unsuitable for conventional ocean disposal. In Los Angeles, a pit previously excavated for island construction has been used for the containment of contaminated sediment.

Existing borrow pits have also been considered for CAD by the Port of New York/New Jersey (Corps 1991, 1992, and 1996) and in San Francisco Bay (Corps and Port of Oakland 1994). In 1997, a 1,500,000-cy CAD pit was excavated in Newark Bay, New Jersey for disposal of contaminated sediments from the Port of New York/New Jersey (Knoesel et al. 1998). In 1996, in association with the deepening of channels at the Port of Boston, Massachusetts, an in-channel CAD cell was excavated and filled with contaminated sediments (Murray et al. 1998). This was a trial cell for a much larger effort (planned to start in late 1998) to excavate and fill more than 40 cells with over 1,000,000 cy of contaminated sediments (Nilson et al. 1998).

The operational details and effectiveness of these capping projects are referenced in the feasibility and implementation section that follows.

2.2.4 Feasibility and Implementation

The dredging, disposal, and monitoring technologies associated with LBC and CAD facilities are well-established. The effectiveness of an LBC/CAD facility in avoiding or minimizing environmental risks is a function of appropriate site location, design and construction, technology and operational controls, and effective long-term monitoring and site closure.

2.2.4.1 Technology and Logistics

A MUDS LBC/CAD alternative would be designed to control water-column impacts during placement, allow effective cap placement, and ensure long-term integrity of the cap. Potential water column impacts are a function of operational methods as well as the physical and chemical composition of the sediments. Cap effectiveness depends on cap sediment characteristics, dredging and placement methods for both contaminated and capping sediments, compatibility of site conditions, material physical properties, and placement methods. Long-term cap integrity (i.e., physical isolation of the contaminants) is a function of cap thickness relative to long-term biological and physical disturbance factors, and potential contaminant losses due to advection/diffusion.

While detailed design features can only be developed on a site-specific basis, common design elements for all LBC/CAD projects include: 1) selection of dredging equipment and material placement methods, 2) determination of the required capping sediment thickness, 3) prediction and verification of material spread and mounding during placement, and 4) evaluation of cap stability against erosion and bioturbation. Different options that might be incorporated into a site-specific design are discussed here.

Depth and Slope Considerations

Water depth and bottom slope are key factors influencing LBC/CAD site selection, facility design, engineering and construction methods, and project cost. For this PEIS, 200 ft was determined to be a reasonable depth that would provide a sufficiently large area for disposal and also make contaminated sediment placement practical and safe (Palermo et al. 1998a). Existing LBC projects have been successfully completed at depths up to 200 ft (SAIC 1998) and Wiley (1995) states that sediment mounds (i.e., LBC) can be constructed at water depths over 200 ft. Construction methods are well-established for CAD projects requiring berm construction at water depths up to 100 ft. Construction of a CAD facility at depths between 100 and 200 ft is considered difficult although not impossible. In fact, McNair (1999) sees no reason why a deep water CAD could not be considered, although at this time the dredging/evacuation technology remains untried.

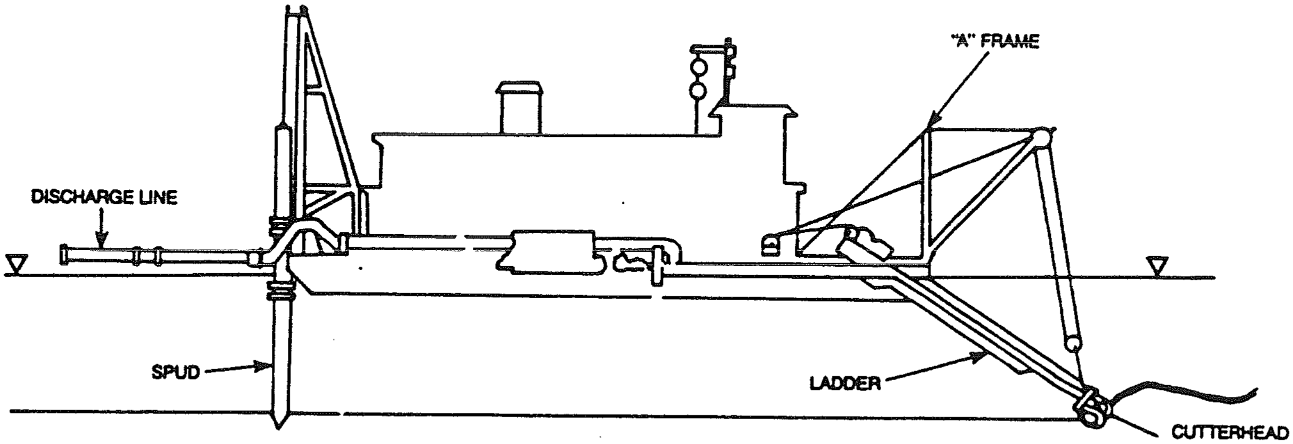
Relative to slope, contaminated sediments may be placed in areas with bottom slopes of up to 6 percent. LBC projects have been located at sites with bottom slopes of 0 to 1 percent and are feasible at slopes up to 3%. Sediment disposal at sites with bottom slopes of 3 to 6 percent requires berm construction but is feasible (Palermo et al. 1998a).

Dredging Equipment and Placement Techniques

Placement techniques at LBC and CAD sites are selected to minimize water column and on-bottom dispersion of contaminated sediments and excessive mixing of capping and contaminated material when the cap is placed. Specific placement methods depend on 1) the physical characteristics of the material, 2) the site conditions, 3) equipment availability, and 4) the distance between dredging and disposal sites.

Dredging Equipment. While dredging equipment and methods are not part of disposal site design, the dredging method affects the characteristics of the sediment (e.g., water content) and so directly influences how sediments can be placed at the disposal site. Some placement methods are appropriate for sediments dredged using certain methods. For this reason, dredging methods are discussed here where they relate directly to the selection of placement methods.

The two basic types of dredging equipment are hydraulic and mechanical (Figure 2-4). Hydraulic dredges use a pump to entrain bed sediments in a liquid slurry and remove the sediments from the bed by suction. The dredged sediment can then be transported via barge to the disposal site or piped directly from the dredge site to the disposal site. Hydraulically dredged sediments contain substantial amounts of water. Conventional mechanical dredges use some form of bucket to excavate and remove bottom sediment. They can not generally be used to directly transport the dredged material to the disposal



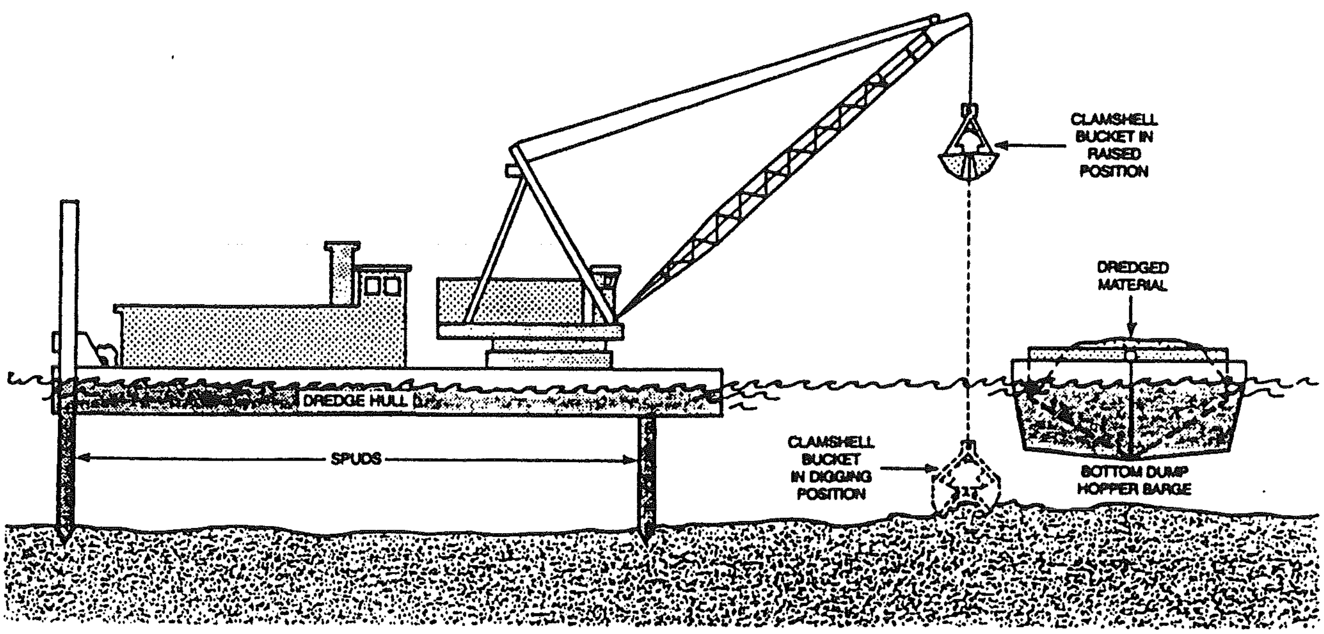


Figure 2-4	Top: The Hydraulic Pipeline Cutterhead Dredge Bottom: Bucket Dredge with Bottom Dump Barge for Off-Site Disposal (from Parametrix 1990)	MUDS Draft PEIS	
		Feb 99	MPEIS Figure 2-4.xar

site, but rather place the sediments on a barge for transport to the disposal site or rehandling facility.

<u>Placement Methods for Contaminated Sediments</u>. Contaminated material is placed at an aquatic disposal site using methods such that:

- Water-column dispersion is minimized
- Bottom spreading is minimized
- Exposure of the contaminated material prior to capping is minimized
- The deposit can be effectively capped and monitored.

Equipment and techniques available for placing contaminated dredged material include both surface and submerged discharge methods (Figure 2-5) (Palermo 1994). The most common conventional equipment and placement methods for surface discharge of dredged material include barge dumping of mechanically dredged material, surface release of hydraulically dredged material from a pipeline, and surface release of hydraulically dredged material from a hopper dredge.

Bottom-dump barge placement of mechanically dredged sediment is currently the most common construction method for LBC mounds and is also acceptable for CAD projects. Because additional water is not added to the material, releasing mechanically dredged material from a bottom-dump barge results in less water-column dispersion than other surface discharge methods. Also, when the dredged material retains its *in situ* (i.e., pre-dredging) water content, it more readily forms a tight, compact mound that can be quickly capped. These characteristics make this placement method especially appropriate for LBC projects, and the method can also be used at CAD facilities. For example, monitoring at LBC facilities in Long Island Sound and the New York Bight showed that mechanically dredged silt and clay released from barges remained in clumps during descent and formed discrete mounds that were very stable, resisted displacement during capping operations, and presented conditions ideal for subsequent capping (O'Connor and O'Connor 1983; Morton 1983, 1987; Sanderson and McKnight 1986).

The hydraulic placement of dredged material from a surface pipeline results in a slower descent, looser mound, and more water-column dispersion compared with the surface release of mechanically dredged material from barges. Placement characteristics resulting from surface release of hydraulically dredged material from a hopper dredge fall between the characteristics resulting from surface release of mechanically dredged material from barges and from surface discharge of hydraulically dredged material from a pipeline. If the contaminated material is placed hydraulically, time should be allowed for settling and consolidation (usually a few weeks) before the cap is placed. This practice minimizes potential mixing of the contaminated and clean materials. These placement methods can be used for CAD projects where the lateral containment features (whether in the form of a bottom depression or berms) limit the extent of bottom spread.

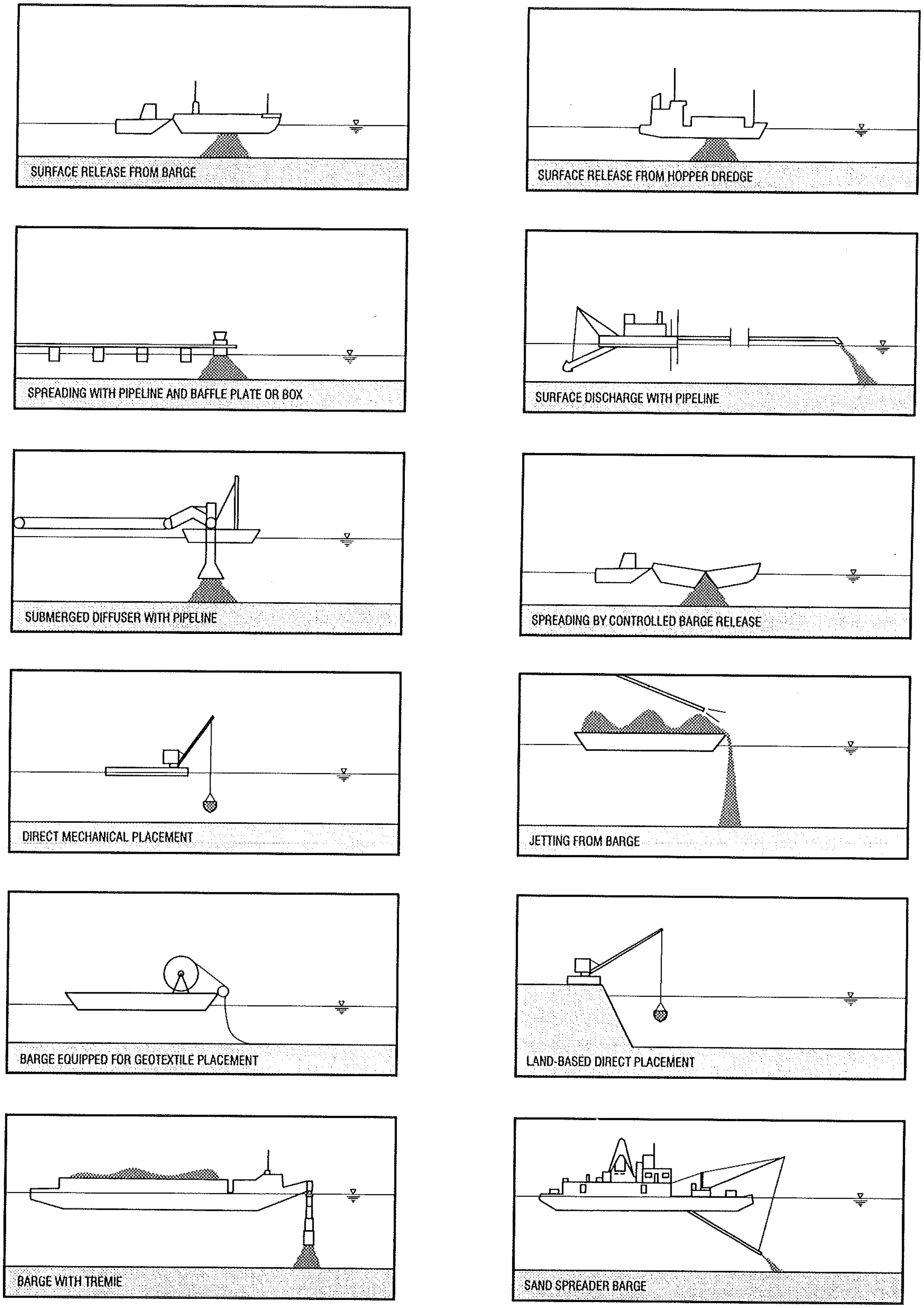


Figure from: Palermo (1994)

Figure 2-5	Equipment Used for Sediment Placement at Aquatic Sites	MUDS Draft PEIS	
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If it is determined on the basis of sediment characteristics and contaminant concentrations that the surface discharge of contaminated sediments would result in unacceptable water-column impacts, spreading, or water-column dispersion, then submerged discharge may be considered. Submerged discharge isolates the material from the water column during part of its descent to the sea floor, resulting in a decrease in potential chemical release to the water column. This technique also decreases entrainment of site water, thereby reducing bottom spread and the area and volume to be capped. Submerged discharge generally involves hydraulic sediment placement through some type of pipeline. A number of methods and modifications are available, including diffusers, gravity-fed downpipes or tremies, and hopper dredges where the dredged material is pumped out via a pipeline (Figure 2-5).

Placement Methods for Capping Material. Capping material can be released at the water's surface using the same conventional equipment described above for contaminated sediments (see Figure 2-5). Additional method modifications to help ensure even coverage and spreading of the cap material include spreading by barge movement or hopper dredges. For the former, split-hull, bottom-dump barges are opened gradually to release the material slowly or are towed across the site as the split-hull is gradually opened. These techniques have been used successfully at sites in Puget Sound, including the in-place capping operation at Eagle Harbor (Nelson et al. 1994). Hopper dredges have been used at the Port Newark/Elizabeth capping project in New York Bight to quickly spread a sand cap over 580,000 cy of contaminated sediments. The hull of a split-hull dredge was cracked open 1 foot and released its load over a 20- to 30-minute period while sailing at 1-2 knots. Identical procedures were used to cap 690,000 cy of contaminated sediments in a 1997 capping project in the New York Bight (Clausner et al. 1998).

The cap may be placed via submerged discharge if the anticipated spreading and dispersal from surface discharge is unacceptable. Because submerged discharge provides additional control and accuracy during placement, the volume of capping material required may be reduced. Hydraulic placement is well-suited for placement of thin layers over large surface areas. A baffle plate (commonly used for river dredging operations) or sand box (used at the Simpson-Tacoma Kraft cap site in Puget Sound) may be attached to the end of the hydraulic pipeline to help ensure even placement, or a slurry may be pumped through a pipeline from a sand spreader barge (used in Japan).

Navigation and Positioning Controls

Controlled and accurate placement of both the contaminated and capping material is crucial for a successful LBC and CAD operation. State-of-the-art equipment (i.e., differential global positioning system or microwave systems) and techniques are required to ensure accurate point placement. Taut-moored buoys, mooring barges, various acoustical positioning devices, and computer-assisted, real-time, helmsman's aids can also used. In all cases, barges or scows must release the material within a prescribed radius of the designated point of placement and in a consistently accurate manner so that adequate coverage is attained. Diligent inspection of operations is needed to ensure compliance with disposal positioning specifications. This would be accomplished as part of the disposal site monitoring program.

Sediment Dispersion and Mound Shape

The physical behavior of a dredged material discharge depends on the type of dredging and placement methods used, physical characteristics of the material, and hydrodynamics of the disposal site. The degree of dispersal and associated water-column contaminant release will dictate the extent to which a given discharge impacts the water column. The geometry of the subtidal deposit or mound will dictate the required area to be capped, cap configuration, and volume of capping material required. Computer models are used to predict the discharge requirements for both contaminated and capping material.

To date, virtually all LBC mounds have been constructed using mechanical dredging with transportation and placement by bottom-dump barges. The resulting mounds have had reasonably consistent shapes. Most mounds have been round or elliptical, with a defined crest that is relatively flat, a side slope (also termed the inner flank), sometimes an outer flank, and a thin outer apron. Most main mound crests have been circles or ellipses 100 to 200 meters in diameter, with elevations of 1-2 meters (though some contaminated mounds with elevations of 3+ meters have been constructed). The inner flank of the mound slopes downward at a slope of approximately 1:35 to 1:70. During deposition, some portion of the material may be transported a considerable distance from the disposal point, creating an apron of fine-grained material, typically 1-15 centimeters in thickness but extending up to several hundreds of meters beyond the main mound flanks (Germano and Rhoads 1984). If designed effectively, disposal within an excavated depression results in much less lateral movement as the dredged material is contained by the CAD cell walls.

Exposure Time Prior to Capping

Placement of the cap material begins as soon as practicable following completion of contaminated material disposal, but there is always some time lag due to logistic constraints. The contaminated material is thus exposed to the water column and benthic organisms for some period of time. Several factors are considered in determining an acceptable exposure time prior to capping:

- Estimates of time required for initial colonization of the site by benthic organisms
- Estimates of time required for initial consolidation of the contaminated material due to self-weight
- Monitoring requirements prior to cap placement.

Depending on the length of exposure time, it is possible for benthic organisms to colonize the contaminated material. Opportunistic species begin recolonizing almost as soon as contaminated material placement operations cease. Bioaccumulation of contaminants by opportunistic species can occur during this time. However, the organisms are buried and thus physically isolated once the cap is placed. In addition, if the cap is of sufficient thickness, few, if any, benthic organisms survive.

From an engineering standpoint, a delay of at least one to two weeks before cap placement is desirable. This delay allows initial consolidation of the contaminated material to occur due to the weight of the material, with an accompanying increase in density and shear strength. These changes increase the contaminated material's stability and resistance to displacement during cap placement. Lag time is especially important for slurried material placed by pipeline or by hopper dredge, where substantial consolidation occurs within a few weeks of placement. In contrast, mechanically dredged sediments contain less water and undergo less post-disposal consolidation.

Monitoring is required to determine the areal extent of the contaminated material prior to capping. Surveys and other sampling activities may require up to several weeks. The time between contaminated material placement and capping must balance environmental exposure with the engineering requirements of stability and the scheduling constraints of monitoring and cap placement operations.

Cap Design

Capping material is placed so that the clean sediments form a layer of the required thickness over the contaminated material. The primary concern in selecting the placement technique is to control the rate of capping material placement so that potential displacement of or mixing with the previously placed contaminated material is minimized. Many of the techniques commonly used for placing capping material are the same as for contaminated material (Palermo 1994), and include both surface and submerged discharges. However, because water-column dispersion of the clean capping material is generally not a concern, submerged discharge is used only if necessary for controlling placement of the capping material.

The cap is designed to physically isolate the contaminated sediments from the water column and benthic organisms, and to control the potential flux of contaminants through the cap. Critical cap design elements are material composition and cap thickness. Dredged material caps are typically composed of single layers of clean sediments. Clean sediments are often available from other dredging projects, and have been shown to be effective at isolating contaminated sediments (Murray et al. 1994).

Thickness is the major cap design criterion. In a conservative design, the minimum cap thickness must equal the sum of the thicknesses required to 1) isolate the chemical contaminants in the underlying sediments, 2) allow for potential bioturbation of the cap by aquatic organisms, 3) protect from erosion caused by physical disturbance factors such as currents and waves, and 4) allow for consolidation of the cap and underlying sediments.

The cap controls contaminant transfer from the contaminated dredged material to the benthic and aquatic environments. Dissolved contaminants can be transported via diffusion and advection. However, most contaminants of concern tend to remain tightly bound to sediment particles, and there is essentially no mechanism that would cause movement of contaminated sediment particles upward into the cap. The cap also controls possible upward movement of contaminated porewater by 1) scavenging and retaining dissolved contaminants and 2) containing porewater that leaves the contaminated deposit during consolidation. Laboratory testing and modeling allow potential long-term contaminant flux and cap effectiveness to be evaluated.

The cap must also physically isolate the contaminated material from benthic organisms. As burrowing organisms move and rework the surface sediments (i.e., bioturbation), they may breach the sediment cap, directly contact the underlying contaminated sediments, and increase the movement of contaminants. The specific assemblage of local benthic species that recolonizes the site, their burrowing depths, and their abundance are key factors in determining the cap thickness required to address bioturbation. In Puget Sound, most deposit-feeders burrow to depths less than one foot, although sea cucumbers (*Molpadia sp.)*, burrowing shrimp (*Callianassa sp., Axiopsis spinulicada)*, and geoducks (*Panopea generosa*) may burrow down to 2 to 3 ft. Existing CAD projects in Puget Sound have used cap thicknesses ranging from 1 to 3 ft (Duwamish Waterway demonstration project). Other in-place sediment capping projects have used caps ranging from 2 to 12 ft (Denny Way, Simpson Tacoma Kraft project) (Palermo et al. 1998b). Monitoring to date indicates these caps have effectively controlled contaminant migration (Ecology 1990a, Wilson and Romberg 1996).

Erosion of the cap is caused by either long-term continuous processes such as tidal currents and normal wave activity or episodic events such as storms. Erosion potential depends largely on site-specific factors, and the level of risk will vary among disposal site locations. A MUDS LBC/CAD site would be situated only in locations with relatively little potential for erosion (see LBC/CAD siting criteria in Appendix B). However, sites with some potential for erosion could be considered if the predicted erosion is addressed by cap design and thickness, monitoring, and long-term management (e.g., periodic cap replenishment).

Consolidation of the cap, contaminated material, and underlying native sediments occurs as sediment particles are pressed together under load. Consolidation occurs once and the amount of consolidation depends on sediment characteristics such as grain size and water content, loading conditions, and thickness of the compressible layers. Information on cap consolidation is required for determining cap thickness (so that the consolidated cap will remain at the required thickness), distinguishing elevation changes due to erosion, and assessing porewater movement upward into the cap from the contaminated sediments below.

At some sites, operational concerns such as vessel anchoring, ability to place thin layers, and unevenness of material placement need to be considered in determining cap thickness. In most cases, these are site-specific concerns, and sites with the potential for these problems are unlikely to be selected for a MUDS LBC/CAD.

Finally, a LBC/CAD MUDS would be selected for placement of contaminated sediments from several projects, and the need for interim capping would need to be evaluated. Upon completion of an individual dredging project or a group of projects occurring within a limited time frame, a cap may need to be placed over the material. The need for an interim cap to temporarily isolate contaminated sediments prior to final capping would depend on the characteristics of the contaminated material, the exposure time until final capping, the frequency of material placement, and site-specific conditions. Interim cap thickness is based on the same factors described above, but the design parameters (especially those for long-term flux, return periods for storms, etc.) are selected to provide containment over the time period anticipated between the interim cap and final cap placement.

Monitoring

Monitoring of LBC/CAD sites is conducted to ensure that contaminants are effectively contained (Palermo et al. 1992). Disposal site monitoring typically includes:

- Water-column monitoring during material placement
- Construction monitoring before, during, and following placement of the contaminated and capping material to ensure that an effective cap has been constructed
- Long-term monitoring to ensure that the cap as constructed is effective in isolating the contaminants and that long-term integrity of the cap is maintained.

Water-column monitoring at the disposal site during sediment placement would be conducted based on site-specific concerns and regulatory requirements. Water quality would be evaluated for conventional parameters (e.g., turbidity, dissolved oxygen) and, if warranted, chemicals of concern.

Appropriate objectives for a LBC/CAD benthic monitoring program include the following:

- Identify bathymetry, organisms, and sediment type at the site
- Based on appropriate models, define areal extent and thickness of contaminated material deposit (to include the apron thickness) to guide cap placement
- Based on appropriate models, define areal extent and thickness of the cap
- Verify that desired capping thickness is maintained
- Evaluate cap effectiveness in isolating contaminated material from the benthic environment
- Determine the extent of organism recolonization and bioturbation potential.

Existing CAD and in-place capping projects in Puget Sound typically include physical, chemical, and biological monitoring during construction and operation to meet the above objectives (Truitt 1986, Sumeri 1995, Wilson and Romberg 1996). A site-specific LBC/CAD management/monitoring plan would be developed for a MUDS facility. The plan would include threshold values and management actions required when threshold values are exceeded. A tiered monitoring approach would be developed with early tiers designed to gather information rapidly and trigger more extensive monitoring as warranted. Possible management options in later tiers include altering disposal techniques or changing the type and/or volume of capping materials.

2.2.4.2 Conceptual Design and Cost

The purpose of the conceptual design is to provide a reasonable scenario for the LBC/CAD alternative for evaluation in this PEIS. A CAD site design was selected based on the design elements and pathways of concern described previously, regional capping project experience, and general Puget Sound environmental characteristics. The conceptual design is used to estimate planning level costs and discuss the potential environmental impacts associated with this alternative. The conceptual design is not intended to establish specific site design, operational, or management requirements for possible, future, site-specific MUDS LBC/CAD facilities or any other regional LBC/CAD project.

Conceptual Design

A CAD (rather than LBC) design was selected for the conceptual design. It is important to note, however, that selection of a CAD design does not preclude consideration of a LBC design as part of future site-specific MUDS efforts if suitable site conditions exist. A CAD design was selected for the conceptual design for the following reasons:

- Because the walls and berms of the CAD better contain the dredged material and eliminate spread during placement, CAD requires less total surface area than LBC to dispose of the same volume of contaminated sediments (relatively shallow, flat-bottomed areas are not extensive in Puget Sound)
- CAD facilities can be developed in areas having bottom slopes too steep for LBC. Given the relatively steep slopes characteristic of the shallower depths (less than 200 ft) in much of Puget Sound, the CAD option was considered a more likely disposal scenario.
- Cap erosion is less of a concern at a CAD site
- The higher initial costs of CAD compared to LBC (due to site excavation requirements) may be offset by reduced capping and construction monitoring costs.

The basic conceptual design for a CAD facility consists of a series of excavated pits or cells that are filled sequentially over the life of the project (see also Appendix C). Each excavated cell is capable of holding one dredging year's volume of contaminated sediments. The pits are excavated annually using a mechanical dredge, and the excavated material is transported by barge and used as capping material at the pit being filled with contaminated sediments or, if not needed, disposed of at a PSDDA site.

Additional assumptions about site characteristics used in developing the conceptual design include a minimum water depth of 25 to 65 ft[1], a maximum water depth of 100 ft[2], and a maximum bottom slope of 3 percent.

The assumptions used in developing the conceptual design represent a reasonable Puget Sound scenario. In fact, there is a range and variety of site characteristics and configurations that may be suitable for a CAD in Puget Sound. For example, the existing Duwamish CAD facility in Puget Sound was constructed in an existing depression and no excavation was required.

Capacity and Size. Capacity of a disposal facility depends on site-specific features such as size and configuration. For the conceptual design, two potential MUDS capacities were analyzed to examine the relationship between site size and costs. The two capacity scenarios included *in situ* dredged material volumes of 500,000 cy and 2,000,000 cy, placed over a 10-year period. For conceptual design, a bulking factor (i.e., the volume the material increases due to dredging and disposal operations) of 20% for mechanically dredged sediments was used to compute CAD cell capacity volumes. Using this bulking factor, the required sediment storage capacity becomes 60,000 and 240,000 cy/year (total capacity of 600,000 cy and 2,400,000 cy, respectively). No sediment consolidation factor was assumed in developing the conceptual design.

The conceptual sequenced CAD design includes 10 cells (one for each year of the 10-year life of the MUDS facility). Each new cell is excavated close to the previous pit that is actively being used for contaminated sediment disposal (Figure 2-6). A cross section of the pit design is shown in Figure 2-7. Dimensions of each individual cell as well as the entire facility for each design volume are summarized in Table 2-1. Each cell is capable of holding one dredging year's volume. For the conceptual design, the annual volume is assumed to be 1/10th of the total CAD design volume (60,000 or 240,000 cy). It is also assumed that sediments excavated from the first year's pit are disposed of at a PSDDA site or used beneficially; sediments from the following year's pits are used for capping contaminated sediments placed in the active pit. It is also assumed that pit excavation and contaminated material placement would occur every year. CAD construction is estimated to require on the order of 2 to 4.5 months for the 500,000-cy and 2,000,000-cy facilities, respectively.

Transport and Placement. For the conceptual design, contaminated sediments placed in the CAD sites are assumed to be mechanically dredged and placed in barges for transport to the CAD site. The dredged material is bottom-dumped from the barge into the excavated CAD cell. Within 4 weeks of disposal, the contaminated sediments are

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[1] A minimum depth not less than 25 ft (typical barge draft) allows barge transport of material. A minimum depth not greater than 65 ft allows excavation of a 35-ft deep pit (as assumed for conceptual design) without exceeding the assumed maximum conceptual design depth of 100 ft (see below).

[2] While CAD sites may be feasible at depths greater than 100 ft (Wiley 1995), to date no CAD facilities have been built below this depth. The MUDS CAD conceptual design uses a maximum depth of 100 ft, a depth at which many CAD and LBC projects have been successfully completed.

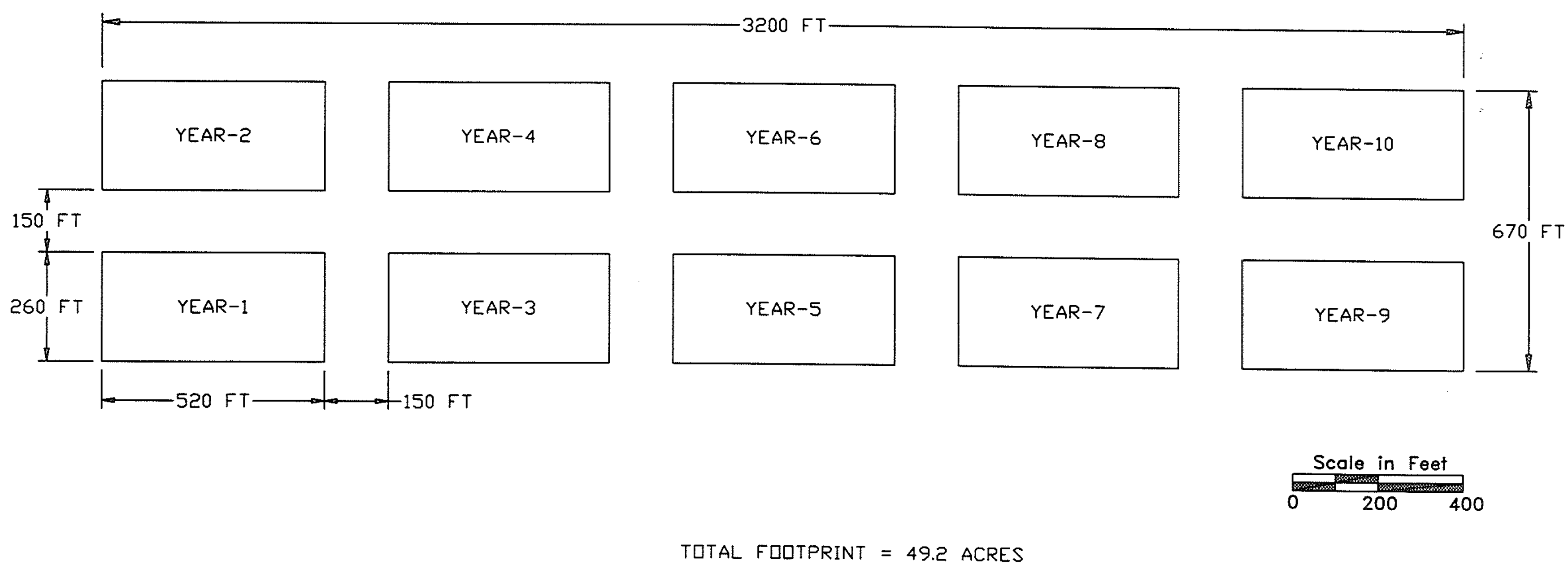

Figure 2-6	Schematic Footprint for 10-Year 500,000 cy Sequenced CAD Site: 10 Annual Cells. The 2,000,000 cy sequenced CAD would occupy an area of 1,030 x 5,000 ft (118.2 acres).	MUDS Draft PEIS Feb 99 — MPEIS Figure 2-6.xar

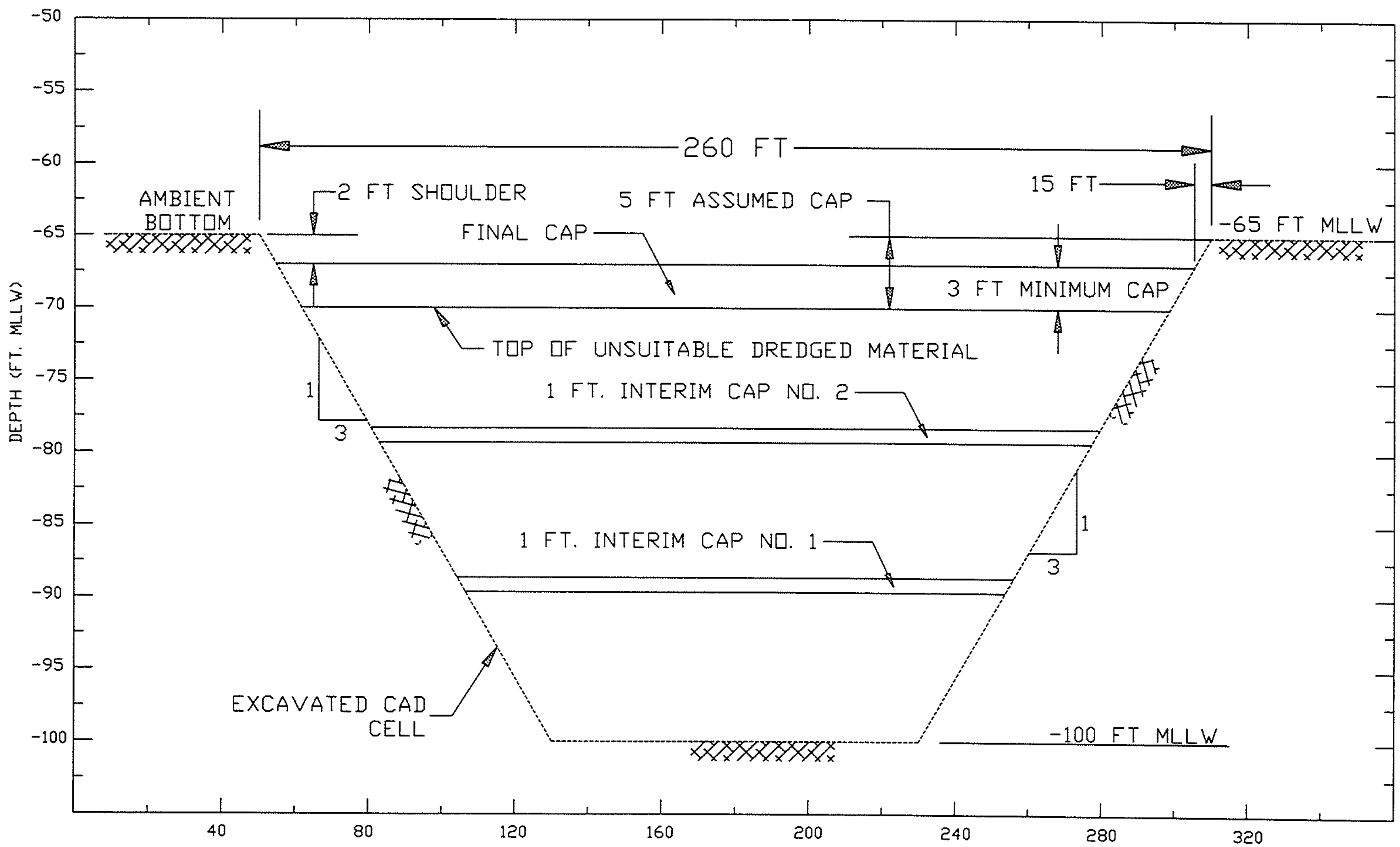

Figure 2-7	Schematic Cross Section of a CAD Cell for the Sequenced 500,000 cy Contained Aquatic Disposal Concept. The 2,000,000 cy CAD cells are as shown except that they are 440 ft across.	MUDS Draft PEIS Feb 99 — MPEIS Figure 2-7.xar

Table 2-1. Dimensions of Sequenced CAD Facility Conceptual Design.

Feature	Units	Design Volume (cy[1])	
		500,000	2,000,000
Single Cell Dimensions	ft	260 x 520	440 x 880
Single Cell Depth	ft	35	35
Cell Side Slope	--	1:03	1:03
Cell Volume Removed	1,000cy	90	332
Contaminated Sediment Capacity[2]			
Single Cell	1,000cy	60	240
10 yr total	1,000cy	600	2,400
Cap Volume			
Single Cell[3]	1,000cy	30	92
10 yr total	1,000cy	300	920
Surface Area			
Single Cell	acres	3	9
10 yr total	acres	49	118

[1] Surface area assumes 150-ft spacing between cells.

[2] Volume assumes 20% bulking factor.

[3] Assumes two interim 1-ft caps and one 5-ft final cap.

covered with an interim cap. The final closure cap for each individual cell is placed at the end of the dredging year or season. Capping material is also mechanically dredged and transported in bottom-dump barges to the site.

<u>Contaminant Control Measures</u>. Clean sand and silts are used for capping material. Interim caps are 1.25 ft thick to ensure a minimum cap thickness of 1 ft. The closure cap is at least 3 ft thick (in actuality, the cap may be thicker to bring the area back to original grade). For the conceptual design, two interim caps and a final 3-ft cap are assumed. Cap material is assumed to be available from an adjacent excavated pit. However, depending on need and timing, additional cap material could come from other regional maintenance dredging projects.

<u>Monitoring</u>. For the conceptual design, monitoring at the CAD site consists of two phases, operational monitoring and long-term monitoring. Operational monitoring includes monitoring activities associated with placement and capping operations at the CAD. Long-term monitoring evaluates the efficacy of the CAD facility in terms of physical stability, isolation of the contaminated sediment from the environment, and to a lesser degree, recolonization by benthic organisms. The monitoring program for the conceptual design was developed based on monitoring programs at existing aquatic disposal sites.

Operational monitoring to confirm accurate contaminated sediment placement and water quality compliance consists of precision bathymetric and sediment-profile surveys and water quality sampling. Prior to any disposal at the excavated CAD cell, a post-excavation bathymetric survey would be conducted to verify the shape and volume of the CAD cell. Additional hydrographic surveys would be conducted prior to the placement of the final cap at the CAD cell and following placement of the final cap. This approach has been successfully utilized at several CAD, in-place cap, and unconfined dredged material disposal sites in the U.S. (SAIC 1995, Port of Los Angeles 1995, Coastal Frontiers 1996).

During disposal of contaminated dredged sediments at a CAD facility, water quality monitoring would be routinely performed to evaluate any impacts. The type of monitoring associated with dredged material disposal typically consists of turbidity, total suspended solids, and dissolved oxygen measurements. Water-column contaminant levels can also be measured, if warranted, based on the project-specific dredged material testing results. The results from these monitoring activities would be compared to applicable water quality criteria and dispersion models.

Following the placement of the final cap at each CAD cell, long-term surface sediment chemistry would be monitored to ensure that subsurface contaminants remain isolated. Biological grab or sediment-profile sampling can be used to assess long-term benthic recolonization and habitat quality. The conceptual design assumes that benthic communities would be monitored using sediment-profile sampling.

CAD Cost Estimate

Using the conceptual design and monitoring approach described above, cost estimates for the 500,000-cy and 2,000,000-cy CAD facilities are summarized in Table 2-2. Basic estimates are for direct costs of materials, labor, and equipment for mobilization-demobilization and operations. Typical rates for indirect costs (15%), contractor profit (10%), and contingencies (20%) are added. Future costs over the phased project development are shown only as present cost. See Appendix C for more detailed cost and design assumptions associated with CAD construction and site monitoring. Other key cost assumptions include:

- No real estate cost is included. Costs for land use or acquisition depend on site configuration and will be factored into the site-specific EIS where all options will be retained. If the property owner is the State of Washington, DNR may be required to assess a fee. This could increase total project costs markedly.
- It is assumed that benthic and/or epibenthic studies would be conducted at the CAD site prior to excavation to determine if habitat mitigation is required. The cost for this study is estimated to range from $200,000 to $500,000. A value of $300,000 was used for this concept level cost estimate.
- Dredging of contaminated sediments and placement at the MUDS CAD are at the expense of the site user (although water quality monitoring required during disposal is a MUDS program activity and expense).

Cost estimates for contained aquatic disposal range from $13 per cy at a 2,000,000-cy facility to $17 per cy at a 500,000-cy facility. (Using the minimum or maximum estimated costs for the habitat mitigation study alters the total cost per cy range by less than $0.60/cy.) Actual site characteristics, facility designs, and monitoring or mitigation requirements different from those assumed for the conceptual design would clearly affect these cost estimates.

Some examples of changes that could make actual project costs lower than the conceptual design estimate are:

- Use of natural depression(s) to eliminate the need for pit excavation (although it is unlikely that 35-ft deep depressions with the required dimensions exist in Puget Sound)
- Coordination of dredging projects to reduce or eliminate requirements for interim caps.

Examples of changes that would make actual project costs greater than the conceptual design estimate include:

- Incorporation of a real estate acquisition or lease fee for the aquatic lands used for the CAD site

Table 2-2. Concept Level Estimated Costs for Contained Aquatic Disposal (CAD).
(See Appendix C for more detailed cost information.)

MAJOR CAPITAL ELEMENTS		500,000-cy Capacity Estimated Cost	2,000,000-cy Capacity Estimated Cost
Pre-construction		$50,000	$50,000
1st Year CAD Cell			
Excavation		$482,200	$1,711,560
Capping		$144,000	$373,400
Monitoring (Bathymetry, SPI, Water & Sed. Chemistry)		$100,000	$150,000
Total Estimated Concept Cost for 1st-Year CAD:		$726,200	$2,234,960
2nd- through 9th-Year CAD Cell			
Excavation		$304,800	$1,219,200
Capping		$144,000	$373,400
Monitoring (Bathymetry, SPI, Water & Sed. Chemistry)		$100,000	$150,000
Total Estimated Concept Cost each, 2nd- through 9th-Year C.		$548,800	$1,742,600
10th-Year CAD Cell			
Excavation (none, completed during 9th cell)		$0	$0
Capping		$234,000	$649,400
Monitoring (Bathymetry, SPI, Water & Sed. Chemistry)		$100,000	$150,000
Total Estimated Concept Cost for 10th Year CAD Cell:		$334,000	$799,400
Total Estimated Concept Cost for 10-Year CAD:			
Pre-construction		$50,000	$50,000
1st-year CAD		$726,200	$2,234,960
2nd- through 9th-year CAD (eight CAD cells)		$4,390,400	$13,940,800
10th-Year CAD		$334,000	$799,400
Post-closure monitoring		$300,000	$450,000
TOTAL ESTIMATED DIRECT COSTS:		**$5,800,600**	**$17,475,160**
ADD (Assumed):	Indirect Costs (15%)	$870,090	$2,621,274
	Contractor Profit (10%)	$580,060	$1,747,516
	Contingencies (20%)	$1,160,120	$3,495,032
Habitat Mitigation Studies[1]		$300,000	$450,000
TOTAL ESTIMATED 10-YEAR CONCEPT COST[2]:		$8,710,870	$25,788,982
	Cost/cubic yard	**$17**	**$13**

[1] **The cost for habitat mitigation studies is variable and is estimated to range from $200,000 to $500,000. Based on this cost range, the total cost/cy would vary from $17.22 to $17.82 at the 500,000-cy facility and $12.82 to $13.04 at the 2,000,000-cy facility. See Section 2.3.4.2 for additional explanation,**

[2] **Total estimated costs do not include the cost for acquisition or use of subtidal aquatic land. Most subtidal aquatic land in Puget Sound is owned by the State of Washington and managed by DNR. If a CAD site is constructed on state-owned land, DNR may be required to assess a user fee. This would increase the estimated cost/cubic yard.**

- Requirements for habitat mitigation due to the short-term loss of benthic habitat during construction or if site or sediment characteristics do not result in long-term re-establishment of the benthic community
- Additional monitoring requirements such as biological surveys to evaluate benthic recolonization or, depending on site location, additional monitoring to evaluate potential impacts on nearby resources of concern.

2.3 NEARSHORE CONFINED DISPOSAL FACILITY ALTERNATIVE

2.3.1 Description

Nearshore confined disposal is the placement of contaminated dredged material at a site constructed partially or completely in water adjacent to shore, where the dredged material is contained by a dike or berm (Figure 2-8). Nearshore fills are accomplished by either excavating a portion of the shoreline and creating space for the disposal site, or by filling an existing indentation in the shoreline. Nearly all nearshore sites use the shoreline as part of the containment structure, with in-water dikes constructed out from the shoreline to complete the enclosure.

The contaminated dredged material is placed in the containment structure in a layer below the mean tide level (MTL) elevation so that the contaminated material remains saturated with water. As long as the material remains saturated and anaerobic (i.e., without oxygen), most contaminants remain associated with the sediment particles, minimizing the potential for contaminant migration from the disposal facility.

Initial construction of the nearshore confined disposal facility (CDF) would occur over several months or, for larger facilities, over a year. Following construction, dredged material placement would be expected to occur for limited periods of time over a 10-year (or less) duration, with material settling after a few weeks. Depending on dredging activity, the site could be inactive much of the time. In the early years, the nearshore CDF would appear as open water ringed by a dike. Once the contaminated material filling the diked area reaches a specified elevation, it is capped with clean material. The clean capping material raises the elevation to just below or at dike level, above the mean high water (MHHW) elevation. The nearshore sites can be finished to grade to allow beneficial reuse or development of the created uplands after completion. Alternatively, they can be finished to grade in the intertidal zone to create intertidal or shallow subtidal habitat.

2.3.2 Contaminant Pathways

The following environmental pathways of concern are associated with a nearshore CDF (see Figure 2-8):

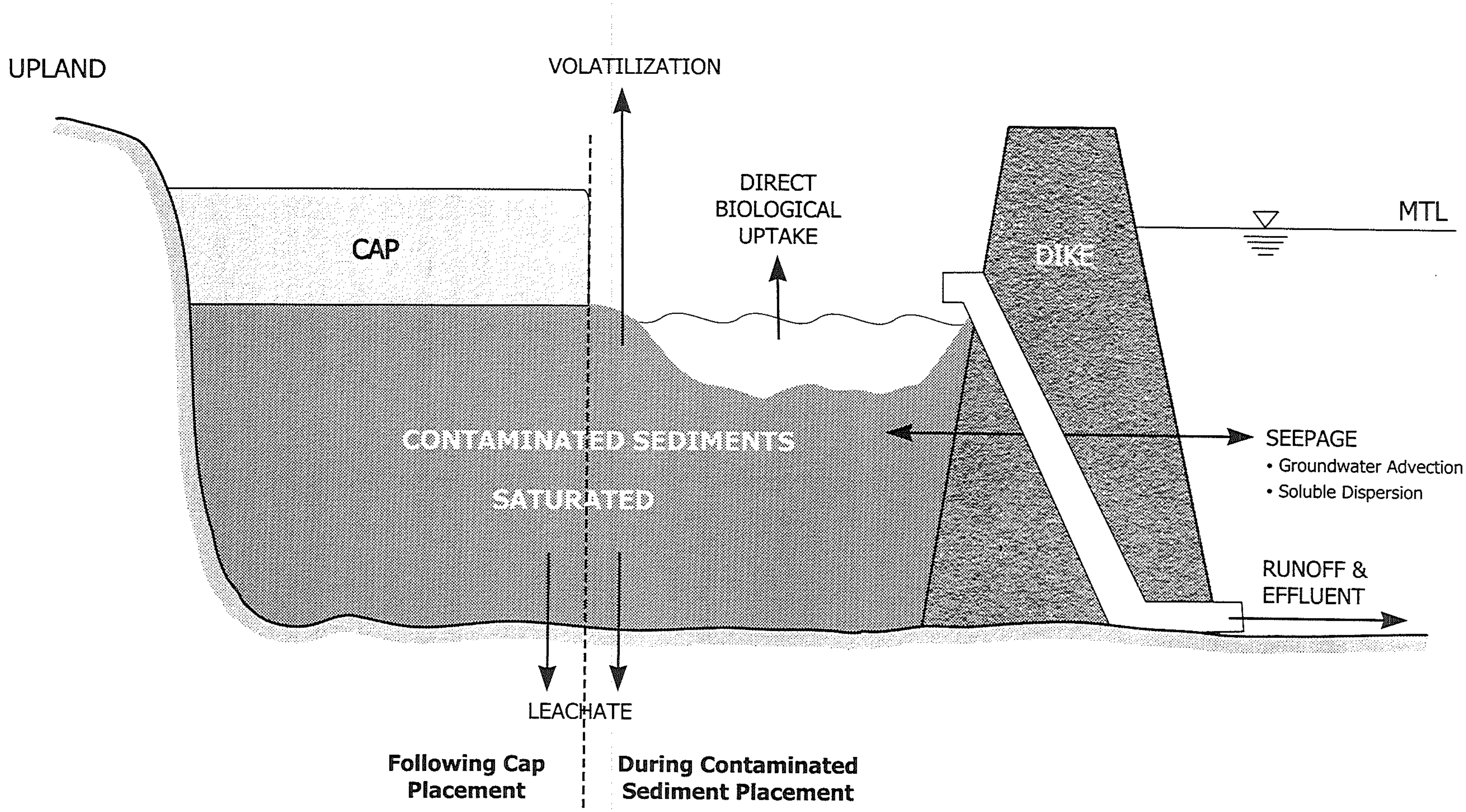

Figure 2-8 Potential Contaminant Pathways for Nearshore CDFs	MUDS Draft PEIS	
	Feb 99	MPEIS Figure 2-8.xar

- Contaminant release in effluent during filling, settling, and dewatering (effluent may contain both dissolved and particulate-associated contaminants) and uptake by biological organisms
- Contaminant release in leachate that passes through the dike or into groundwater
- Contaminant transport (volatilization) from sediment into the air and uptake by birds and mammals, including humans
- Direct uptake by plants or animals by organisms that come in contact with the contaminated dredged material or overlying water ponded in the CDF.

The primary objectives of nearshore confined disposal are to provide adequate storage capacity to accommodate the required volume of dredged material and to contain the dredged material such that any release of contaminants from the site meets environmental or regulatory standards. Site operations (e.g., placement methods, control of flow to and from the containment area), treatment of effluent or other discharges, and containment structures and site controls (e.g., covers) are basic site design and operational procedures to control contaminant release from nearshore CDFs.

2.3.3 Regional Examples

Large nearshore CDFs are located in Puget Sound, the Great Lakes region, the Atlantic Coast, and California. In Puget Sound, the following nearshore sites have been constructed recently, taking advantage of existing piers or other port terminal facilities to provide two or three of the dikes for the CDF:

- The Terminal 91 Short Fill Project for the Port of Seattle consisted of placing two berms spaced about 120 meters apart across the slip between the solid fill piers of Pier 90 and 91 (Boatman and Hotchkiss 1997, Converse Consultants et al. 1992).
- The Port of Tacoma constructed a containment berm across the Milwaukee Waterway to contain remediation-dredged material from Sitcum Waterway and navigation-dredged material from Blair Waterway (Verduin et al. 1994).
- A nearshore CDF was also used for the Port of Everett Marine Terminal Improvement Project (Hartman Associates 1996) and included confining contaminated dredged material between existing Piers 1 and 3.

The above three CDFs, initially constructed in water, became upland areas once the fill reached elevations above the mean high water elevation. The Terminal 91 and Milwaukee Waterway sites have been capped with clean material and converted to container facilities or parking areas; similar future uses are planned for the Port of Everett nearshore CDF.

Several other nearshore CDFs have been or are currently being considered in Puget Sound. The Bellingham Bay Pilot Project (BBPP) is evaluating possible nearshore sites for confined sediment disposal of contaminated sediments from throughout Bellingham Bay. The Corps and the Port of Seattle are evaluating several potential disposal sites for placement of contaminated sediments from East Waterway, Seattle Harbor. Sites being evaluated in the federal/state EIS for the East Waterway Project include three nearshore confined sites: Pier 27, Terminal 91, and Lockheed Aquatic, adjacent to West Waterway (Martin 1998). Finally, the Port of Seattle, the Corps, and Ecology previously prepared a NEPA/SEPA EIS that evaluated the feasibility and impacts of establishing a large nearshore CDF in Elliott Bay in the Lockheed aquatic area of Southwest Harbor to provide areawide (Elliott Bay and Duwamish Estuary) contaminated sediment disposal capacity (Corps et al. 1994). However, this facility was never constructed.

2.3.4 Feasibility and Implementation

The dredging, disposal, and monitoring technologies associated with nearshore disposal facilities are well-established. As described in Section 2.3.3, several nearshore disposal facilities for contaminated sediments have been constructed successfully (based on monitoring results) in recent years in Puget Sound. The effectiveness of a nearshore site in avoiding or minimizing environmental risks is a function of appropriate site location, design and construction, operational controls, and effective long-term monitoring and site closure.

2.3.4.1 Technology and Logistics

While site-specific design features will depend on the individual project and site characteristics, the general design elements to be addressed at all nearshore CDFs are described here.

Containment Dikes

The basic function of the containment dike is to provide the structural strength necessary for long-term containment of the dredged material. The dike is designed to control contaminant migration to the adjacent receiving waters. At the same time, the dike must allow for the release of excess runoff and effluent from the site during placement of the dredged material. Another possible function of the dike, if it is constructed of permeable materials, is its potential contaminant treatment function (Boatman and Hotchkiss 1997).

The selection of a dike design and construction method depends on site-specific geotechnical conditions, wave effects, maintenance requirements, and seismic concerns. Dike engineering design includes selection of location, height, cross section, material, and construction method. Many elements of dike design will depend on site-specific features. For example, the bed sediments affect dike stability and the amount of foundation consolidation. The height of the containment dike is generally determined by the depth of water, the shoreline configuration (slope, topography, and the relative elevations of land and sea bottom), the need to adequately contain sediments, and the final intended use of the site (e.g., intertidal habitat, usable uplands). The dike should be constructed high enough so that there is sufficient capacity to retain sediments during placement and following consolidation and dewatering.

Three nearshore dikes in Puget Sound have been constructed using sand and gravel as fill material. Rock fill dikes are commonly used in the Great Lakes region. Sheet pile walls or cellular cofferdams may also be used for nearshore CDFs. However, Washington Department of Fish and Wildlife (WDFW) restrictions on the use of vertical bulkheads below MHHW generally prohibit their use in Puget Sound.

Dike construction can include an impervious core within the dike to prevent contaminated seepage from migrating through the dike wall; however, this is a high-cost item and may not be necessary to prevent contaminant migration. Monitoring at the Terminal 91 nearshore CDF in Seattle demonstrated that an impervious core was not required (Ecology 1989). Boatman and Hotchkiss (1997) monitored water quality in the dikes and modeled flow and contaminant transport through the berm at Terminal 91. They concluded that organic contaminants were biodegraded and the mobility of metals was reduced through sulfate reduction, coprecipitation, and adsorption occurring in the dike. They also reported that if an impervious core was required to retard groundwater flow through the contaminated dredged material, it would be more effective and cost less to place this barrier on the upland side of the CDF rather than in the dike (Hotchkiss 1998).

Dikes constructed in the water require protection from erosion due to waves. The erosion protection is generally an armor layer made of rock. The size of the rock and number of rock layers (and thereby cost) are a function of the expected severity of the waves. Waves generated both by passing vessels and storms are considered. Knowledge of the potential changes in water level primarily due to tides and wind is also required. The combination of waves and water levels determines the required height of the dike erosion protection. A modeling study is typically conducted for finalizing site-specific designs.

Dike design must also address seismic concerns (e.g., earthquakes) and requires the input of appropriate experts. Site-specific factors to be considered include determination of the required safety margin and earthquake category, an evaluation of the seismic hazard, determination of foundation conditions, and liquefaction susceptibility. The dike material should be designed to be non-liquefiable for the design-based earthquake. If liquefiable materials are present in the foundation, they may need to be removed or improved, or alternative designs may need to be considered.

Transport and Placement

Dredged material can be transported and placed in a nearshore CDF using one or more of several methods: hydraulic pipeline placement, direct barge transport and dumping, or mechanical rehandling of dredged material from barges to the CDF. Direct placement of material by hydraulic pipeline is economical if the site is located near the dredging area. With this method, the sediment and water slurry is discharged directly into the containment area. However, the large amount of water entrained in hydraulically dredged material may require additional settling and effluent discharge controls. The applicability of this method is limited by distance from the dredged site to the CDF.

Use of mechanical dredges to place dredged material is not limited by distance if there is direct water access to the CDF. The sediments can be transferred from the barge to the nearshore CDF by several methods, depending on the distance between the CDF and the closest barge access. Possible unloading methods include the following:

- Use a clamshell bucket to transfer the dredged material to a conveyor belt to move the material over the dike to the CDF
- Use a clamshell bucket to transfer the dredged material from the barge directly into the CDF, with a chute or conveyor to transfer the dredged material beyond the interior toe of the dike
- Slurry the material in the barge by adding water, mixing, and pumping the slurry through a pipeline to the CDF
- Provide a notch in the berm to allow the barge to enter the CDF and bottom dump or unload the sediment with a front-end loader or bucket (Hartman Associates 1996).

Because of its successful use in Puget Sound nearshore fills, direct disposal from a barge within the CDF is a viable unloading option. With this method, the barge enters the containment area through an opening in the dike and the barge hopper is opened, allowing the material to drop into the CDF. The Terminal 91 nearshore CDF in Seattle was completed using direct dumping from barges behind the dikes. The direct barge dumping method was also used at the Port of Everett Pier 1 and Pier 3 nearshore CDF (Gregoire 1997).

Although detailed procedures will be required for specific sites, there are some basic operational controls for fill placement at a nearshore CDF. Contaminated material is only placed below MTL to ensure that it remains saturated and anaerobic. Most contaminants remain associated with particles (i.e., immobile) when sediments are saturated and anaerobic. In addition, during material placement, the CDF must be operated to retain suspended solids such that only clarified water is released or discharged during filling. For operations involving placement by barge using a notch in the dike, solids retention and dispersion can be controlled by the scheduling and frequency of placement, limits on the size of barges used, and the use of a silt curtain or other barrier across the dike notch. For sediment transfers over the dike, either hydraulically or mechanically, the fill area and volume must be large enough to allow settling of the fine-grained sediments.

Effluent Control

The volume of effluent discharged during filling and consolidation depends on the volume of water displaced by dredged material placement and the volume of water contained in the dredged material. Because nearshore facilities are constructed in intertidal or shallow subtidal areas below MTL, all nearshore CDFs are filled with water during the initial stages of filling. At a minimum, the volume of water discharged as effluent is approximately equal to the volume of material placed in the site. Until the fill breaks the water surface, the effluent is largely displaced ponded water from inside the site. The dredged material placed at the CDF may also contain water and increase the water volume that must be discharged. After adequate settling to remove particles and a high fraction of contaminants, this excess water either flows through the notch in the dike, seeps slowly through the berm, or exits through engineered effluent control structures or outlets.

In Puget Sound, dredged material is typically moved mechanically and does not contain the large volume of water associated with hydraulically dredged material. Effluent control measures have therefore not been required at nearshore CDFs filled by mechanically dredged material. At the Terminal 91 CDF in Puget Sound, monitoring indicated that effluent and suspended solids control measures were not required when water in the CDF was displaced by mechanically dredged sediments during filling.

In contrast, if hydraulic filling methods are used, the dredged material would contain a significant volume of water, and settling to remove suspended solids prior to effluent discharge would be required. Effluent controls such as sluices or spill boxes may be incorporated in CDF design to control effluent release and allow time for particles to settle, thereby reducing the amount of suspended solids reaching the receiving water. Weir structures may also be used to allow discharge of clarified excess water during filling.

Additional Control Measures

A variety of design elements or features may be incorporated to provide additional pathway control and prevent or minimize contaminant release. The types of control measures selected depend on site-specific characteristics and contaminant types and concentrations. Some common control measures are briefly described below.

Possible leachate control measures include groundwater pumping (upgradient of the CDF), liner systems, sheet pile walls, and slurry walls. Previous investigations at Puget Sound nearshore CDFs have demonstrated that leachate control measures may not be necessary for environmental protection (Palermo et al. 1998a). However, leachate control may not have been an issue at these CDFs because of their specific geology, and leachate control will need to be considered during site-specific CDF design.

In general, the geochemical conditions for nearshore fills reduce the need for leachate, seepage, and effluent controls. The low permeability of fine-grained dredged material limits contaminant migration through the site and berm. Water flow barriers and controls (e.g. liners, leachate collection or groundwater pumping, and subsurface drainage systems) have not typically been used at in-water sites in Puget Sound. However, at some CDF sites in other regions, liner material has been placed along the inside slope of nearshore dikes, and sheet pile sections have been used for seepage control (e.g., in Great Lake CDFs). If warranted, such features could be incorporated into a MUDS nearshore CDF.

A final cover or surface layer of clean sediment (i.e., cap) is highly effective in controlling several potential contaminant pathways. Cover layers have been included in Puget Sound nearshore CDF designs, and typically consist of a barrier with very low permeability, such as a flexible membrane, a compacted clay layer, asphalt, or concrete. The cover reduces leachate generation by minimizing rainfall infiltration into the fill, isolates the dredged material from plants or animals and so eliminates the potential for biological uptake, minimizes volatilization of contaminants, and eliminates erosion and transport of contaminants in surface runoff.

If a notch in the dike is left open to allow barge movement in and out of the CDF, fish and other aquatic life may also pass in and out, potentially accumulating contaminants. To minimize this potential, a moveable barrier, such as a silt curtain or wire mesh, could be placed across the notch when there is no barge traffic.

Monitoring

A monitoring program is developed to ensure compliance with regulatory requirements and to operate the CDF safely and efficiently. Monitoring includes evaluation of the potential environmental pathways including surface water, groundwater, air, plant, and animal uptake. Monitoring during filling primarily addresses water quality in runoff or effluent. Long-term monitoring focuses on contaminant migration from the nearshore CDF to receiving waters through the dike. Monitoring programs typically include contingency measures (e.g., requirements for additional sampling, operational changes) that are triggered if target levels or standards are not achieved. Monitoring programs at existing nearshore CDFs in Puget Sound include physical, chemical, and biological sampling to address these pathways (Hotchkiss 1988).

Effluent monitoring is necessary if effluent must be discharged during filling and during rainfall runoff when the contaminated material is exposed (i.e., prior to capping with clean material). Analyses are conducted that evaluate effluent suspended solids and possibly chemicals of concern. Monitoring during material placement or during runoff may also include water column samples in the receiving waters at the dilution zone boundaries to verify compliance with water quality standards.

Groundwater and/or leachate monitoring is required for contaminated material where groundwater contamination or leachate transport through the dike (seepage) is a concern and typically requires the installation of monitoring wells for sampling of seepage and/or groundwater and subsequent chemical analysis. Hotchkiss et al. (1995) described a plan for monitoring fill at the Terminal 91 nearshore CDF that included detailed chemical analysis of multiple wells in the berm, hourly sampling over the full tidal cycle, and tracking of indicator chemicals moving through the berm.

Air emissions are generally not monitored at nearshore CDFs. Air monitoring may be considered in the exceptional circumstance where extremely high concentrations of volatile organic contaminants are present in the dredged material and where there is a high likelihood of human receptors. However, material of this type is not likely to be permitted for disposal at a Puget Sound nearshore CDF (see Section 1.5.3).

Biological monitoring may be used as an indicator of contaminant migration from the site. For example, benthic organisms adjacent to the site could accumulate contaminants, and a long-term bioaccumulation monitoring program for biota in the vicinity of a nearshore CDF could be instituted. However, any biological monitoring program must be designed to distinguish potential impacts from the CDF from impacts due to background contamination or other existing contaminant sources.

2.3.4.2 Conceptual Design and Cost

The purpose of the conceptual design is to provide a reasonable Puget Sound scenario for the nearshore CDF alternative. A conceptual nearshore CDF design was developed based on the design elements and pathway controls described above, past technical experience with nearshore CDFs in Puget Sound, and regional environmental characteristics. The conceptual design is used in this PEIS to discuss the environmental consequences and generate a cost estimate for the alternative. The conceptual design is not intended to establish site design, operational, or management requirements for possible, future, site-specific, MUDS nearshore CDFs or any other regional nearshore CDF project.

Conceptual Design

The conceptual design for the nearshore dike is based on typical nearshore site conditions in the Puget Sound area and a relatively straight shoreline configuration (see also Appendix C). The shore forms one side of the facility. Other assumptions include:

- Shore line elevation sloping from the water's edge (at a slope of 2H:1V) down to a level bottom
- Water depth of 50 ft at the outer dike at mean high water
- Mean tide level of +7 ft mean lower low water (MLLW).

A cross section and dimensions for the conceptual design dike are shown in Figure 2-9. Material for the dikes is assumed to be a relatively coarse-grained (i.e., sand and gravel) commercial fill that is placed mechanically by a split hull barge or a bucket dredge. (Note that a geotechnical analysis for the specific dike height and material type would be required for any site-specific project.) The exterior face would be protected from erosion by a 3-ft layer of riprap. The inner dike face would be armored by a 1.5-ft layer of quarry run stone. Bank protection would be placed concurrently with dike construction.

Capacity and Size. Capacity of a disposal facility depends on site-specific features such as bathymetry and configuration, and it is likely that the actual dimensions and capacity at a MUDS facility would differ from that used in the conceptual design. To examine the relationship between site size and costs, the conceptual design analyzed two potential MUDS capacities, *in situ* dredged material volumes of both 500,000 cy and 2,000,000 cy.

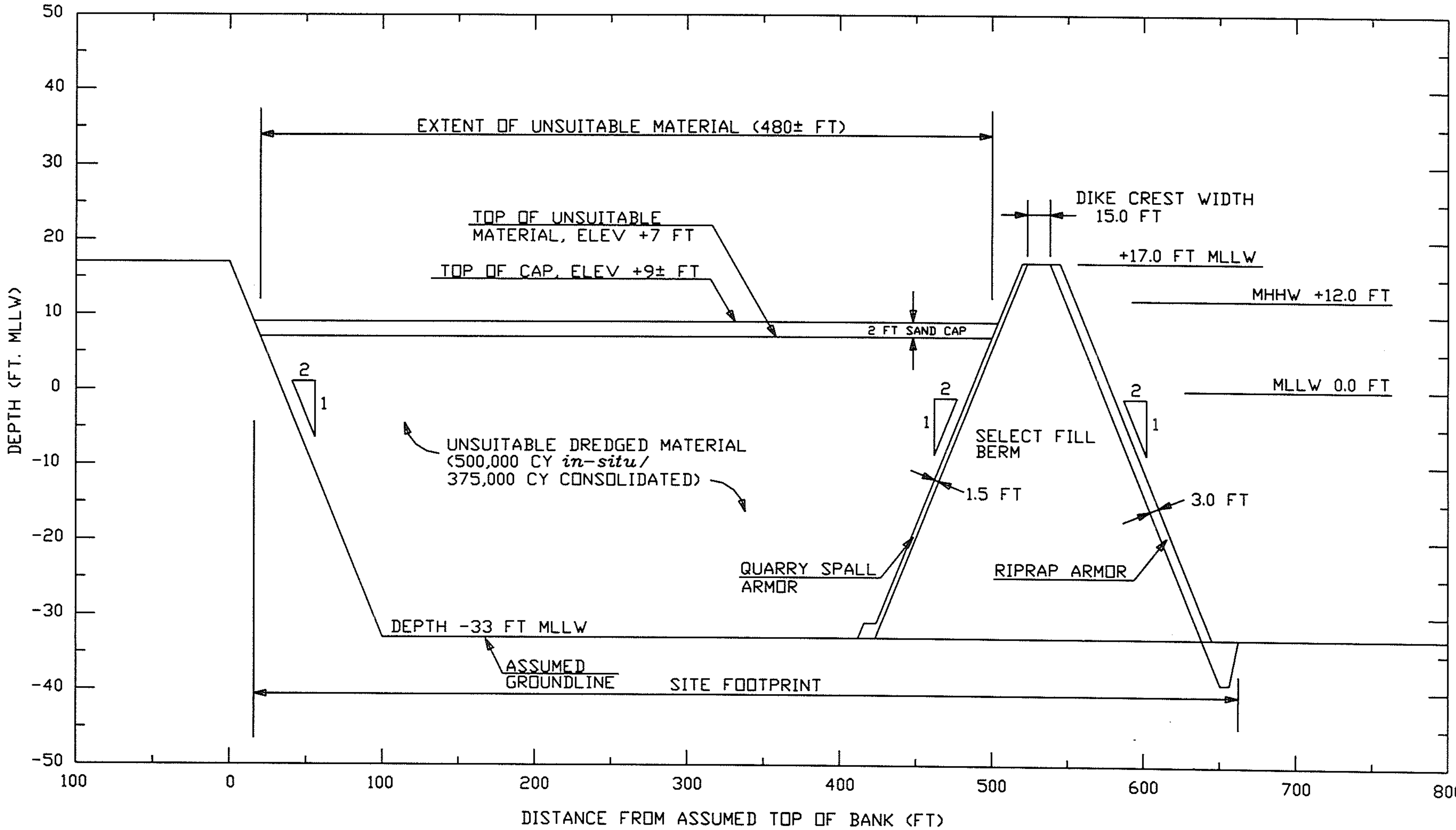

Figure 2-9	Schematic Cross Section of 500,000 cy Nearshore Confined Disposal Concept. The 2,000,000-cy CDF is 1,050 ft from the top of the bank to the toe of the dike.	MUDS Draft PEIS Feb 99 | MPEIS Figure 2-9.xar

For the purpose of conceptual design, 25-percent consolidation following placement was assumed. It was also assumed that the material was placed over a 10-year period (an actual site could operate for shorter or longer periods, or could be inactive for several years).

A rectangular geometry was assumed for the conceptual design. Nominal dimensions for sites with the two capacities are presented in Table 2-3, and the general configuration is illustrated in Figure 2-10. Nearshore CDF construction is estimated to require on the order of 9.5 to 15 months for the 500,000-cy and 2,000,000-cy facilities, respectively.

Transport and Placement. The conceptual design assumes that the dredged material is mechanically dredged and transported to the disposal site by barge. The material is offloaded by clamshell directly into the CDF with subsequent redistribution as needed within the CDF using a small hydraulic dredge. The offload clam is anchored with the haul barge offshore adjacent to the CDF perimeter dike. Sets of pile dolphins are provided along the CDF perimeter to assist in temporary barge moorage and/or offloading. Dredged material is placed by clamshell directly over the dike into the CDF along the interior perimeter slope. The deposited material sloughs downslope and builds a layer of dredged material spreading into the CDF along the interior dike perimeter. As the fill builds along the dike interior, a portable hydraulic dredge is periodically used to redistribute the dredged material deposit away from the dike and across the CDF expanse. This maintains additional capacity along the dike available for continued clamshell offloading.

As the CDF is filled, the offload barge is moored at dolphins adjacent to various points along the dike to ensure that the dredged material spreads over the entire surface area. An outflow structure (e.g., an adjustable weir) is placed in the dike in case it is necessary to drain excess water associated with dredged sediment, storm water, or storm surges that elevate water levels above MHHW. The contaminated sediment is placed no higher than +7 ft MLLW to ensure the material remains saturated and anaerobic.

An alternate method for placing contaminated sediment in the CDF is direct dumping from a barge that enters the CDF through a notch in the berm (see Section 2.3.4.1). This method has been used successfully for several Puget Sound disposal projects; however, these disposal facilities were open for relatively short time periods. For the 10-year operating period assumed for the MUDS conceptual design, direct sediment placement over the dike using a clamshell bucket was assumed.

Contaminant Control Measures. The conceptual design cannot address specific requirements for additional controls to reduce contaminant losses because contaminant pathway testing was not conducted in this programmatic phase of the study. However, pathway testing would be done as part of any site-specific MUDS design effort. For purposes of the conceptual design, contaminant control measures include a water control structure and a final cover of clean material. No liners, low-permeability barriers, or leachate collection systems are assumed in the design. This is based on the success of

Table 2-3. Dimensions of Conceptual Nearshore Confined Disposal Site Design.

Feature	Units	CDF Volume (cy)	
		500,000	2,000,000
Elevation Reference Datum, MLLW	ft	0	0
Average Bottom Elevation below MLLW	ft	-33	-33
Elevation of MHHW	ft	12	12
Elevation, top of dike	ft	17	17
Elevation, top of contaminated dredged material fill	ft	7	7
Depth (thickness) of contaminated dredged materials	ft	40	40
Dike side slopes (H:V)	--	2:1	2:1
Crown width, top of dike	ft	15	15
Exterior dimensions at dike toe (LxW)	ft	1,270 x 645	2,070 x 1045
Footprint surface area	acres	19	50

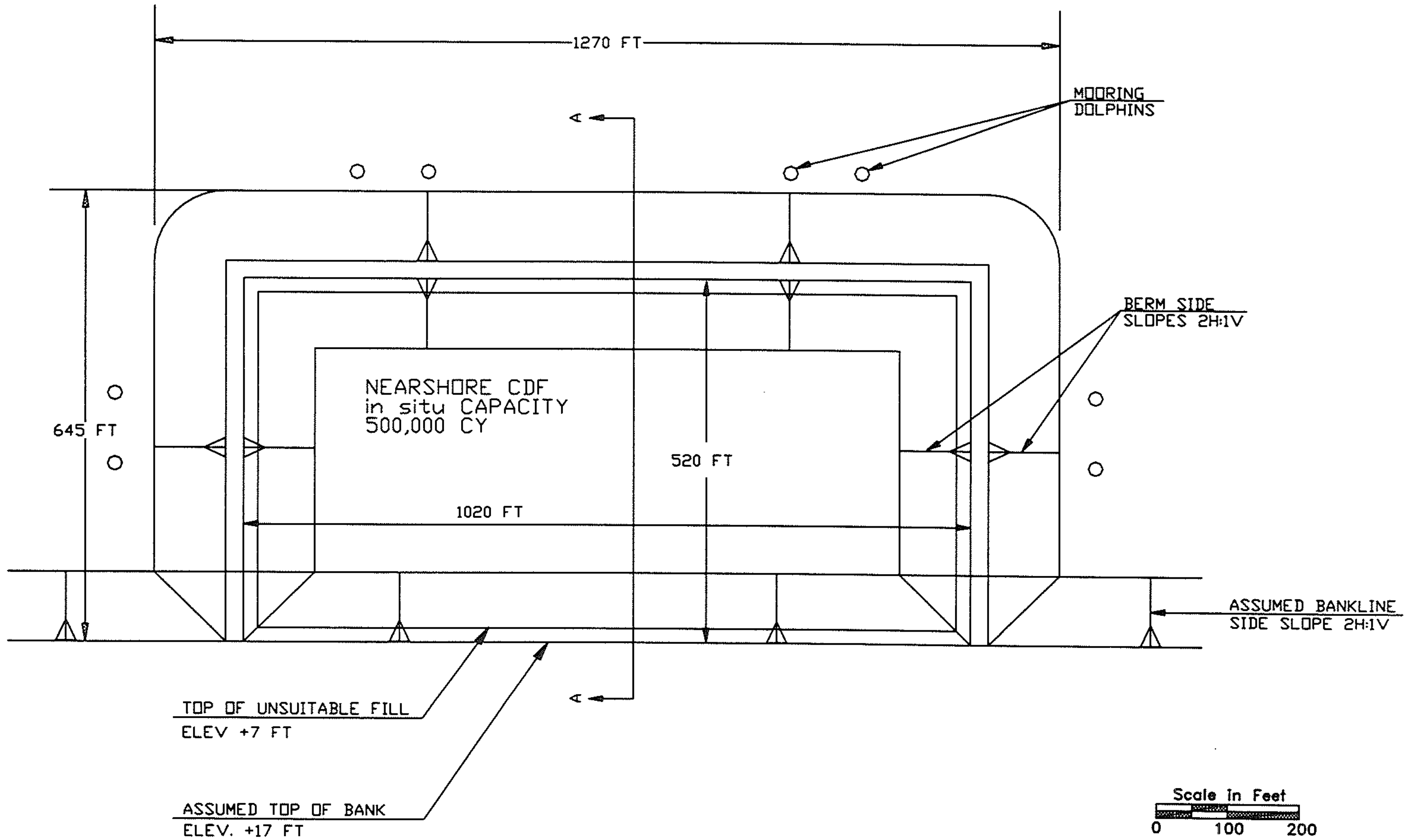

Figure 2-10	Schematic Plan View of 500,000 cy Nearshore Confined Disposal Concept. The 2,000,000-cy CDF is similar but occupies a 1,045 x 2,070 ft area.	MUDS Draft PEIS	
		Feb 99	MPEIS Figure 2-10.xar

nearshore CDFs in Puget Sound in containing leachate contaminants without such controls.

During the placement of contaminated sediments, ponded water may accumulate in the CDF. However, experience with nearshore CDFs in Puget Sound has indicated that excess water may slowly flow through dikes constructed of permeable material and so outflow structures may not be required if the site is filled mechanically. For the conceptual design, an adjustable decant weir is included in the design in the event operations indicate it is necessary to control water levels (Figure 2-11). Clarified water would be discharged into Puget Sound through a submerged outfall/diffuser. Gravity discharge occurs only when the adjusted interior water level is higher than the outer tide height. The discharge pipe would be equipped with a backflow valve to prevent outer high tides from backing into the CDF cell.

A 2-ft layer of imported clean fine sand would be placed as a final cap over the completed CDF. This cover controls volatilization, surface runoff, and plant and animal uptake after site closure (Palermo et al. 1998a). It is assumed that the cap material would be dredged elsewhere by clamshell, transported by haul barge to the CDF site, and offloaded by clamshell to a limited reserved area within the perimeter of the CDF cell. A portable hydraulic dredge would be used to distribute the capping material evenly over the entire CDF dredged material deposit. Once the cover layer is above MHHW, the excess water would be decanted and the cover allowed to drain and dry up. Although a layer of either topsoil or pavement could be placed over the cover material, no assumptions about post-closure site use were made for the conceptual design, and a final cover layer is not included.

Monitoring. Water quality monitoring is conducted in the CDF during active placement of contaminated sediments to ensure compliance with water quality standards. The goal of the long-term monitoring program is to monitor potential leaching of contaminants of concern along transport pathways and to determine that the site design is effective in keeping the confined sediments saturated. Previous monitoring at regional nearshore CDFs has focused on the need to demonstrate that the CDFs are effective in controlling contaminant migration from confined fill material. Studies at Terminal 91 demonstrated the effectiveness of this CDF in controlling contaminants (Boatman and Hotchkiss 1997).

For a nearshore CDF, the primary transport pathways during operation and after site closure are through the containment dike either in the intertidal zone or the subtidal zones (Palermo et al. 1998a). The intertidal and subtidal zones represent two distinct pathways. The intertidal zone is characterized by a variably saturated zone that periodically fills and partially drains with the tides. Consequently, there is potential water movement through the dike, but at reduced rates due to tidal fluctuations. The subtidal zone is marked by a much less dynamic tidal effect and also much weaker groundwater movement due to the combined effect of low-permeability dredge fill and high-density seawater encountered below the tide level.

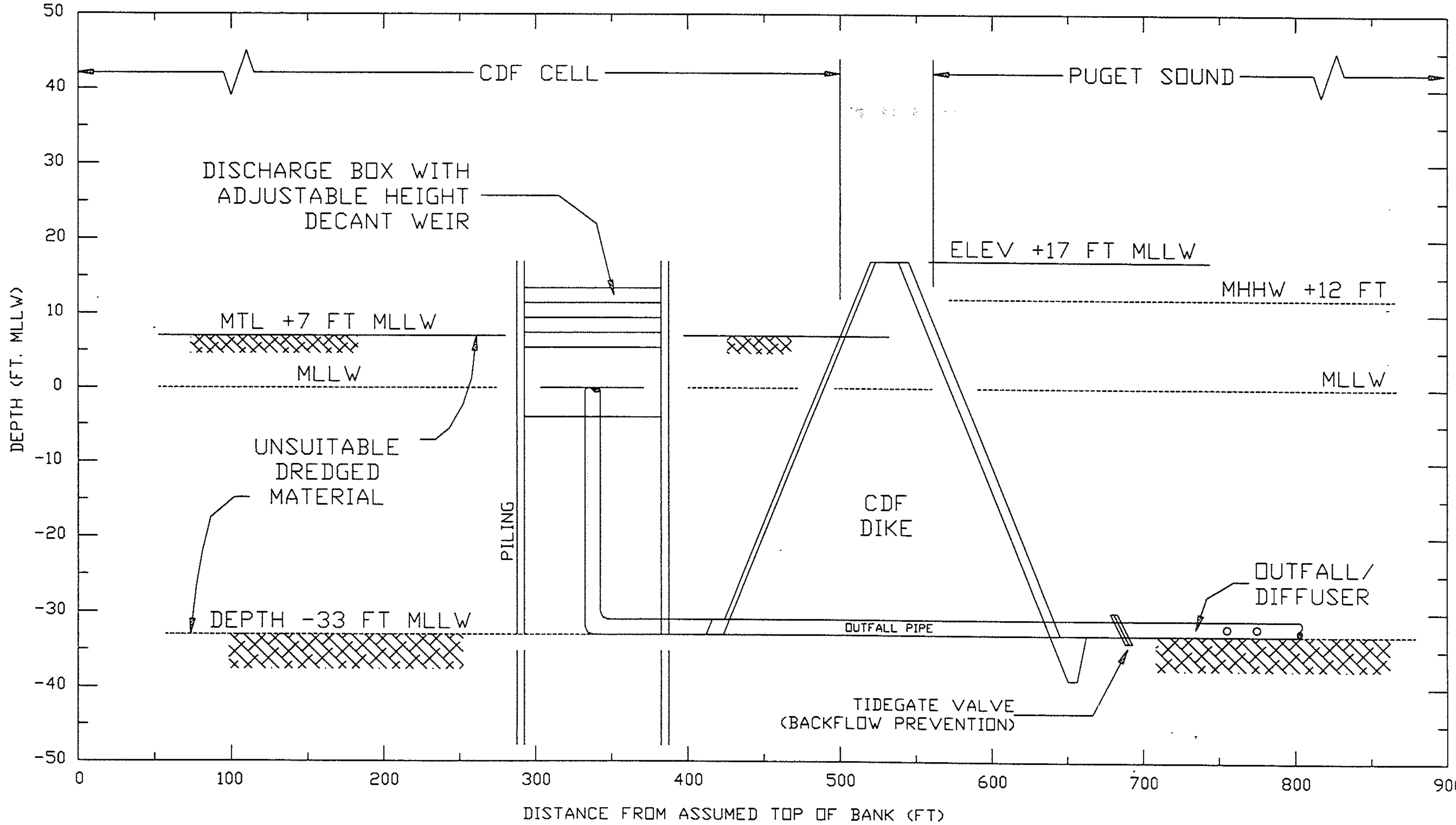

Figure 2-11 Schematic Nearshore CDF Drainage System	MUDS Draft PEIS	
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To adequately monitor for contaminant migration through the dike, it is necessary to install well pairs with one well completed in the intertidal zone and one in the subtidal zone. The locations should be as close to the shoreline as practicable. In additional to the nearshore wells, a piezometer should be located on the upland side of the dike for the purpose of showing water levels over the fill material and demonstrating that the fill is contained under saturated conditions. Upland groundwater monitoring should provide initial information on background conditions. Finally, biological monitoring of organisms in the fill material may be conducted during periods of low site use to monitor potential contaminant uptake by vegetation or invertebrates that occupy the site prior to final capping and closure.

Because of the reworking of the sediment fill with hydraulic dredges inside the CDF and the use of uniform dike material, relatively few well pairs would demonstrate the effectiveness of the CDF. For conceptual design costing, it is assumed that for the 500,000-cy CDF, two well pairs would be located along the dike parallel to the shore and one well pair would be placed on each side of the dike segments perpendicular to the shore. For the 2,000,000-cy CDF conceptual design, a total of eight well pairs would be included in the monitoring design. Groundwater analyses would include chemicals of concern identified in a site-specific monitoring plan. Sampling and analyses would also be conducted in accordance with a site-specific monitoring plan developed once site use frequency is established (for conceptual design costing purposes, semi-annual sampling events are assumed).

Nearshore CDF Cost Estimates

Cost estimates for the 500,000 and 2,000,000 cy nearshore CDF conceptual design described above are summarized in Table 2-4. Basic estimates are for direct costs of materials, labor, and equipment for mobilization-demobilization and operations. Typical rates for indirect costs (15%), contractor profit (10%), and contingencies (20%) are added. Future costs over the phased project development are shown only as present cost. See Appendix C for more detailed cost and design assumptions associated with CDF construction and site operation. Other key assumptions include the following:

- Based on information received from several Puget Sound port representatives, nearshore (intertidal and shallow subtidal) real estate values range from approximately \$2.00 to \$6.00 per sq ft. A mean value of \$4.00 per sq ft or \$165,350 per acre was used to estimate real estate acquisition costs.
- The shallow subtidal and intertidal habitat filled by the nearshore CDF would need to be replaced. Habitat mitigation costs (per acre of filled land) have ranged from about \$300,000 to \$600,000 per acre for similar projects in Puget Sound (Hart Crowser 1997). The median value of \$400,000 per acre was used for this concept level cost estimate.
- It is assumed that groundwater and effluent chemical monitoring demonstrate that contaminants are not migrating from the site and that biological monitoring is not required.

Table 2-4. Concept Level Costs Estimated for Constructing MUDS Nearshore CDF.
(See Appendix C for more detailed cost information.)

MAJOR CAPITAL ELEMENTS	500,000 cy Capacity Estimated Cost	2,000,000 cy Capacity Estimated Cost
Pre-construction	$50,000	$50,000
CDF Cell Construction	$5,316,850	$9,446,100
Offload & Re-distribute Dredged Materials	user's expense	user's expense
Re-distribute by Hydraulic Dredge/Pipeline	$1,121,500	$4,870,000
Final Sand Cap	$393,700	$1,232,000
Monitoring Costs	$725,863	$1,175,544
TOTAL ESTIMATED DIRECT COSTS:	**$7,607,913**	**$16,773,644**
ADD: Indirect Cost (15%)	$1,141,187	$2,516,047
Contractor Profit (10%)	$760,791	$1,677,364
Contingencies (20%)	$1,521,583	$3,354,729
REAL ESTATE ACQUISITION (assumes $174,000/acre)[1]	$3,306,000	$8,700,000
HABITAT MITIGATION (assumes $400,000/acre)[1]	$7,600,000	$20,000,000
TOTAL ESTIMATED 10-YEAR CONCEPT COST:	**$21,937,474**	**$53,021,784**
Cost/cubic yard	**$44**	**$27**

[1] The costs for real estate acquisition and habitat mitigation studies are highly variable. Real estate acquistions costs are estimated to range from $87,000/acre to $261,000/acre. Habitat mitigations costs are estimated to range from $300,000 to $600,000/acre. Based on these cost ranges, the total estimated cost/cy would range from $37 to $55 at the 500,000-cy facility and $22 to $34 at the 2,000,000-cy facility. See Section 2.4.4.2 for additional explanation.

Cost estimates for disposal at a nearshore CDF range from $27 per cy at a 2,000,000-cy facility to $44 per cy at a 500,000-cy facility. Actual site characteristics, facility designs, monitoring, or mitigation requirements different from those assumed for the conceptual design could significantly alter these cost estimates. For example, total project cost is greatly influenced by the cost for real estate acquisition and habitat mitigation; however, the cost of these two components is highly variable. If the minimum and maximum cost estimates for both real estate and habitat mitigation are used, the cost range for disposal at a nearshore CDF is $22 to $34 per cy at a 2,000,000-cy facility and $37 to $55 per cy at a 500,000-cy facility.

Many other factors could affect total project costs. Examples of changes that could make actual project costs lower than the conceptual design estimate include:

- Locating the facility within a shoreline inlet or old berthing slip that is closed off by a cross dike (as has been done for most existing Puget Sound CDFs) so that the length of the dike that needs to be constructed is reduced.
- Using a notch in the dike to allow direct barge dumping of material within the disposal area instead of transferring the material over the dike.
- Reduced mitigation costs if major construction is not required as part of the mitigation.
- Redeveloping the property following site closure could substantially reduce the total project cost. Existing nearshore CDFs in Puget Sound have been constructed by local ports and have been justified economically based on post-closure use of the land created by the CDF.

Examples of changes that could make actual project costs greater than the conceptual design estimate include:

- Incorporating an impervious core within the dike
- Requiring surface water collection and management following site closure
- Encountering site-specific geotechnical conditions that increase dike material costs
- Adding a final cover and other basic site development costs (e.g. fences, lights).

2.4 UPLAND CONFINED DISPOSAL FACILITY ALTERNATIVE

2.4.1 Description

The upland CDF alternative is the placement of contaminated sediments within a diked confinement structure via pipeline or other means (Figure 2-12). The contaminated sediments are covered with clean material to allow beneficial reuse after completion. Upland CDFs are designed to retain dredged sediment solids while providing acceptable suspended solids and/or contaminant concentrations in effluent for discharge to receiving waters. All dredged material at upland CDFs is placed above the water table. As a

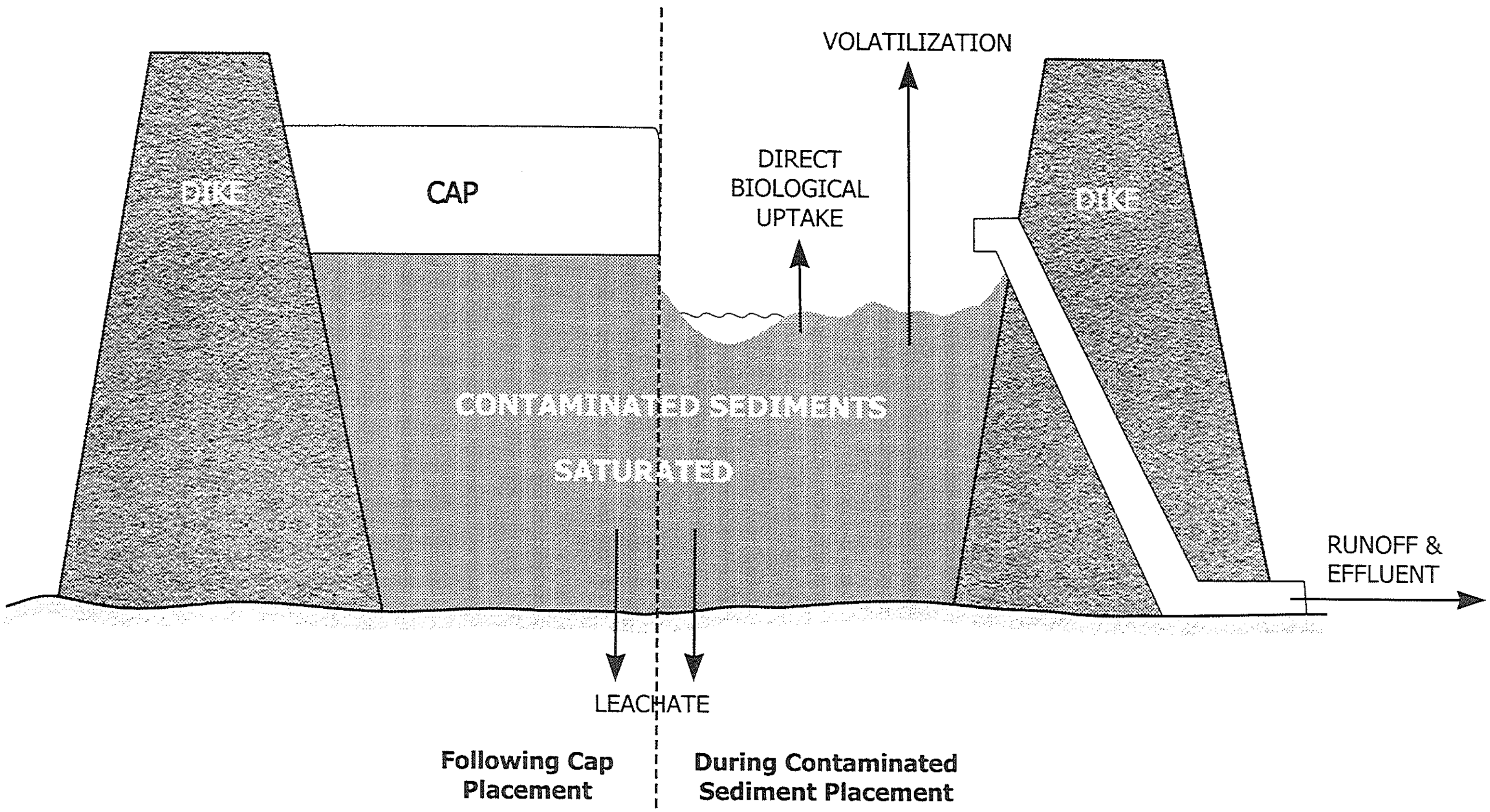

Figure 2-12 Potential Contaminant Pathways for Upland CDFs

MUDS Draft PEIS | Feb 99 | MPEIS Figure 2-12.xar

MUDS facility, an upland CDF would be used over many years with dredged material being added periodically over the design life of the facility.

There are three primary objectives in the design and operation of an upland CDF: 1) provide adequate storage capacity for meeting disposal requirements; 2) maximize retention of solids within the confinement area; and 3) control contaminant releases from the facility. A principal design criterion of upland CDFs is to retain as high a percentage of fine-grained sediments as possible. Because most contaminants in sediments remain attached to solid particles during dredging and placement into the upland CDF, this process is reasonably efficient for containing contaminants.

Dredged sediments typically contain 10 to 50 percent solids. The amount of water added depends on the design of the dredge, physical characteristics of the sediments, and operational factors such as pumping or transport distance. Because of its water content, dredged material that is placed in an upland CDF is either dewatered at a nearshore rehandling facility prior to placement at the upland CDF or the dredged material is placed directly in the upland CDF, in which case it may initially occupy several times its final volume. Much of the excess water is discharged as effluent from the dewatering facility or the upland CDF during filling operations, and then natural drying forces continue to dewater the dredged material. As the sediments dewater, their volume is reduced and additional storage capacity is created. Therefore, short-term operational storage capacity can be as important a factor in design and management of the upland CDF as long-term storage capacity. Dewatering results in the sediment eventually consolidating to approximately the volume it occupied before dredging occurred. In this section, technology and design considerations for both components of upland confined disposal (i.e., the dewatering facility and the upland CDF) are discussed.

2.4.2 Contaminant Pathways

The pathways of concern associated with the upland alternative include (see Figure 2-12):

- Effluent discharge to surface water during filling operations and dewatering
- Rainfall surface runoff
- Leachate into groundwater
- Volatilization to the atmosphere
- Direct uptake by plants and animals and food web cycling.

The effects on surface water, groundwater, air, plants, and animals depend on the characteristics of the dredged material, management, and operation of the site during and after filling, and the proximity of the CDF to potential receptors.

2.4.3 Regional Examples

Nationally, upland CDFs are one of the most common dredged material disposal methods, although there are currently no upland CDFs for contaminated sediments in the Puget Sound area. Upland CDFs exist in most other regions of the country and are extensively used in the Atlantic and Gulf Coast regions of the U.S. Large upland sites (some larger than 1,000 acres) are actively being used near the following cities:

- Wilmington, North Carolina
- Charleston, South Carolina
- Savannah, Georgia
- Jacksonville, Florida
- Mobile, Alabama
- New Orleans, Louisiana
- Galveston, Texas.

2.4.4 Feasibility and Implementation

The design, engineering, and monitoring technologies associated with upland CDFs are well-established.

2.4.4.1 Technology and Logistics

The technologies for dredging and transporting the sediments are discussed in Section 2.2.4. The technologies associated with disposing sediments in an upland environment are closely tied with solid waste landfill technologies and are discussed in the following sections. The water content of dredged sediments for disposal at both the upland CDF and solid waste landfill alternatives must be reduced before disposal. Dewatering requires rehandling of the contaminated sediments at an on-shore or nearshore facility and is typically included and permitted as part of a project dredging plan. Dewatering methods are discussed below.

Dewatering Facility

A dewatering facility is typically comprised of multiple cells where material can be actively disposed of, left for dewatering, rehandled for transport to the upland disposal site, or stored for a short period while other cells are occupied. Individual cells are lined or paved to control leachate infiltration into the groundwater, depending on regulatory requirements and the level of contamination in the sediments. Dikes of compacted soil or concrete provide the outside walls and separate the dewatering facility into individual cells.

Offloading Facilities. A dewatering facility is typically located at a shoreline or nearshore location to allow barge transport of the dredged sediment. When a barge with contaminated dredged material arrives at the dewatering facility, the sediments are transported by one of several methods, depending on the distance between the dewatering facility and the point of closest access by the barge. The following methods available to transfer sediments from a barge to the dewatering facility or CDF are the same as those for a nearshore CDF:

- Deposit the sediments by clamshell to a conveyor belt extending from the barge to the dewatering facility.
- Deposit the sediments by clamshell to roll-off containers or dump trucks for transport to the dewatering facility or CDF. A chute or conveyor belt can then move the sediments from the trucks to various spots within the rehandling facility or CDF.
- Mix the sediments with water to form a slurry that could be transported by a pipeline to the dewatering facility or CDF.

Water Management. All water within the operations area is collected and treated to meet water quality requirements before discharge back to surface waters. Water is collected from the following sources:

- Free-water ponding in the arriving haul barge
- Drainage water from each dewatering cell
- Rainwater runoff from the entire operations area including the cell surfaces
- Water from wheel washing of the out-bound transport vehicles.

Operations. Dredged material is centrally placed in each dewatering cell by a conveyor belt delivery system. The site manager selects the amount and type of materials for each cell based on site needs and dredge volumes. The diverted dredged material tends to mound beneath the belt discharge point, leaving the gravity drainage path toward the outside ends of the cell. If needed, a rubber-tired loader can enter the cell or a clamshell can be used to assist in distributing the dredged material to both properly fill the cell and enhance surface drainage.

Dredged material is left in the cell to allow pore water to be extruded to the surface by the weight of consolidation. Limited ditching can be used to promote effective surface drainage. All free-water drainage arising within the cell is removed, typically by selective pumping. Heavy rainfall can complicate the surface drainage and water removal process.

When the dredged material mass has dewatered to the point of meeting the EPA paint filter test requirement (no free-water seepage within 5 minutes), the dredged material is mechanically rehandled (loader, clamshell, hoe) to trucks or containers for transport offsite to the upland CDF. In some instances, fine-grained dredged sediments do not dewater sufficiently by simple consolidation and surface drainage to meet the no-free-water requirement. Desiccants can be added and mixed to meet the requirement for these materials. Loaded vehicles are wheel-washed before leaving the paved operations area to limit track-out of contaminated dredged materials. The entire operations area is managed to limit losses of dredged materials through efficient sediment transfer to the upland CDF.

Upland CDF

While site-specific design features will depend on the individual project and site characteristics, the general design elements to be addressed at all upland CDFs are described here.

Containment Dikes. The major considerations for design, operation, and placement of upland CDF containment dikes include transport and placement of material, site capacity, dewatering and long-term management, and other pathway controls. Site conditions must allow for construction of geotechnically sound structures for effective containment of ponded water and dredged material. The containment structures must be designed to withstand seismic events.

CDF confinement structures consist primarily of earth-fill embankments (dikes), whose principal objectives are to retain solid particles and ponded water within the disposal area while allowing clarified effluent to be released to natural waters. The height and geometric configuration of the dikes are determined primarily by capacity requirements, availability of construction materials, site restrictions, and prevailing geotechnical conditions (Palermo et al. 1998a).

The primary dike in a containment facility extends around the outer perimeter of the containment area. Cross and spur dikes also can be constructed to create cells within the site or increase site effectiveness. Dike design factors include selecting the location, height, cross section, materials, and construction methods. Design and construction methods vary with project constraints, which include foundation conditions, material availability, and construction equipment availability.

Transport and Placement. Upland sites may be located at some distance from both the dredging area and waterfront access. The method selected for the transfer of dredged material from dredging areas to an upland CDF depends on the proximity of the CDF to the dredging area and the dredging technology used to excavate the sediments. Direct placement of hydraulically dredged sediments into a CDF by pipeline is feasible if the site is located near the dredging area, but this is likely to be applicable only at a very small number of potential sites in Puget Sound. If direct placement is not feasible, then material can be transported to the upland site in containers or trucks, after being rehandled at a shore-based dewatering facility (as described previously). The methods available to transfer sediments from the rehandling facility to the upland CDF include mechanical rehandling (loader, clamshell, hoe) to lined and watertight trucks or rail cars for overland transport.

Capacity and Solids Retention. An upland CDF is designed to have adequate volume to meet both the short-term storage capacity requirements during filling operations and the long-term requirements for the anticipated life of the site. Sufficient surface area and dike height with freeboard must be available for retention of fine-grained material to maintain effluent water quality. If the CDF is hydraulically filled, it is also designed with sufficient capacity to retain suspended solids during settling so that only water containing no or little suspended solids or contaminants are discharged. The initial storage capacity and surface area is governed by settling processes that occur in a CDF during placement of fine-grained dredged sediments. Testing sediments to determine their settling rate can help define the ultimate size and design of the containment area.

Dewatering and Long-term Management. Upland CDFs are managed to allow for passive or active dewatering of fine-grained material. Long-term management primarily involves control of runoff and continued dewatering to maximize dredged material consolidation and storage capacity at the facility. A multiuser upland CDF would be designed for long-term use. If the surface area of the upland CDF is fixed at the beginning (no areal expansion in the future), the remaining storage capacity at any given time is a function of the dredged material fill height. Settlement from consolidation is a major factor in estimating long-term storage capacity. The weight of dredged material may also compress the soil under the containment area and result in additional settlement. Settlement of the containing dikes also affects the available storage capacity.

Drying or dewatering of sediment placed at the CDF may be passive or active. Passive dewatering entails using natural forces such as wind and the heat of the sun to dry out the sediment. Active dewatering involves the creation of trenches in the CDF to drain surface water and expose more of the dredged material to evaporative processes. Dewatering has several benefits:

- Shrinkage and additional consolidation of the material creates more volume in the CDF for additional dredged material
- The drying process changes the dredged material into a more stable soil form amenable to removal and potential uses such as raising the dike to create more capacity in the CDF (depending on level of contamination)
- Dewatered material remaining in the CDF forms a more stable base with predictable geotechnical properties.

Dewatering creates an aerobic environment that may improve conditions for biodegradation of organic contaminants, but also increases the mobilization of other contaminants such as metals.

Additional Control Measures. Controlling contaminant release through any of the possible pathways must be considered in site design. When conventional CDF disposal techniques are ineffective, additional contaminant control measures and management actions are necessary, including:

- Treatment of discharge to surface water
  - Suspended solids removal
  - Metals removal
  - Organics treatment
- Engineered controls such as liners
- Site operations such as surface water management and daily cover

Treatment of Discharges to Surface Water. Discharge from an upland CDF includes sources such as effluent from active filling operations, surface runoff, leachate, or water from dewatering or treatment processes. Before any discharge is released to receiving waters, residual contaminants must be removed. Most of the contaminants from these discharges are associated with suspended solids. Suspended solids removal is the most critical treatment procedure because it offers the greatest benefits in improving effluent quality, not only by reducing turbidity but by removing particulate-associated contaminants. Particle settling, chemical flocculation, filtration, sand-filled weirs, and wetland filtration have all been used for suspended solids removal at upland CDF projects (Palermo at al. 1998a).

Other treatment technologies remove specific contaminants from surface water discharges. A variety of contaminants may be present in dredged sediments and may possibly require more than one treatment process. Metals removal processes at CDFs are similar to those commonly used for industrial applications. Ion exchange and precipitation are probably the two most efficient metals removal processes, but they are generally designed for specific metals often requiring major investments in operational control for efficient results. Flocculents have been demonstrated to be effective in removing suspended solids from dredging effluents, but removing dissolved heavy metals through flocculation has not been evaluated in field applications (Palermo et al. 1998a).

The applicability and effectiveness of treatment options for dissolved organic contaminants are mostly dependent on the concentration and flow rate of the discharge. The principal organic treatment process options are carbon adsorption [applied to a PCB spill on the Duwamish Waterway in the 1970s (Blazevich et al. 1977)], UV light and chemical oxidation [used for dredged material effluent from the New Bedford Harbor Superfund site (Otis 1994)], oil separation, and wetlands/phytoremediation. Biological processes such as nitrification, nutrient catabolism, and photosynthesis are important degradation mechanisms for nutrients, oxygen-demanding materials, and other organics in upland CDFs. Mechanical biological wastewater treatment processes are not used because sufficient organic matter is seldom available to support biological growth and because operation of biological systems under the conditions of fluctuating flows and temperatures is difficult. The status of other treatment options for contaminated sediments are discussed in Section 2.8.

Engineered Controls. Site controls such as liners, surface covers, sheet pilings, slurry walls, groundwater pumping, and subsurface drainage are effective at preventing migration of contaminants from the dredged material (Cullinane et al. 1986, Averett et al.

1990). Liners have not been used extensively at upland CDFs for contaminated sediments because the low permeability of fine-grained sediments following compaction acts to prevent contaminant migration. As at nearshore CDFs, surface covers reduce leachate generation by minimizing rainfall infiltration, prevent uptake by plants and animals, minimize volatilization of contaminants at the surface, control dust, and eliminate transport of contaminants by rainfall and runoff. In addition to the final surface cover, more frequent interim covers may be used as necessary to control sediment transport and contaminant migration. Sheet pile and slurry walls can provide a barrier to leachate movement, but the barrier should be tied to a geologic formation with low permeability. Graded stone dikes with sheet pile cutoffs have been used or proposed at upland CDFs to control leachate migration. Because sheet piles are not leakproof and deteriorate over time, they should be used only as a secondary containment measure. Leachate collection techniques such as groundwater pumping and subsurface drainage have also been used.

Site Operations. The manner in which the CDF is operated can reduce the exposure of material through surface water, volatilization, and groundwater pathways. The decision to apply certain management options often requires trade-offs. For example, managing pond water during and after disposal operations controls contaminant exposure. Mobilization of contaminants from dredged material depends on the oxidation state of the solids. Most metals are much less mobile when maintained in an anaerobic reduced condition. On the other hand, aerobic sediments generally improve conditions for biodegradation of organic contaminants, but exposed aerobic sediments generally present the greatest potential for volatilization of contaminants (Corps 1998).

Monitoring. The basic monitoring elements at an upland CDF are similar to those at a nearshore CDF (Section 2.3.4.1). Environmental pathways of concern at an upland CDF include effluent discharge and groundwater. Groundwater effects include potential impacts to drinking water supplies or surface waters, but these impacts are typically minimized by the siting process (Appendix B). In some cases, air quality and plant and animal uptake may also be of concern. Monitoring would include installing groundwater wells and sampling on a regular basis.

2.4.4.2 Conceptual Design and Cost

The purpose of the conceptual design is to provide a reasonable scenario for the upland CDF alternative for evaluation in this PEIS. An upland site design was selected based on the design elements and pathways of concern described previously, existing project experience, and general Puget Sound environmental features. The conceptual design is used to estimate planning level costs and discuss the potential environmental impacts associated with this alternative. The conceptual design is not intended to establish site design, operational, or management requirements for possible, future, site-specific MUDS upland facilities or any other regional upland CDF project.

The basic conceptual designs for the dewatering facility and the upland CDF are summarized in this section. More detailed information is presented in Appendix C.

Dewatering Facility - Conceptual Design

The conceptual design selected for this MUDS dewatering facility is to dewater clam-shelled dredged material without adding slurry water for hydraulic pumping. This design should improve and shorten the dewatering process, support a smaller site area, and avoid management and treatment of large hydraulic flows. The plan calls for a small number of adjacent cells, each capable of holding one or two barge loads of dredged material.

Capacity and Size. Alternative layouts for the dewatering facility assumed disposal rates for the following capacities: 1) a 500,000-cy disposal need over 10 years, or 50,000 cy/year; and 2) a 2,000,000-cy disposal need over 10 years, or 200,000 cy/year. Figure 2-13 shows the general layout of the dewatering facility used for this conceptual design. Nominal dimensions for sites with the two capacities are presented in Table 2-5. The overall combined capacity would be sufficient to provide for holding times resulting in acceptable dewatering at the assumed disposal rate.

Dewatering/Holding Time. The conceptual design assumes that dredged material must be dewatered to meet the EPA paint filter test requirement before it can be transferred to upland CDF (or landfill) disposal (i.e., no-free-water seepage within 5 minutes testing). Dredged material in Puget Sound is expected to range from well-draining sands/gravels to slow-draining, high water content muds. There is no reliable technical basis for efficiently sizing the re-handling facility holding capacity to ensure dewatering to the no-free-water requirement for the wide variety of possible dredged material textures. Rather, it is assumed that a four-day holding time would adequately dewater most Puget Sound dredged materials to allow re-handling and transport to the upland CDF. This assumption is based on local construction and dredging experience. However, there may be some projects in Puget Sound where dredged material cannot be readily dewatered by the MUDS rehandling facility and therefore require project-specific dredging and disposal procedures.

Holding Capacity. The aggregate multi-cell capacity is sized to provide a target holding/dewatering time for dredged materials of four to five days (see above) prior to re-handling and transfer to the upland disposal site. The overall rehandling facility capacity is sized to accommodate the expected daily loading (throughput) rate of 250 cy/day and 1,000 cy/day at the 500,000-cy and 2,000,000-cy facilities, respectively. However, actual daily rates are dependent on dredging project activity, including dredging rates and barge sizes, and would vary from long periods of no disposal to times when more than one project is delivering to the offload site each day. For this concept development, it is assumed that the maximum throughput rate over a 4-day target holding/dewatering time is 1,500 cy/day for the smaller (50,000 cy/yr) facility and 2,500 cy/day for the larger (200,000 cy/yr) facility. This results in assumed 4-day holding time capacities of at least 6,000 cy and 10,000 cy for the small and large options, respectively.

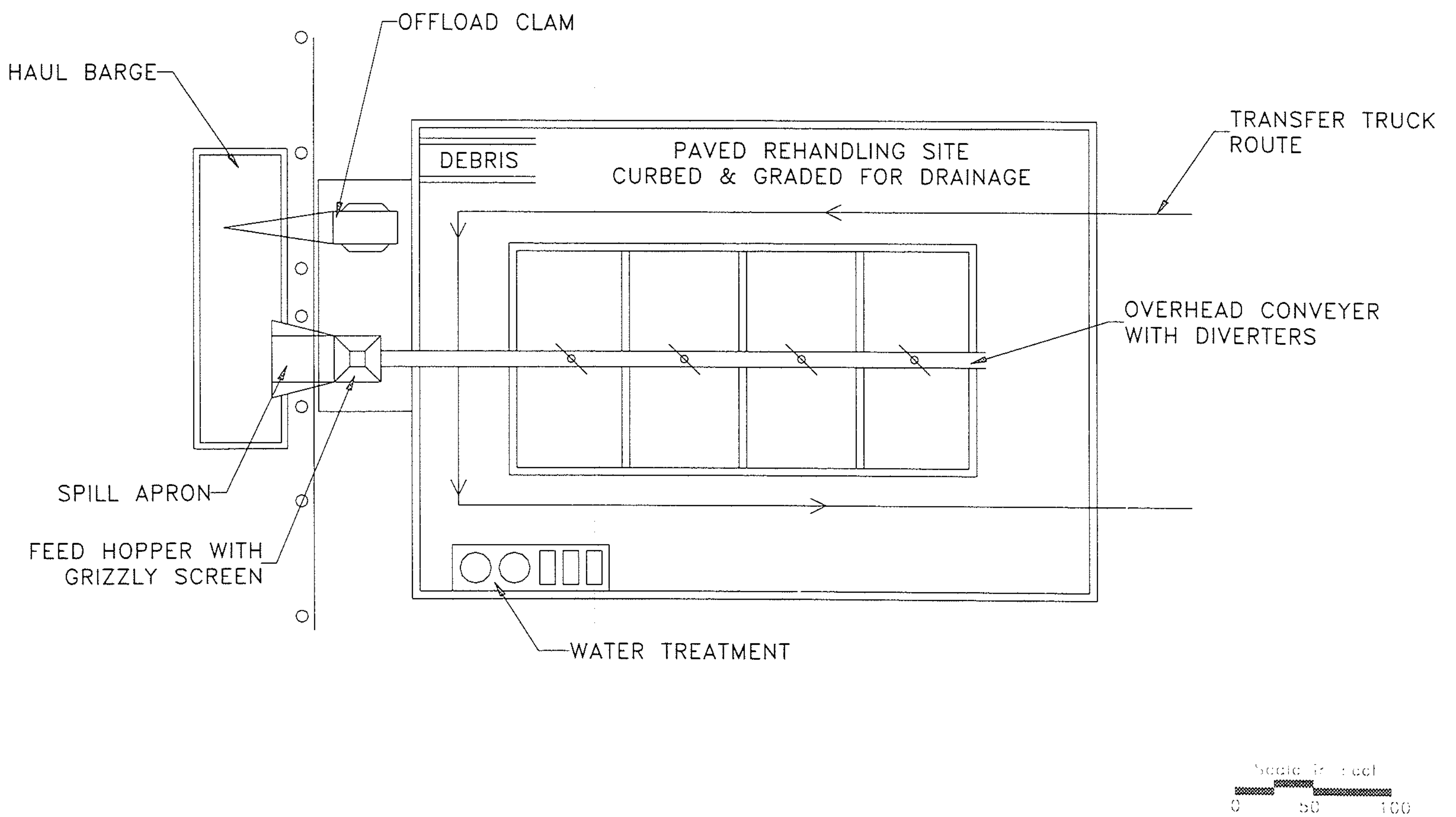

Figure 2-13	Schematic Plan View of the Upland Rehandling/Dewatering Site The site would occupy an area of approximately 300 x 400 ft (2.7 acres) to 400 x 600 ft (5.5 acres) depending on capacity and throughput rate.	MUDS Draft PEIS Feb 99 — MPEIS Figure 2-13.xar

Table 2-5. Features of Dewatering Facility Conceptual Design.

Feature	10-Year Rehandling Capacity	
	500,000 cy	2,000,000 cy
Assumed throughput rates:		
10-year	500,000 cy	2,000,000 cy
Annual	50,000 cy	200,000 cy
Daily avg. over 9-mo. dredging season	250 cy/day	1,000 cy/day
Max. over 4-day dewatering period	1,500 cy/day	2,500 cy/day
Required min. 4-day holding capacity	6,000 cy	10,000 cy
Number of cells (min.)	4 cells	4 cells
Depth of dredged material (max.)	6 ft	6 ft
Cell Size (nom.)	60 ft x 150 ft	75 ft x 200 ft
Cell capacity (@ 6 ft deep)	2,000 cy	3,300 cy
Surface area footprint (approximate)	3 acres	6 acres

The number of holding cells is also dependent on the operating plan. For this concept it is assumed that a minimum of four dewatering cells is required. This supports active disposal to one cell, gravity dewatering in the second cell, rehandling for transport in the third cell, and one additional cell for management of possible overload or problem materials (e.g., mixing desiccants). One of the four cells also can be reserved for management of problem sediments as needed, with the remaining three active cells providing the required minimum 4-day holding capacity. Assuming that the depth of dredged materials in a filled cell is 6 ft, Table 2-5 details the approximate cell layout parameters.

Transport and Placement. The conceptual design assumes that the dredged material is mechanically dredged and transported to the dewatering facility by barge. The conceptual design also assumes that an industrial waterfront site with navigation depths of at least -15 ft MLLW is available with convenient access to upland truck and/or rail transportation. A clamshell is used to offload the material from the barge directly into a hopper assembly that feeds a conveyor belt to the dewatering cells. A water-side apron device is added to the hopper to prevent spillage between the barge and the hopper, and a 'grizzly'-screen mechanism is added to remove debris too large for the hopper/conveyor system. The conveyor belt carries dredged material from the hopper out across the top of the cell array, and remote-actuated diverter assemblies deflect delivered dredged material at appropriate locations as needed into each cell.

Contaminant Control Measures. The dewatering facility comprises at least four individual cells. The dewatering cells are located as near the waterfront dock as practicable. Most of the rehandling site is paved and curbed to provide both a durable long-term work surface as well as drainage collection and containment. The cell walls are formed of portable rectangular concrete blocks to a minimum height of 8 ft. The four cells are situated adjacent to each other, using a single block wall between adjacent cells. A geotextile fabric is used to line the seams and bottom. Cell sizes and/or surface access to the cell interior are obtained by moving the concrete blocks.

All water arising within the operations area is collected and treated to meet water quality requirements for discharge back to Puget Sound. Collected water includes free water ponding in the barge, drainage water from each dewatering cell, rainfall runoff, and water from wheel washing of the outbound trucks. All collected water is routed by gravity drainage or pumping to a primary treatment system (pond) using gravity settling followed by filtration for removal of residual suspended solids as described by the Corps (Palermo et al. 1998a). Solids removed by the treatment processes are disposed of in the dredged material dewatering cells. Additional special treatment steps such as flocculation or carbon absorption are possible as required for water quality compliance, but these are not included in this conceptual design.

Upland CDF - Conceptual Design

The long-term upland CDF consists of a large diked confinement area built to receive dewatered dredged material over a 10-year period. The major area is divided into three or more diked sub-cells. For this concept development it is assumed that the disposal site must meet basic construction requirements for a municipal landfill. (See Section 2.5.4.2 for a description of the requirements for municipal landfills.) A bottom liner and leachate collection system are installed beneath each cell. All site water (drainage, leachate and surface runoff) is collected and treated by gravity settling and filtration prior to discharge. Dewatered dredged material arriving by trucks from the waterfront rehandling/dewatering site is deposited and advanced within each sub-cell by conveyor system. As the fill builds, low-ground-pressure equipment is used to eventually grade and progressively cap the emerging consolidated deposit with a layer of low-permeability soil, a geotextile membrane, and topsoil.

Site Layout. The overall site is a rectangular plan with an approximate 2:1 length:width ratio. Cross-dikes are constructed to divide the major cell into (at least) three sub-cells. It is probable that the filling sequence over time would complete filling of one sub-cell before beginning at the next. Each sub-cell, with cross-dikes and a leachate collection system, would be more or less constructed and operated to completion as an independent disposal cell. Construction of the upland CDF is estimated to require on the order of 11 to 17 months for the 500,000-cy and 2,000,000-cy facilities, respectively.

The assumed thickness of the dredged material disposal deposit is 8 ft. The plan provides for a 200 ft buffer/operating area fringe around the disposal cell, with fencing, a site management office, and shops.

Capacity and Size. Two 10-year disposal capacities are considered common, 2,000,000 cy and 500,000 cy *in situ* dredged material volume. An assumed net bulking/consolidation factor of 0.75 is applied, which reduces conceptual capacity at the disposal site to 1,500,000 cy and 375,000 cy, respectively. A schematic plan view of the 500,000 cy option is shown in Figure 2-14. Figure 2-15 is a partial cross section of the conceptual design. The design for the 2,000,000-cy option would be the same except that the overall dimensions would increase. Nominal dimensions for sites with the two capacities are shown in Table 2-6.

Transport and Placement. Dewatered dredged material is transferred by sealed-bed trucks from the waterfront dewatering/handling facility to the long-term upland disposal site. The trucked dredged material is then transferred into the CDF cell by conveyor because the soft dredged material does not initially provide enough structural stability to allow equipment operation. Trucks dump directly to a conveyor feed hopper and a mobile conveyor system would deposit the dredged material in a planned distribution pattern within the cell. At some point in cell building, it should be possible to begin working the

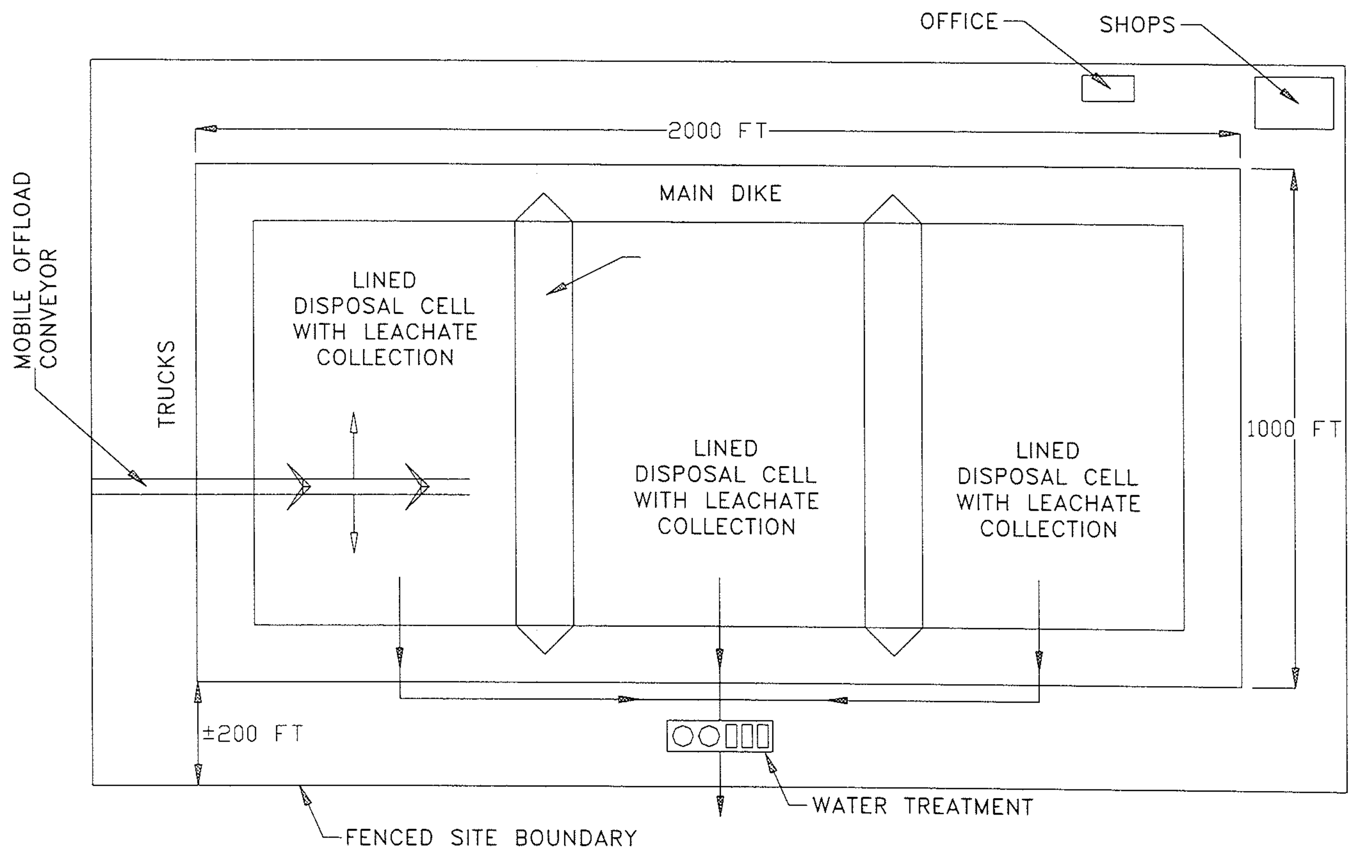

Figure 2-14 Schematic Plan View of Upland Disposal Site for 500,000 cy Option	MUDS Draft PEIS	
	Feb 99	MPEIS Figure 2-14.xar

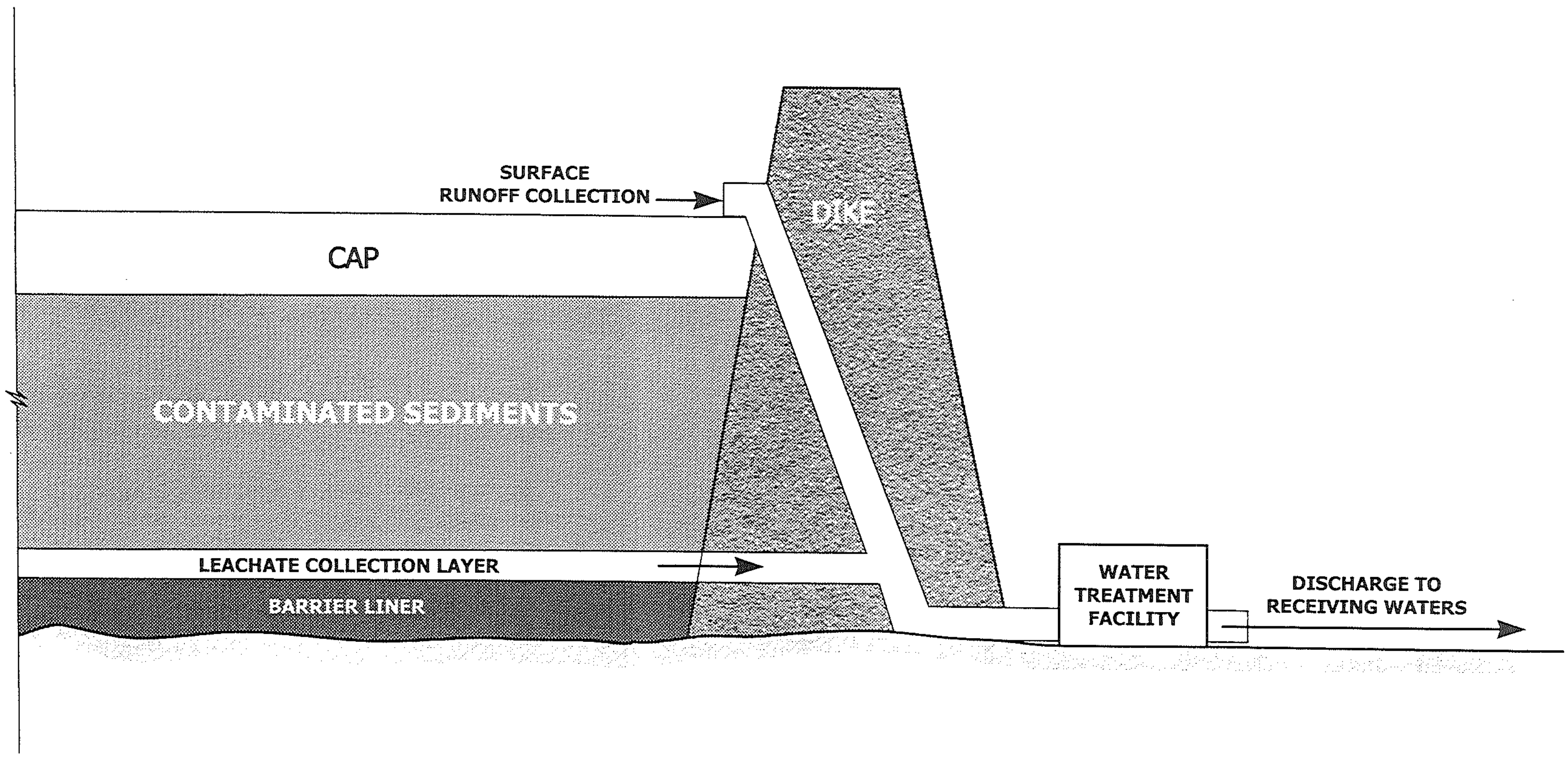

Figure 2-15 Cross Section of the Lined Cell for Upland CDF Conceptual Design (from Palermo et al 1998a)	MUDS Draft PEIS	
	Feb 99	MPEIS Figure 2-15.xar

Table 2-6. Features of an Upland CDF Conceptual Design.

Feature	10-Year Disposal Option	
	500,000 cy	2,000,000 cy
Assumed Disposal Rates:		
10-year total (in situ volume)	500,000 cy	2,000,000 cy
Annual (in situ volume)	50,000 cy	200,000 cy
Daily average (9-month dredging season)	250 cy/day	1,000 cy/day
Maximum daily (assumed)	1,500 cy/day	2,500 cy/day
Disposal Cell Capacity (assume 0.75 consolidation ratio)	375,000 cy	1,500,000 cy
Disposal Cell:		
Thickness of dredged material deposit	8 ft	8 ft
Height of containment dike above leachate collection system (incl. 2 ft ponding & 2 ft freeboard)	12 ft	12 ft
Overall height of dike above base level site grade (approx)	15 ft	15 ft
Dike crown width	20 ft	20 ft
Dike side slopes	3H:1V	3H:1V
Overall footprint of diked disposal cell	1,000 ft x 2,000 ft	1,900 ft x 3,700 ft
Perimeter dike length (nom)	6,000 ft	11,200 ft
Perimeter dike volume (approx)	217,000 cy	404,000 cy
Number of sub-cells (assumed)	3	3
Number of cross-dikes	2	2
Total length of cross-dikes (2, nom)	2,000 ft	3,800 ft
Total cross-dike volume (2, approx)	72,000 cy	137,000 cy
Leachate Collection Field (overall):		
Footprint (cell interior, approx.)	850 x 1,850 (36 ac)	1,750 x 3,550 (142 ac)
Volume of 2-ft clay liner	116,000 cy	458,000 cy
Volume of 1.5-ft sand/gravel layer	87,000 cy	344,000 cy
Capping and Cover (overall):		
Volume of 1.5-ft clay liner	89,000 cy	347,000 cy
Volume of 2-ft soil cover	118,000 cy	463,000 cy
Surface area footprint (approximate)	46 acres	162 acres

consolidated fill surface with low ground pressure equipment to extend and advance the conveyor system farther into the disposal cell.

Containment Dikes. Perimeter and cross-dikes are built to an interior cell height of 12 ft above the top of the leachate collection system. It is assumed that the design is capable of withstanding structural and seismic design requirements. The crown (top) width is 20 ft to provide for a durable graveled all-weather access road. A dike cross section is shown in Figure 2-15.

Contaminant Control Measures.

Leachate Collection. A leachate collection system is installed under each disposal cell in preparation for deposition of dredged materials. The assumed leachate collection system consists of a 2-ft compacted clay barrier layer at the bottom of the cell, an impermeable geotextile membrane overlaying the clay, and a 1.5-ft layer of coarse sands/gravels over the geotextile. The leachate liners extend up the dike slope to the planned top elevation of the dredged materials (+8 ft). Perforated pipes buried within the sand/gravel layer collect the leachate and it is pumped to the water treatment plant. A schematic cross section of the assumed leachate collection system is also shown in Figure 2-15.

Cap and Cover. The upland conceptual design disposal plan assumes an annual cover to minimize long-term exposure of dried dredged material prior to capping. As the dredged material fill becomes accessible to equipment, the top would be graded and capped. This progressing cover approach would leave only the recent wet deposits in the yet-to-be-completed portion of the cell exposed to the air, thereby minimizing opportunity for wind-blown migration of surface-dried contaminated sediments offsite. The closure cap would consist of 1.5 ft of imported compacted low permeability clay and an impermeable geotextile membrane. An additional 2-ft layer of topping soil is added to encourage surface vegetation.

Water Treatment and Management. All water arising within the cell during and after filling is collected and provided primary treatment for solids removal before discharge. Water sources include pore water extruded from the dredged material deposit and rainfall runoff.

Adequate treatment consists of gravity sedimentation of settleable solids within the ponded waters of the dredged material cell, followed by filtration through a set of vertical sand/gravel filters constructed for this purpose. Dual sand filters are required to allow continuous treatment by one filter while the other is undergoing maintenance.

Collection and treatment of the potentially large amount of rainfall runoff is needed only while the emerging dredged material mass is exposed at the surface. After cell closure the impermeable cap precludes contact of surface drainage with the dredged material, thereby allowing such runoff to be discharged overland without collection and treatment.

Dewatering Facility - Cost Estimate

A consistent disposal rate is assumed for sediments at the dewatering facility. However, depending on dredging/disposal schedules of Puget Sound projects there may be weeks or even months when little or no dredged material is received. Still, the sites require about the same level of personnel and operations coverage (and cost) during slack dredging times in order to be ready to receive and process dredged materials as needed (e.g., the personnel cannot be intermittently furloughed without pay due to the complexity of the facility, processes, etc.). The problem would be in how to cost-effectively keep the sites open, managed, and ready to receive and efficiently process dredged material with a skilled crew and special equipment.

Concept level costs are estimated for construction of the rehandling and dewatering facilities for both the 500,000 cy and 2,000,000 cy 10-year CAD options. Basic layout and assumptions are described above. Basic estimates are for direct costs of materials, manpower, and equipment for mobilization, demobilization, and operations. Typical rates for indirect costs (15%), contractor profit (10%), and contingencies (20%) are added. The concept-level estimated cost summary for the dewatering facility is shown in Table 2-7. The estimated costs are $3/cy for the 2,000,000-cy dewatering facility and $11/cy for the 500,000-cy facility. See Appendix C for a more detailed discussion of the cost estimate.

Upland CDF - Cost Estimate

The upland disposal alternative involves complex operational logistics. The disposal of the contaminated dredged material requires three major steps: 1) offloading from the haul barge to the upland dewatering facility; 2) rehandling and transport by truck or rail to the final upland disposal site; and 3) rehandling and distribution of the hauled sediments at the upland disposal site. The steps are mutually dependent upon the throughput rate of dredging and disposal as it occurs over the 9-month annual dredging period. For the conceptual design, it is assumed that dredged material must be dewatered, transported, and disposed of at the upland disposal site within days of its receipt at the dewatering facility in order to maintain adequate open capacity for incoming dredged material. As stated above, actual dredging activities in Puget Sound would vary in their schedules, and the "downtime" experienced would constitute an additional cost that is not included in this cost estimate.

Costs are estimated in Table 2-8 for construction of the long-term upland CDF for both the 500,000-cy and 2,000,000-cy 10-year disposal options. Primary cost factors include site preparation and grading, dike building, leachate collection, water treatment, offload/distribution, and site monitoring. Basic estimates are for direct costs of materials, manpower, and equipment for mobilization-demobilization and operations. Typical rates for indirect costs (15%), contractor profit (10%), and contingencies (20%) are added. Future costs over the phased project development are shown only as present cost. Appendix C contains additional cost estimate details.

Table 2-7. Concept Level Estimated Costs for Construction of Upland Rehandling/Dewatering Site. (See Appendix C for more detailed cost information.)

Major Capital Elements		500,000-cy Capacity Estimated Cost	2,000,000-cy Capacity Estimated Cost
Marine Portion		$1,051,300	$1,072,000
Upland Site Work		$993,500	$1,363,000
Offload System		$900,000	$1,050,000
Monitoring (Effluent Water Quality)		$60,000	$120,000
TOTAL ESTIMATED DIRECT COSTS:		**$3,004,800**	**$3,605,000**
ADD (Assumed):			
	Indirect Costs (15%)	$450,720	$540,750
	Contractor Profit (10%)	$300,480	$360,500
	Contingencies (20%)	$600,960	$721,000
REAL ESTATE ACQUISITION (assumes $327,000/acre)[1]		$1,046,400	$1,504,200
TOTAL ESTIMATED 10-YEAR CONCEPT COST:		**$5,403,360**	**$6,731,450**
	Cost/cubic yard	**$11**	**$3**

[1] **The costs for real estate acquisition are highly variable and are estimated to range from $174,000/acre to $523,000/acre. Based on this cost range, the total estimated cost/cy would range from $10 to $12 at the 500,000-cy facility and $3 to $4 at the 2,000,000-cy facility. See Section 2.5.4.2 for additional explanation.**

Table 2-8. Concept Level Estimated Costs for Construction of Upland Disposal Site.
(See Appendix C for more detailed cost information.)

Major Capital Elements		500,000-cy Capacity Estimated Cost	2,000,000-cy Capacity Estimated Cost
Pre-Construction		$100,000	$200,000
Upland CDF Site Work		$7,192,000	$25,396,000
Offload/Site Equipment		$719,000	$1,019,000
Other Site Development		$701,000	$1,084,000
Monitoring		$742,500	$1,092,000
TOTAL ESTIMATED DIRECT COSTS:		**$9,454,500**	**$28,791,000**
ADD (Assumed):			
	Indirect Costs (15%)	$1,418,175	$4,318,650
	Contractor Profit (10%)	$945,450	$2,879,100
	Contingencies (20%)	$1,890,900	$5,758,200
REAL ESTATE ACQUISTION (assumes $174,000/acre)[1]		$8,004,000	$28,014,000
TRUCK HAULING (assume 15 miles, $8.60/cy)		$4,310,000	$17,240,000
TOTAL ESTIMATED 10-YEAR CONCEPT COST:		**$26,023,025**	**$87,000,950**
	Cost/cubic yard (CDF)	$52	$44
	Cost/cubic yard (dewatering)	$11	$3
	Total Cost/cubic yard	**$63**	**$47**

[1] The costs for upland real estate acquisition are highly variable and are estimated to range from $85,000/acre at rural locations 30 miles from the dewatering facility to $525,000/acre for nearshore (5 miles from the dewatering facility) industrial property. Based on this cost range, the total estimated cost/cy would range from $63 to $89 at the 500,000-cy facility and $47 to $69 at the 2,000,000-cy facility. The mid-level cost estimate for dewatering (Table 2-7) is assumed. See Section 2.5.4.2 for additional explanation.

MUDS upland disposal operations would require more comprehensive consideration than what is assumed in this cost estimate. The following cost assumptions were made:

- Both the marine offload rehandling/dewatering facility and the upland disposal site are available to receive and process dredged material for the entire annual 9-month open dredging window. This essentially assumes that the annual average throughput rates of 250 cy/day and 1,000 cy/day would apply more or less continuously during the dredging year for the 500,000-cy and 2,000,000-cy disposal capacities, respectively. However, there would be periods of high throughput as well as standby time during the dredging season.
- Both the rehandling/dewatering facility and the upland disposal site are considered permanent year-around sites that require at least some management, operation, maintenance, and security even when dredged material is not being processed.
- Transport of dredged material to the dewatering facility is by barge, and costs are paid by the dredger.
- For purposes of this cost estimate, the dewatering facility is assumed to be located on the shoreline to allow use of a conveyor to transfer sediments from the barge to the facility. It is possible that land acquisition costs could be reduced by using property set back from the shoreline; however, additional offloading and transport costs would result.
- For purposes of this cost estimate, the upland CDF location is assumed to be in an active industrial area relatively close to the shoreline, and within 15 miles from the dewatering facility. While the cost of this property type is relatively high compared to more rural locations, transportation distance and hauling costs are lower and habitat mitigation and/or land use changes are less likely to be required. While siting in rural areas is possible, siting concerns (e.g. land use, public acceptance) likely increase mitigation and transportation costs.
- Land acquisition costs are $174,000/acre, an average value obtained by contacting representatives of the major Puget Sound ports. Real estate cost estimates ranged from $525,000/acre for industrial waterfront property (e.g., Port of Seattle) to inland acreage in the Puget Sound region at $85,000/acre.
- Habitat mitigation is not required for the upland CDF (i.e., the siting process would avoid areas of concern).

The final cost estimates for disposal at an upland CDF range from $47 per cy at a 2,000,000-cy facility to $63 per cy at a 500,000-cy facility. Actual site characteristics, facility designs, monitoring or mitigation requirements different from those assumed for the conceptual design could substantially alter actual costs. For example, land acquisition costs are highly variable depending on location. If an abandoned property (i.e., brownfields) was obtained at no cost, estimated total disposal costs for the conceptual design would be reduced by $14 per cy (2,000,000-cy facility) and $16 per cy (500,000-cy facility). If total costs are estimated based on obtaining land at the lowest estimated cost ($85,000/acre) but at a greater distance (30 miles) from the dewatering facility, total disposal costs would range from $48 per cy at a 2,000,000-cy facility to $63 per cy at a

500,000-cy facility. Similarly, if total costs are estimated based on the maximum estimated land cost ($525,000/acre) near (5 miles) the dewatering facility, total disposal costs would increase to $69 per cy at a 2,000,000-cy facility and $89 per cy at a 500,000-cy facility.

Many factors could also affect total project costs. Some changes that could make actual project costs lower than the conceptual design estimate include:

- Use of abandoned property (i.e., brownfields), significantly reducing land acquisition costs
- Redevelopment of the property following site closure that could reduce total project cost
- Site topography characteristics (e.g., natural depressions or ridges) that reduce dike construction requirements.

Examples of changes that could make actual project costs greater than the conceptual design estimate include the following:

- Addition of habitat mitigation requirements could substantially increase total project costs
- Increased "downtime" and less efficient operations at the dewatering facility or upland CDF due to scheduling of dredging projects
- Additional requirements for leachate and rainfall runoff treatment.

2.5 SOLID WASTE LANDFILL DISPOSAL ALTERNATIVE

2.5.1 Description

The solid waste landfill alternative is the placement of contaminated sediments within an existing solid waste landfill. Solid waste landfills in the state of Washington are regulated primarily by the Minimum Functional Standards For Solid Waste Handling (WAC 173-304), Criteria For Municipal Solid Waste Landfills (WAC 173-351), and the Resource Conservation and Recovery Act (RCRA) (Subtitle D). These regulations were established by the state and federal governments to ensure protection of human health and the environment. Dredged material that is not eligible for open-water disposal and not classified as dangerous waste is categorized as "problem waste" under the minimal functional standards (WAC 173-304-100). Generally, if sediments are not eligible for open-water disposal and they pass the TCLP (Toxicity Characteristic Leaching Procedure) test, they can be disposed of in a landfill.

The sediments must be dewatered prior to transport to a landfill because of the water content in dredged material. Dewatering requires rehandling of the contaminated sediments at an onshore facility and is typically included and permitted as part of a project dredging plan. The dewatering facility is commonly a bermed containment area, although storage tanks have also been used. Dewatering methods are similar to those used at upland CDFs (as described in Section 2.4.4), and depending on the facility design, may include active dewatering (e.g., using trenches to collect effluent for discharge to receiving waters) and/or passive dewatering (e.g., settling and desiccation).

2.5.2. Contaminant Pathways

The possible pathways of contaminant migration from a solid waste landfill are similar to those for the upland alternative and include:

- Effluent discharge to surface water during shoreline rehandling and dewatering
- Rainfall surface runoff
- Leachate into groundwater
- Volatilization to the atmosphere
- Direct uptake by animals and food web cycling.

Effects on surface water, groundwater, air, plants, and animals depend on the characteristics of the dredged material, management and operation of the rehandling site during dewatering, and the proximity of the rehandling facility to potential receptors. Effects on surface and groundwater quality as well as other environmental elements at the solid waste landfill are controlled through design regulations and site management.

2.5.3 Regional Examples

Private and public landfills currently operating in Washington and Oregon have accepted contaminated sediments for disposal. The two largest operating private landfills in the region are Roosevelt landfill in southern Washington operated by the Regional Disposal Company of Rabanco and Columbia Ridge landfill in northern Oregon operated by Waste Management, Inc.

The Roosevelt landfill meets or exceeds all RCRA Subtitle D standards, and the State of Washington's minimum functional standards for non-arid areas, even though the site only receives 6 to 9 inches of precipitation per year. The site occupies an area of more than 2,500 acres and has an approved capacity of over 120 million tons of waste. The facility has two liners, leachate and methane gas collection systems, a groundwater monitoring program, and other typical regulated features. Rail lines currently serve the site.

The Columbia Ridge landfill also meets or exceeds RCRA Subtitle D standards. The site occupies approximately 2,000 acres in the high desert of north-central Oregon and has an approved capacity of roughly 123 million tons of waste. This site has the same environmental protection features as the Roosevelt landfill as well as direct rail access.

Additional regional landfill capacity is currently being planned for two areas in Washington. Landfills are in the planning phases for Adams County in eastern Washington and the Tulalip site in Snohomish County.

The Weyerhaeuser Company operates a demolition landfill in Cowlitz County, Washington. Weyerhaeuser's facility is permitted for 1,000,000 cy/year with a total capacity of 50,000,000 cy. The facility is built to RCRA Subtitle D standards. Currently, the facility is permitted only for demolition waste and debris associated with forest practices. Local health department approval would be required before the facility could accept contaminated sediments.

County governments operate solid waste landfills for disposal of material generated within their jurisdictions. These landfills are regulated under the Criteria For Municipal Solid Waste Landfills (WAC 173-351). These regulations contain many of the same standards and requirements as discussed above under the minimum functional standards. The solid waste management plans for most counties have policies on contaminated soils, but not contaminated sediments. While many of these sites can accept contaminated sediments, the capacity of these landfills is limited. Because of the difficulty in siting new landfills near metropolitan areas, most jurisdictions are reluctant to accept a large volume of unanticipated material such as contaminated sediments.

In addition to the landfills described above, a 1,300-acre RCRA Subtitle C hazardous waste landfill is located just west of the Columbia Ridge landfill in northern Oregon near the town of Arlington. Any material designated as hazardous or dangerous waste can be disposed of at this facility.

2.5.4 Feasibility and Implementation

The siting, design, construction, and monitoring requirements associated with solid waste landfills are fully defined. Regional landfills exist that will accept contaminated sediments and satisfy disposal requirements.

2.5.4.1 Technology and Logistics

The technologies and logistics for disposing of contaminated sediments in an existing solid waste landfill are established. Small volumes of contaminated sediments from Puget Sound projects have been disposed of in landfills in Washington. The technologies for dredging and transporting sediments are discussed in Section 2.2.4, and the technologies for a dewatering/rehandling facility are discussed in Section 2.4.4.

Transport

Transport of sediments to a solid waste landfill would be similar to that discussed for the upland alternative (Section 2.4.4). Sediments would be dredged and placed on a barge for transport to a shoreline rehandling facility for dewatering. If the dredge area is close to the rehandling facility, the sediments could be transported via pipeline.

Once the sediments are sufficiently dewatered, current practice is to put dewatered sediments in 20-ft or 40-ft containers for transport by truck or rail to a landfill. These containers often have extra liners to prevent leakage. Additional rail lines may be necessary at the rehandling facility to provide short-term storage of rail cars. Once sediments are unloaded at the landfill, they can be placed in an active cell for disposal or, if appropriate, used as daily cover material for other waste materials.

Monitoring

Groundwater monitoring is an existing requirement at landfills. In addition to installing a background well, a sufficient number of wells must be installed at appropriate locations and depths to yield groundwater samples from those hydrostratigraphic units that have been identified as the earliest potential target pathways and conduits of flow for groundwater and contaminant movement. The number, spacing, and depths of monitoring wells would be based on the characteristics of the landfill site. When an existing landfill is closed, post-closure monitoring requirements include monitoring air and water resources as long as necessary for the facility to stabilize and to protect human health and the environment.

2.5.4.2 Conceptual Design and Cost

Conceptual Design

Because the solid waste landfill alternative uses existing landfills as a disposal site, a conceptual design is not included in this report. There are existing regulations such as the minimum functional standards (WAC 173-304) for handling and disposing of solid waste. These include location, collection, transportation, and landfilling standards; general facility requirements; and closure/post-closure requirements.

Some of the location standards that would apply to a landfill that accepts contaminated sediments include the following:

- No facility can be located on or near geologic features that could compromise the integrity of the facility.
- No facility can be located where the bottom of the liner is less than 10 ft above seasonal high level of groundwater. No landfill can be located over a sole source aquifer or within 1,000 ft of a downgradient drinking water well.
- No facility can be located within 200 ft of any water body, nor any wetland or public land being used by a public water system for watershed control for municipal drinking water.
- The active filling area at a facility cannot be located on an unstable hill.
- No facility can be located within 10,000 ft of an airport runway used by jets, or within 5,000 ft of a runway used by smaller, piston-type aircraft. No facility can be located in areas designated by the U.S. Fish and Wildlife Service or Washington Department

of Fish and Game as critical habitat. No facility can be closer than 1,000 ft from a state or national park. No facility can be located within 250 ft of a residential area.

Collection and transportation standards include requirements to prevent littering, cleaning of containers to prevent odors, container loading and moving to prevent spillage, and monthly inspection of equipment.

Landfilling standards include minimum functional standards for performance, design, and operations. Minimum standards for performance include the following:

- At the time the landfill is closed, the facility may not contaminate the groundwater below the landfill beyond the boundary of the landfill.
- A facility may not cause a violation of any ambient air quality standards at the property boundary.
- A facility may not cause a violation of any receiving water quality standard.

Minimum functional standards for design include the following:

- All landfills must minimize liquids entering the active area of the landfill by prohibiting the disposal of sludges with free liquids, designing the landfill to prevent all the run-on of surface waters resulting from a maximum flow of a 25-year storm into the active area of the landfill. The landfill must be designed to collect the surface water runoff and other liquids resulting from a 24-hour, 25-year storm from the active area and closed portions of the landfill.
- All landfills must install a leachate collection system in order to prevent no more than 2 ft of leachate developing at the topographical low point of the active area, and install a treatment system to meet the requirements for permitted discharge.
- Landfills must use liners having one of three designs. The standard design is a 4-ft layer of recompacted clay or other material with a permeability of no more than 1×10^{-7} centimeters per second (cm/sec) and a slope of no less than 2 percent. An alternative design has two layers: an upper liner of at least 50 mils thickness made of synthetic material, and a lower layer of at least 2 ft of recompacted clay or other material with a permeability of no more than 1×10^{-6} cm/sec and a slope of no less than 2 percent. Finally, in arid areas having less than 12 inches of precipitation per year, liners are not required. However, monitoring is required and waste material can be no less than 10 ft from the seasonal high level of groundwater. Landfill operators must take corrective action if leachate or waste constituents are detected in soils above the groundwater level that could violate performance standards.
- Landfills located in a 100-year floodplain must comply with local and state floodplain regulations, and landfills must be designed and operated to not restrict the base flood flow, the temporary water storage capacity of the floodplain, or result in washout of solid waste endangering human life, wildlife, land or water resources.
- Landfills must be designed so that when they are closed permanently, a 2-ft layer of 1×10^{-6} cm/sec or lower permeability soil can be placed above the waste. In arid areas,

the permeability of the cap layer has to be less than 1 x 10^{-5} cm/sec. Synthetic liners may replace soil covers if they are at least 50 mils thick. The grade of the final surface slopes should not be less than 2 percent and the side slopes not more than 33 percent. A final cover of 6 inches of topsoil is required, and it must be seeded with grass or other shallow-rooted vegetation.

- Landfills must be designed to collect and dispose of gases unless it can be shown that little or no landfill gases will be produced.
- Landfills must be fenced at the property boundary to impede access by the public and animals. The landfill must monitor groundwater and may also be required to monitor subsurface gas, ambient air quality, noise, leachate, and surface waters (including runoff).

Minimum functional standards for maintenance and operation include the following:

- All landfills must be operated in conformance with an approved plan of operation.
- The landfill must be operated so as to control road dust, prohibit open burning, collect scattered litter to avoid fire hazard or aesthetic nuisance, prohibit scavenging, and control insects, rodents, and other vectors.
- Landfill operators must thoroughly compact the solid waste before succeeding layers are added, and must cover the waste fully with at least 6 inches of compacted cover material after each day of operation.
- Landfill operators must maintain the required monitoring systems.
- Disposal, storage, treatment, or handling of dangerous waste is prohibited unless the requirements of WAC 173-303 are met.

Solid Waste Landfill Cost Estimate

Costs associated with this alternative include the dewatering facility (as described in Section 2.4.4), hauling of the sediments from the dewatering facility to the landfill, and disposing of the sediments at the landfill (Table 2-9). The cost estimate for the dewatering facility is described in Section 2.4.4.2. The costs for hauling and disposing of sediments at a landfill (including tipping fees) are estimated at $45/cy for a rail car and about $54/cy for a truck (Hart Crowser 1997). These costs assume the use of lined containers.

The final total cost estimates for disposal at a mixed waste landfill range from $48 to $57/cy at a 2,000,000-cy facility to $55 to $65/cy at a 500,000-cy facility. These estimates are based on the conceptual design for a dewatering facility and current estimated landfill disposal costs. Actual dewatering facility designs or requirements or transportation costs different from those assumed could substantially alter actual costs. Also, it is important to note that actual landfill disposal costs cannot be firmly determined until the actual time frame and volumes to be disposed are known. These details will be better defined during the MUDS site-specific effort and the relative cost of the existing landfill alternative can then be compared to the other disposal alternatives.

Table 2-9. Concept Level Costs for Disposal in Solid Waste Landfill.

Major Cost Elements	Unit	Unit Cost	500,000-cy Capacity Quantity	500,000-cy Capacity Estimated Cost	2,000,000-cy Capacity Quantity	2,000,000-cy Capacity Estimated Cost
Dewatering Facility[1]	L.S. (from Table 4-7)			$5,403,360		$6,731,450
Transport to Landfill (assumes ~ 30 miles)						
Truck	cy	54	500,000	$27,000,000	2,000,000	$108,000,000
Rail	cy	45	500,000	$22,500,000	2,000,000	$90,000,000
Total Estimate Costs:						
Truck				$32,403,360		$114,731,450
Rail				$27,903,360		$96,731,450
	Range of Costs/cy			**$55 -$65**		**$48 - $57**

[1] The costs for the dewatering facility are variable, depending on real estate acquisition costs, and ranged from $4,913,760 to $6,030,560/acre at the 500,000 cy facility, and from $6,027,650 to $7,633,050 at the 2,000,000 cy facility. Based on this cost range, the total estimated cost/cy for land fill disposal would range from $55 to $66 at the 500,000-cy facility and $48 to $58 at the 2,000,000-cy facility. See Section 2.5.4.2 for additional explanation.

2.6 MULTIUSER ACCESS TO PRIVATELY-DEVELOPED CONFINED DISPOSAL PROJECTS

This alternative calls for access to larger privately-developed confined disposal projects by users other than the project proponent. For example, a disposal site has a potential capacity of 400,000 cy but the project proponent only has 250,000 cy of contaminated material. The additional 150,000 cy of capacity at the site could then become available to other users with contaminated sediments.

Project proponents have been reluctant to provide multiuser access to their disposal projects because of the following concerns:

- Extended time frames for site development and closure
- Lost capacity for their own disposal projects
- Inherited liability of accepting contaminated sediments from other parties.

The contaminant pathways and design elements of a multiuser access facility would be similar to the pathways and design elements of the disposal alternative chosen for the multiuser facility (e.g., nearshore or upland). The major differences between the disposal alternatives previously discussed in this chapter and this alternative would be how long the site would be open for disposal to accommodate multiple users, how the liability would be managed for multiple parties, and how the site would be managed and operated.

2.7 COMBINATIONS OF ALTERNATIVES

A combination of two or more of the alternatives previously described is also a MUDS alternative. This alternative could be a hybrid composed of any of the action-based alternatives. For example, a CAD facility could be located adjacent to a nearshore CDF, or a location including both nearshore and upland CDF could be developed. The combination alternative could also be composed of multiple sites that are not necessarily adjacent to each other. For example, a number of small facilities at different locations may best meet a region's capacity and logistical needs.

Siting and capacity criteria are critical elements in determining the feasibility of the combination alternative. Because a combination alternative would not be identified until completion of the PEIS and initiation of the site-specific site selection process, the combination alternative is not directly evaluated in this PEIS. However, the action-based alternatives that could be part of a combination or hybrid alternative are evaluated individually, and the environmental consequences of any potential combination alternative can be assumed to be a composite of the consequences of the individual alternatives.

2.8 TREATMENT OF DREDGED MATERIAL

While treatment in itself is not a disposal option per se, it has potential to reduce the volume of dredged material requiring disposal at a confined facility (EPA et al. 1996). Treatment generally occurs as part of material handling activities between dredging and disposal, and most treatment technologies would require storage between the dredging step and the treatment step (e.g., a diked storage area similar to a confined disposal site or dewatering facility) (Figure 2-16). Dredged material treatment processes act by 1) sorting or separating sediments into fractions having different levels of contaminants, 2) reducing or destroying contaminants, and/or 3) converting contaminants into less reactive or available forms.

Technologies for physically separating contaminated sediment fractions from the bulk sediments include screens, hydrocyclones, gravity separation, or froth flotation. All of these technologies have been widely used in the mining industry, most have been used in pilot-scale demonstration dredging projects (EPA 1994), and one full-scale project using screens, hydrocyclones, and belt filtration was conducted in Germany. Sediment sorting or separation technologies are often considered part of pretreatment because this may be required prior to implementing other treatment technologies.

Contaminated sediment may be treated to remove contaminants or reduce contaminant concentrations. These processes produce relatively "clean" sediments that no longer require special disposal or handling and may be available for other beneficial uses. Processes for treating dredged material solids or slurries to remove or convert contaminants fall under one of the following categories: bioremediation (use of microorganisms to break down organic contaminants), chemical treatment (e.g., oxidation, reduction, chelation, dechlorination,), extraction (removal of contaminants by dissolution in a solvent), thermal (incineration and thermal desorption), radiant energy, and immobilization (stabilization or solidification processes which limit the mobility of contaminants) (Palermo et al. 1998a). Some of these treatment processes have been applied in pilot-scale demonstrations. A few (thermal, immobilization) have been applied at full-scale projects.

In general, treatment technologies to remove contaminants have not been widely used because of their high cost relative to disposal costs. They have not yet been used for maintenance dredging projects (Palermo et al. 1998a). EPA (1994) reviewed treatment options and reported costs for a number of treatment technologies based on field demonstrations at several different sites across the country. The costs reported by Palermo et al. (1998a) and EPA (1994) are shown in Table 2-10. Although project-specific factors affecting cost (such as project volume and scale) vary widely among projects, treatment costs generally ranged from approximately $100 to over $1,000 per cy.

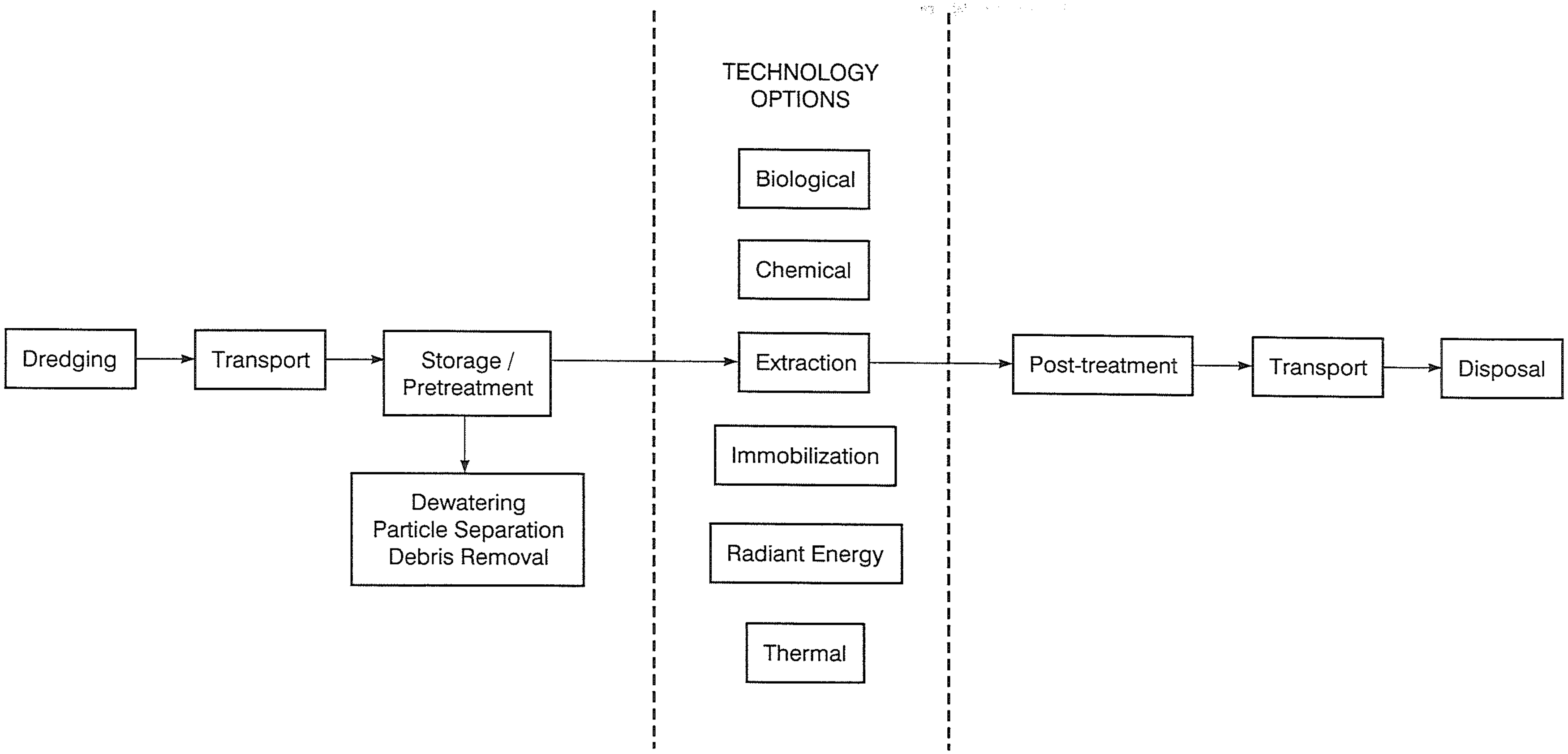

Figure 2-16 Process for Treatment of Contaminated Sediments

MUDS Draft PEIS

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Table 2-10. Treatment Technology Costs.

Treatment Technology	$/cy
Biological Treatment	
Bioslurry	$80-200
Bioremediation	$70-150
Chemical Treatment	$100-300
Extraction	$150-300
Immobilization	<$100
Thermal	
Desorption	$100-400
Incineration	>$1,000
Radiant Energy	not known

(Palermo et al. 1998a, EPA 1994)

Treatment remains a potentially valuable option that may be pursued in any dredged material disposal project, however, treatment was not explored more fully in the PEIS for the following reasons. First, except for recent demonstration programs and a few Superfund cleanups, only a limited number of treatment technologies have actually been applied on a pilot scale or full scale project and the base of experience for treatment of contaminated sediments is still limited. Second, the feasibility and cost-effectiveness of treatment depend on factors such as the quantity of material, initial contaminant concentration, and the target contaminant concentration. These factors are specific to the material to be dredged and must be assessed on a project-specific, not programmatic, basis. Finally, costs for most treatment processes are currently much greater than the costs for disposal at a solid waste landfill or at other confined disposal facilities.

Treatment will become a more viable option when/if the costs of treatment approach the costs of other feasible disposal options. In New York/New Jersey Harbor, for example, millions of cubic yards of contaminated sediments must be dredged annually and disposal options are increasingly limited (EPA 1998a). The Water Resources Development Act (WRDA) of 1992 and 1996 mandated a demonstration of the feasibility of decontaminating sediments in this region. Bench and pilot-scale tests of various technologies, including thermal destruction and desorption processes, stabilization/solidification, sediment washing, advanced chemical treatments, and solvent extraction methods, were completed in December 1996. Now, the WRDA program is focusing on a system of low- to high-temperature technologies that can accommodate a range of sediment contamination. These approaches include a sediment washing method, a high-temperature process to destroy organic compounds and bind metals into a cementitious matrix, and a plasma-arc vitrification process. The large-scale treatment facilities will become operational in 1 to 2 years. Currently, dredged material in New Jersey is stabilized with fly ash and used for construction material and cover. The total cost of dredging, stabilization, and disposal currently exceeds costs of disposal in a confined facility in Newark Bay by about $5 to $15 per cubic yard. However, WRDA managers are confident that a full-scale sediment washing and cement production operation will eventually be cost competitive.

The Puget Sound Confined Disposal Site Study interagency team will continue to monitor this, and other sediment treatment developments, as the program goes forward. When or if sediment treatment is shown to be cost and technically effective, treatment will be evaluated as an alternative (or, more likely, as part of a combination alternative) for addressing contaminated sediments from Puget Sound.

3.0 AFFECTED ENVIRONMENT

Implementation of a MUDS alternative would affect aquatic, nearshore or upland areas within the Puget Sound region. Although any single MUDS facility would impact a limited area (most likely on the order of 5 to 150 acres), specific sites have not been identified in this programmatic EIS (see Appendix A). For this reason, information presented here to describe the affected environment is very general and is intended to highlight basic characteristics and potential areas of concern. Additional detailed information would be required as part of any site-specific EIS.

NEPA and SEPA define a list of elements of the environment to be considered in an EIS. The elements of the environment that are expected to be affected by a MUDS facility include the physical environment, biological resources, environmental health, land and water use, and transportation and utilities. The affected environment corresponding to each of these elements is discussed in the following sections.

3.1 EARTH, AIR, AND WATER

3.1.1 Geology

The Puget Sound and adjacent waters drain a 35,000-km^2 area known as the Puget Sound Basin (Figure 3-1). The Puget Sound Basin is elongated north to south and extends approximately 200 miles from the Fraser River in Canada to near Centralia, Washington. From east to west, the basin extends from the crest of the Cascade Range to the Olympic Mountains and the straits of Juan De Fuca and Georgia. The main body of Puget Sound was formed by a glacial lobe of the Cordilleran ice sheet during the Pleistocene epoch, which occurred between 10,000 and 1.6 million years ago. The rapidly sloping bottom topography, relatively wide basins, compact glacially formed clay layers, and relict glacial tills are the legacy of this relatively recent geological activity (Crandel et al. 1958). Between the mountains and the main body of Puget Sound are broad, generally flat, lowland plains. Lake, ridges, and major stream valleys in the lowlands have a predominantly north-south and northwest to southwest alignment as a result of the moving ice during the last glaciation.

Puget Sound encompasses an area of about 6,500 km^2 and is one of the deepest marine basin areas in the United States. The northern portion consists of the straits of Juan de Fuca and Georgia with water depths of 600 to 800 ft. The southern portion includes the various inlets of south Puget Sound (Budd, Eld, Totten, and Hammersley inlets) where depths typically range to 300 ft.

As part of the Pacific Northwest, the Puget Sound Basin is in an active geological area. The Pacific Northwest contains a boundary between two of the tectonic plates that make up the earth's surface. This boundary, called the Cascadia subduction zone, is the largest active fault in North America outside Alaska, and runs along the Pacific Coast between southern British

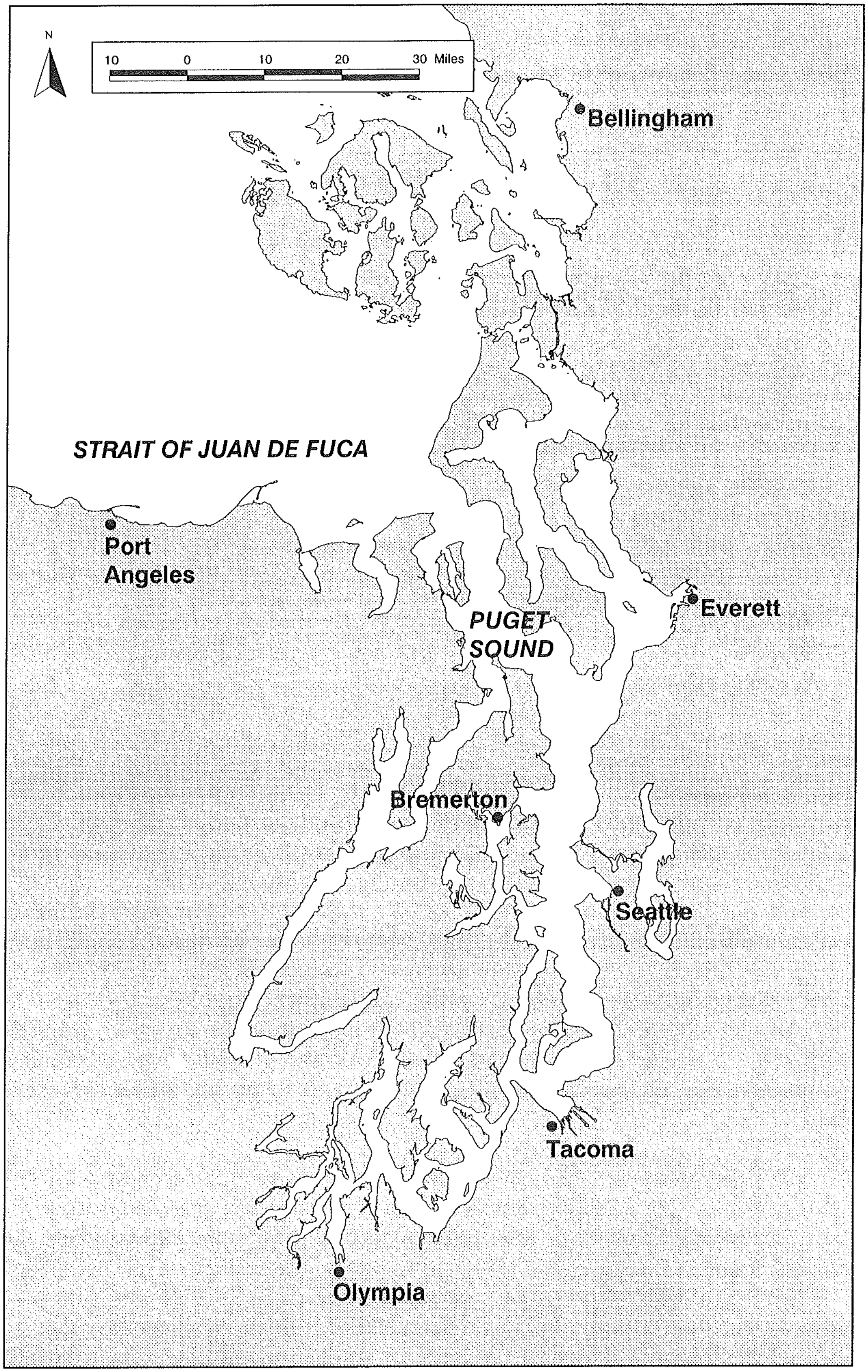


Figure 3-1 The Puget Sound Basin	MUDS Draft PEIS
	February 1999
	MPEIS Figure 3-01.xar

Columbia and northern California. Similar plate boundaries have been the source of most large earthquakes around the Pacific Ocean (USGS 1995).

In addition to seismic activity, the Puget Sound Basin also has the potential for volcanic activity. Three volcanoes are located in the Cascade Mountains on the eastern edge of the Puget Sound Basin. Two of the three volcanoes were active within the last 150 years (Mount Baker and Mount Rainier), and the third, Glacier Peak, was active within the last 200-300 years (Topinka 1997).

3.1.2 Soils

The soils of the Puget Sound Basin are considered young soils left behind by a glaciation event that occurred about 10,000 years ago. These glacial deposits are composed of many layers of unconsolidated sedimentary materials such as sand or gravel and till. Fine-grained soil layers accumulated during periods when glaciers were not in the area. Volcanic activity from the Cascade Mountains has contributed layers of volcanic ash.

Common soils in Puget Sound upland areas consist of a surface layer of coarse, gravelly to sandy loams with good drainage, overlying a layer of hardpan with poor drainage. This soil type is rather acidic and infertile. In lowland areas of the Puget Sound basin, particularly the major river valleys, alluvial soils (transported by water) are present and may be very fertile and support a range of vegetation (e.g., the Skagit River delta) (Kruckeberg 1991).

3.1.3 Air

Air quality of the Puget Sound Basin is generally quite good. However, urban areas can experience moderately degraded air quality, especially at certain times of the year. For example, carbon monoxide is often more of a problem during winter months, while ozone is more prevalent during hot summer months. Carbon monoxide emissions from automobiles increase during cold weather because automobiles run less efficiently when cold. Ozone is created by chemical reactions of nitrogen oxides and volatile organic compounds in the air. Because these formations are sunlight activated, ozone is more likely to occur during the summer. Ozone effects also tend to occur over relatively large areas because the chemical transformations occur over time, allowing the precursors to be transported away from their sources. Carbon monoxide is formed directly at its sources, such as highly used roadways, so it tends to be more localized (Port of Everett 1995).

Ecology and local air-quality agencies measure carbon monoxide, ozone, particulate matter, sulfur dioxide, nitrogen oxides, and lead at nearly 100 monitoring stations throughout Washington (most of these stations are in the Puget Sound lowlands). The readings for these six air quality components are compared to National Ambient Air Quality Standards (NAAQS) which are based on health criteria. Areas that do not meet these standards, based on monitoring information collected over a period of years, are designated as being "nonattainment" areas for the exceeding air pollutants. Until the local air-quality agency can demonstrate current and projected future compliance with NAAQS, and has an application for attainment status approved by EPA, the designation of nonattainment remains. In addition to monitoring air quality, the local agencies are responsible for the development of regional regulations and a state implementation plan (SIP) designed to achieve NAAQS.

The study area for this PEIS is under the jurisdiction of three local air-quality agencies. The Puget Sound Air Pollution Control Authority (PSAPCA) monitors air quality in King, Kitsap, Pierce, and Snohomish counties. Since 1991, there have been no violations of ambient air quality standards in the PSAPCA region (PSAPCA 1998). Brief periods of elevated air pollution levels (i.e., exceeding the "impaired air trigger" level) were recorded in 1996 for carbon monoxide, ozone and particulate matter, but there were no measured exceedances of health-based standards (PSAPCA 1997). Even with these recent years of relatively good quality air in the PSAPCA region, there remain three nonattainment areas for particulate matter: city of Kent, King County, and Pierce County. The Olympic Air Pollution Control Authority (OAPCA) monitors air quality in Clallam, Grays Harbor, Jefferson, Mason, Pacific, and Thurston counties. The Lacey-Olympia-Tumwater area of north Thurston County is the only nonattainment area in the OAPCA jurisdiction. It was designated in 1987 for high levels of particulate matter, but since then the air quality has dramatically improved and in 1997 OAPCA members submitted a redesignation request to Ecology and EPA (OAPCA 1998). The Northwest Air Pollution Authority (NWAPA) monitors air quality in Island, Skagit, and Whatcom counties. There are currently no areas under NWAPA jurisdiction with nonattainment designations (NWAPA 1998).

The 1990 Clean Air Act Amendments provide that no federal agency shall support any activity that does not conform to a SIP and that the head of each agency has the responsibility to ensure that the agency's activities conform to the relevant SIP. As of January 31, 1994, federal agencies must prepare a written conformity analysis and determination for proposed actions in nonattainment areas for which the total of direct and indirect emissions of the six air quality components caused by the action will exceed NAAQS. This Federal General Conformity Rule (40 CFR Parts 6, 51, and 93) applies to federal actions except actions covered by the transportation conformity rule, actions that are exempted, and actions with associated emissions below specified levels.

3.1.4 Surface Water

The Puget Sound basin is one of the three main hydrological regions in Washington state. This region covers roughly 20% (13,640 miles^2) of all of the state's land area (Ecology 1987). Surface water runoff from the east slope of the Olympic mountains to the west slope of the Cascades flows to Puget Sound. Approximately 42 major rivers and streams in the lowlands drain into the main body of the Puget Sound (EPA 1998b). There are hundreds of other identified rivers and streams in the Puget Sound drainage basin. Peak stream discharges caused by heavy rainfall and/or snow melt usually occur between October and April and may contribute to flooding. One-hundred-year floodplain maps published by the Federal Emergency Management Agency show flood data for the region.

Surface water is central to the many communities in the Puget Sound region. The U.S. Geological Survey (USGS 1990) estimated that in 1990 total surface water use in the Puget Sound Basin was 543 million gallons per day. This total includes all uses (e.g., drinking water, hydroelectric power generation, recreation) for both fresh and marine waters.

In addition to fresh water runoff, Puget Sound is also influenced by the marine waters of the Pacific. The exchange of water between Puget Sound and the Pacific ocean is brought about by swift tidal currents in the Strait of Juan de Fuca; however, the many narrow passes and shallow entrances can restrict this exchange, and water conditions in Puget Sound are far from homogeneous. In some areas, tidal turbulence is violent and mixing is rapid and complete. In restricted bays and inlets removed from such channels, the interchange of water is relatively slight (Kruckeberg 1991).

3.1.4.1 Surface Water Quality

The quality of water in Puget Sound is determined in part by the amount of inflowing contaminants and the amount of layering of water based on salinity and temperate differences (water column stratification). Stratification of the water column prevents nutrients, contaminants, and oxygen from dispersing which potentially leads to areas of poor water quality. Areas in Puget Sound most susceptible to stratification are those influenced by freshwater inflows because of the salinity difference between freshwater and sea water. PSWQA (1998) reported eight areas of Puget Sound where stratification was most persistent due to semi-enclosure by land and inflow of freshwater: Bellingham Bay (Nooksack River), Skagit Bay and Saratoga Passage (Skagit River), Port Susan (Stillaguamish River), Possession Sound and Port Gardner (Snohomish River), Elliott Bay (Duwamish river), Commencement Bay (Puyallup River), Budd Inlet (Deschutes River), Hood Canal (Skokomish, Duckabush, and Dosewallips rivers), and Sinclair Inlet (several minor streams).

The primary pollutants of concern in Puget Sound waters are disease-causing bacteria and viruses associated with fecal coliform bacteria and toxins such as heavy metals, polycyclic aromatic hydrocarbons (PAHs), and chlorinated organic compounds. Bacteria from human, marine mammal, and wild and domestic animal fecal matter enter the water with runoff from poorly managed farms and logging areas, streets and developed areas, improperly treated sewage from boaters, and failing on-site sewage treatment systems. Levels of fecal coliform bacteria in rivers flowing into Puget Sound have not significantly improved or declined since 1984, but more than one-half the river stations monitored violate state standards (PSWQA 1998a). In certain areas of Puget Sound, water quality is degraded to a degree that limits public uses. These impaired water bodies, as well as those having good water quality and no use limitations, are listed in WAC 173-201A. For example, part of Commencement Bay is listed as Class C (fair) because of high levels of pollutants and uses such as fish and shellfish harvesting and swimming are limited or restricted.

3.1.5 Groundwater

There is an estimated 80 million acre-feet of groundwater stored in near-surface aquifers in the state. Most of this groundwater is contained in basaltic lava rocks of central Washington and in glacially-derived or other unconsolidated sedimentary deposits in the Yakima River, Spokane, and Puget Sound areas (Ecology 1988). In 1990, it was estimated that 350 million gallons of groundwater were used each day in the Puget Sound Basin (USGS 1990).

Under petition, EPA can designate an aquifer as a "sole or principal source aquifer" if that source supplies 50% or more of the drinking water to an area and no reasonable alternatives are available (Ecology 1988). As of 1998, EPA has designated 11 sole source aquifers in Washington state; nine of these are in the Puget Sound Basin. The Puget Sound Basin sole source aquifers are Camano Island, Whidbey Island, Newberg Area, Cross Valley, Cedar Valley (Renton Aquifer), Central Pierce County, Marrowstone Island, Vashon-Maury Island, and Guemes Island (EPA 1998c) (Figure 3-2).

3.2 WILDLIFE

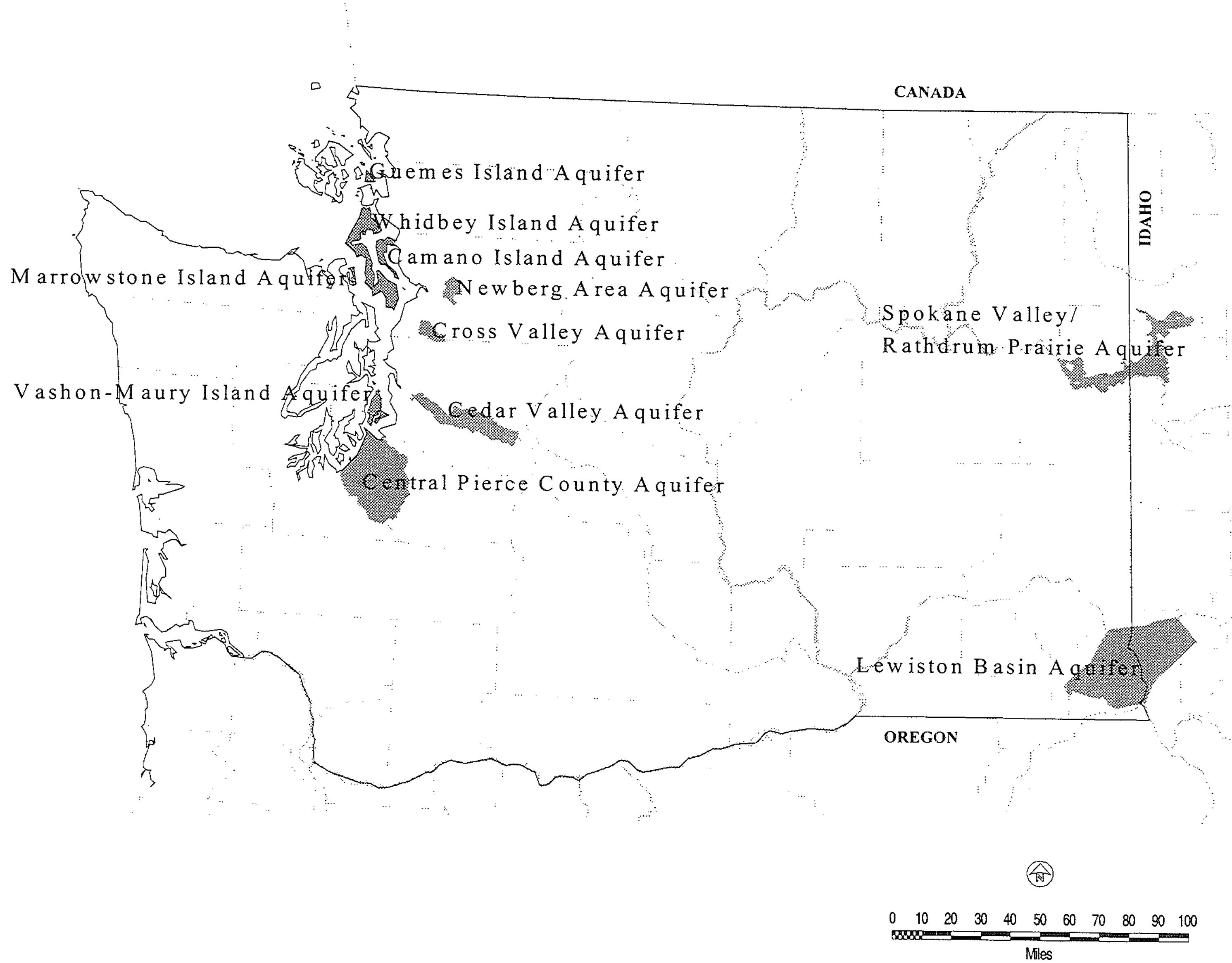
The distribution of key habitat features (e.g., wetlands) and major wildlife concentration areas for the five Puget Sound geographic areas of interest defined in Appendix A (Bellingham Bay, Port Gardner, Elliott Bay, Sinclair Inlet, and Commencement Bay) are shown in Figures 3-3 through 3-7. These important habitat and wildlife features, as well as others, are discussed in the sections that follow.

3.2.1 Habitat

The intertidal and subtidal habitats of Puget Sound consist mainly of sediments ranging from very fine-grained clays and silts to cobbles and boulders, and all intermediate combinations. The relatively few areas of solid rock substrate are found mostly in northern Puget Sound, the San Juan Islands, and the Strait of Juan de Fuca. The substrate in a given area is largely determined by current velocities along the bottom. Higher velocities erode fine sediments while lower velocities allow sediments to accumulate. The combination of current velocity and other factors, such as the slope of the bottom and shape of the basin, can result in broad areas of uniform substrate (e.g., mud flats) or heterogeneous areas of different sediment types.

Substrates can be classified as either "soft" or "hard". Sediment areas consisting mostly of clay and silt with variable amounts of sand and gravel are soft substrates. Flatter portions of Puget Sound typically have this type of substrate. Greater amounts of gravel, cobble, and rock in sediments form hard substrates. Areas of high current velocity and/or steep slopes typically have hard substrates.

The lowlands surrounding Puget Sound are extensively modified by human activity. Habitats in the lowlands consist of urban areas, farmlands, grasslands, shrub communities, oak woodlands, conifer woodlands, riparian forests, and wetlands (Ecology 1988). The wooded habitats can be



SOURCE:
EPA Region 10 — Seattle Geographic Information Section

Figure 3-2 Sole Source Aquifers in Washington State	MUDS Draft PEIS	
	Feb 99	MPEIS Figure 3-02.xar

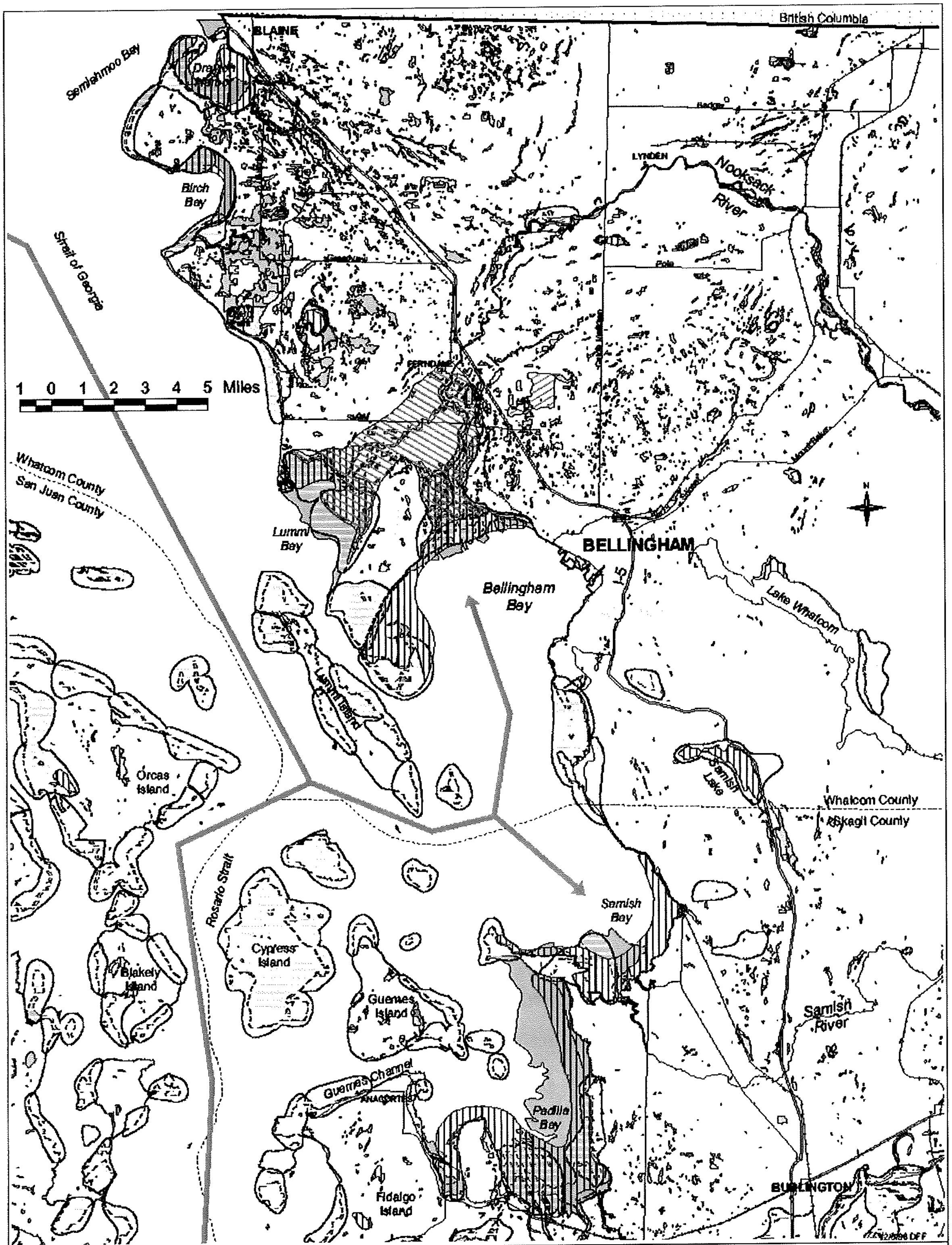


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Figure 3-3. Bellingham Bay - Affected Environment

U.S. Army Corps of Engineers

Striplin Environmental Associates

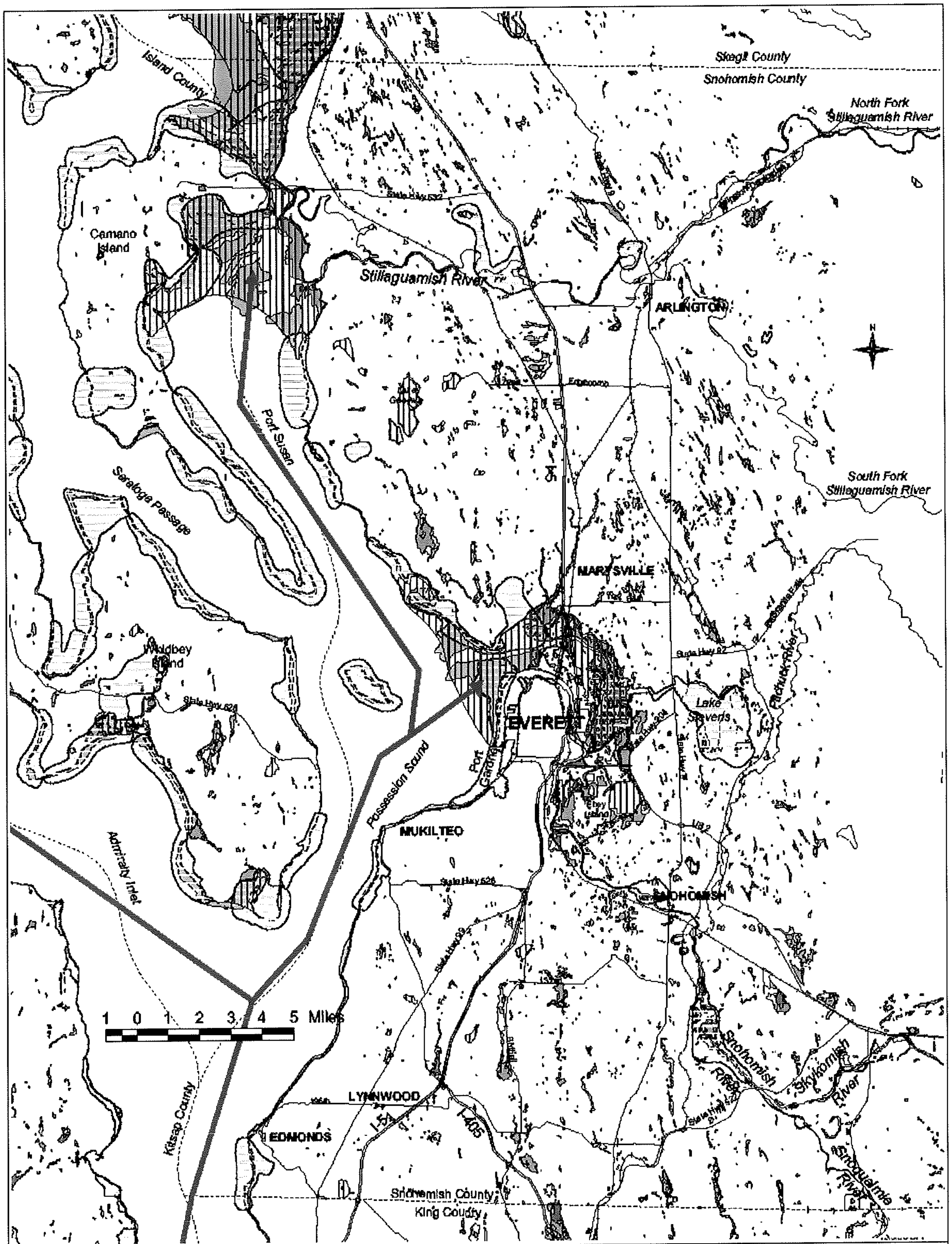

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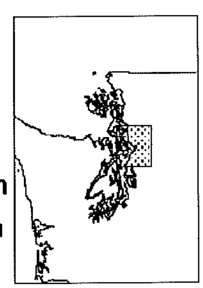
Figure 3-4. Port Gardner - Affected Environment



Wetlands

- Aquatic Bed
- Emergent Vegetation
- Scrub/Shrub
- Forested Wetland

Wildlife

- Peregrine Falcon
- Waterfowl Concentration
- Shorebird Concentration
- Bald Eagle
- Salmon Runs

U.S. Army Corps
of Engineers

Striplin Environmental Associates

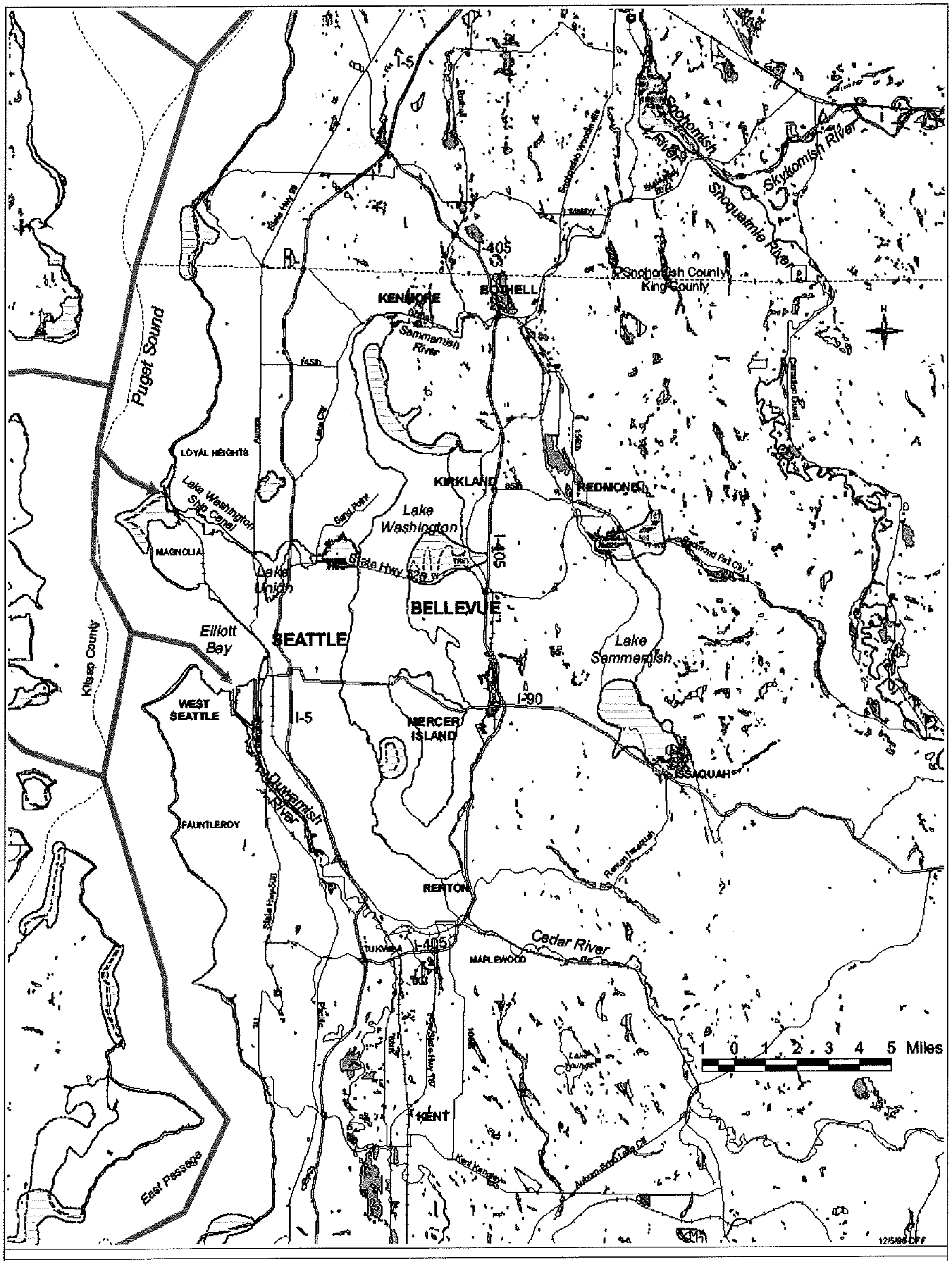


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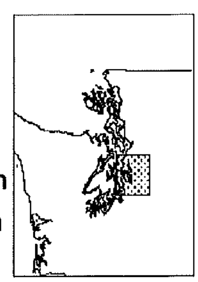
Figure 3-5. Elliott Bay - Affected Environment

Wetlands

- Aquatic Bed
- Emergent Vegetation
- Scrub/Shrub
- Forested Wetland

Wildlife

- Peregrine Falcon
- Waterfowl Concentration
- Shorebird Concentration
- Bald Eagle
- Salmon Runs



U.S. Army Corps of Engineers

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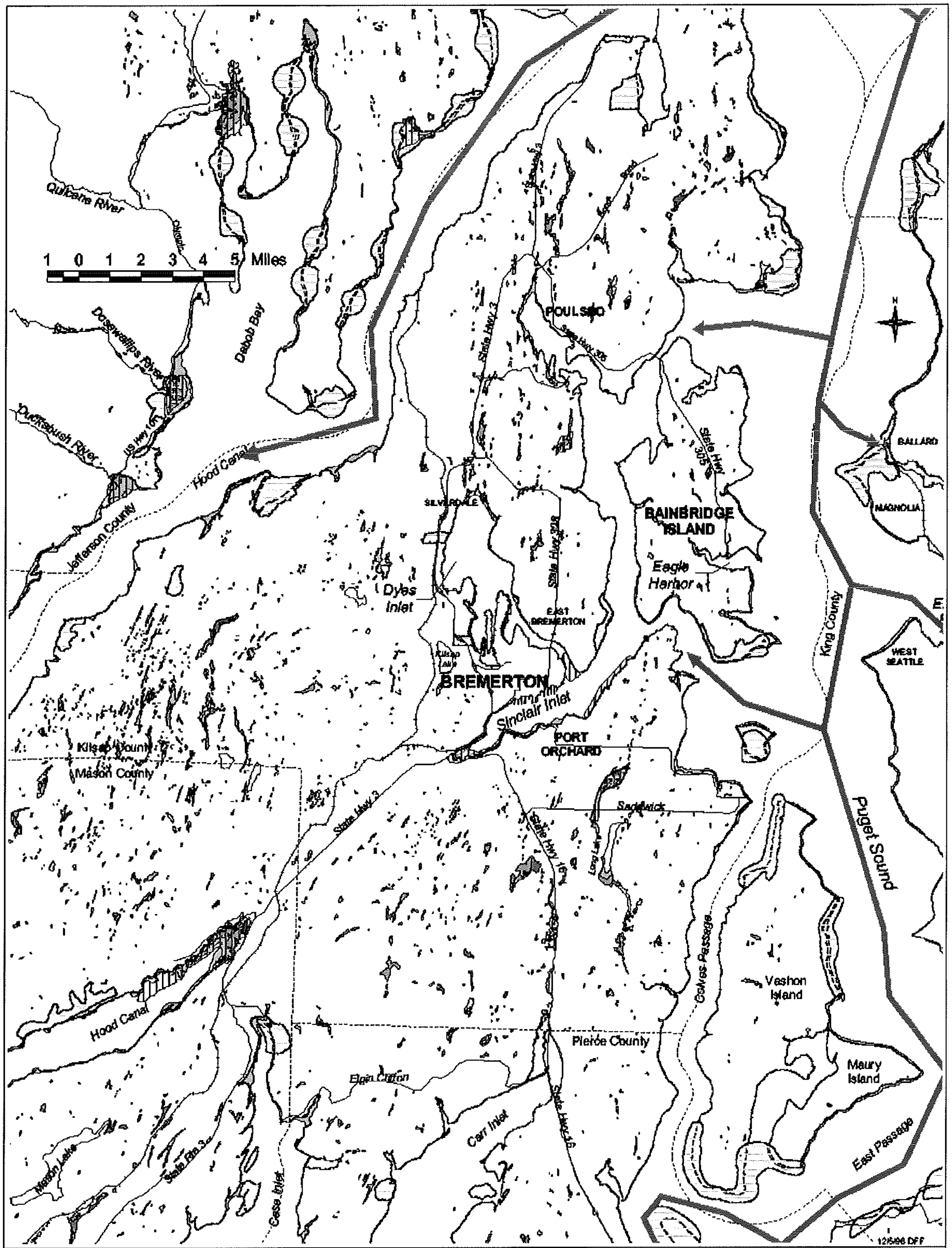

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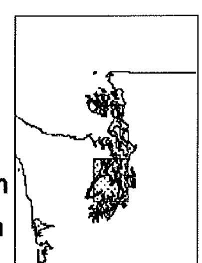
Figure 3-6. Sinclair Inlet - Affected Environment



Wetlands

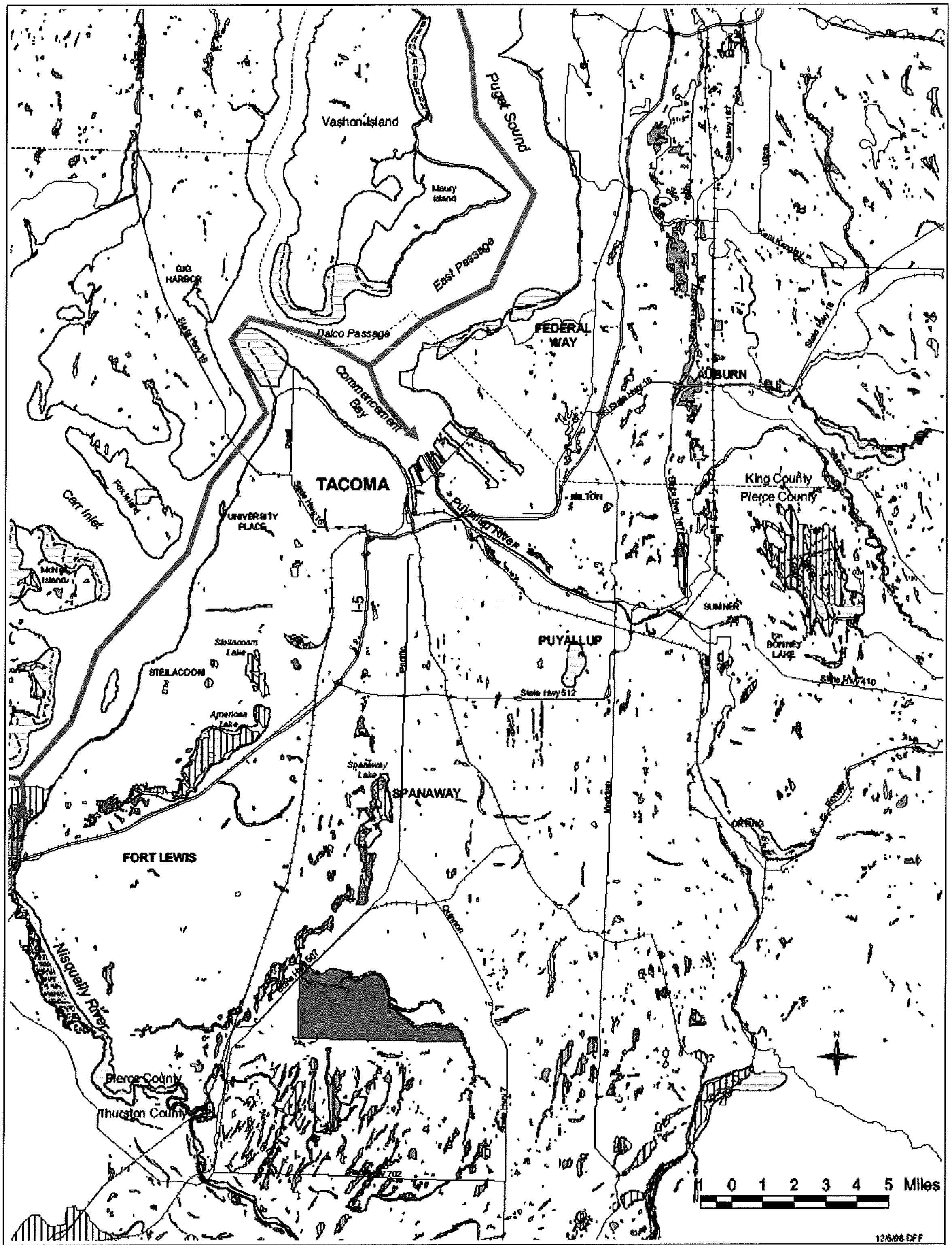
- Aquatic Bed
- Emergent Vegetation
- Scrub/Shrub
- Forested Wetland

Wildlife

- Peregrine Falcon
- Waterfowl Concentration
- Shorebird Concentration
- Bald Eagle
- Salmon Runs

U.S. Army Corps of Engineers

Striplin Environmental Associates



Puget Sound Confined Disposal Site Study
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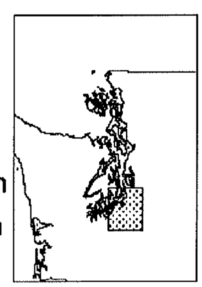
Figure 3-7. Commencement Bay - Affected Environment

Wetlands
- Aquatic Bed
- Emergent Vegetation
- Scrub/Shrub
- Forested Wetland

Wildlife
- Peregrine Falcon
- Waterfowl Concentration
- Shorebird Concentration
- Bald Eagle
- Salmon Runs



U.S. Army Corps of Engineers

Striplin Environmental Associates

classified as old growth forests, which have important and unique characteristics, or more typically second or third growth forests. The major trees species found in the Puget Sound lowlands include Douglas fir, red alder, black cottonwood, big leaf maple, Oregon ash, western hemlock, and western red cedar.

Of these terrestrial habitats, old growth forests and wetlands are of special concern. Old growth forests possess unique characteristics that are required as habitat for many organisms. Wetlands (see Figures 3-3 to 3-7) also provide food and habitat for terrestrial wildlife as well as aquatic wildlife. In addition to food chain support, wetlands also provide shoreline stabilization, flood peak reduction, groundwater recharge, and water quality improvement (Ecology 1988).

3.2.2 Benthic Communities

The different types of marine substrate support a range of plant and animal communities. Soft substrates consisting of fine-grained sediment (e.g., clay, silt, sand) support specific assemblages of marine invertebrates that live on or within the surface sediment layer. The general types of organisms in soft-bottom areas include marine worms (i.e., polychaetes), crustaceans such as amphipods, and bivalve molluscs such as clams. Shrimp and crabs may also be found in these areas. The relative abundances of the different types of invertebrate species will vary depending on factors such as the size of the sediment particles, the amount of detritus and organic material present, the amount of light reaching the bottom, and wave action and currents (Kozloff 1976). For example, more animal species are usually present in physically undisturbed depositional areas. For this reason, sandy areas exposed to strong currents generally support fewer species than relatively protected muddy or sandy bays. All soft substrate invertebrate communities are important as they provide food for fish and shellfish. In particular, soft substrate areas shallow enough for light penetration may support eelgrass (*Zostera* spp.) beds, which are critical habitat for many invertebrates and nurseries for many fish species.

Hard substrates such as rock, gravel, riprap, and docks provide surfaces for various encrusting and attached species of algae. Animals that graze on these algae associate with these plant communities, as do higher trophic-level animals (i.e., predators) that feed on the herbivores and each other. Typical organisms in these communities include invertebrates such as sea cucumbers, sea urchins, anemones, snails, chitons, and barnacles (Parametrix 1990). Kelps are algae that require a hard substrate on which to anchor. Kelp beds provide food and refuge for a variety of fish and invertebrates. While most common along the outer Washington coast and in the San Juan Islands, kelp are found in hard substrate areas of Puget Sound in waters usually shallower than 65 feet (Kruckeberg 1991, Parametrix 1990).

3.2.3 Shellfish

Puget Sound supports several marine invertebrate fisheries, including Dungeness crab, shrimp, oysters, geoducks and other clams. Most of these species are harvested both commercially and recreationally. The following information about these species groups is summarized from the

Puget Sound Environmental Atlas (Evans-Hamilton and D.R. Systems 1987), unless otherwise noted.

No major Dungeness crab (*Cancer magister*) populations occur south of The Narrows (Tacoma, WA), within the East Passage, or along the inner Strait of Juan de Fuca, but other areas of Puget Sound support well-established commercial and sport fisheries.

The major species of the commercial shrimp industry is the spot prawn (*Pandalus platyceros*). Spot prawn are found in Carr Inlet, Hood Canal, Holmes Harbor, Port Susan, and in the central San Juan Islands.

Sheltered embayments with intertidal and shallow subtidal beds containing gravel or cobbles are good habitat for oysters. Hood Canal, Dabob Bay, and southern Puget Sound are the primary locations for commercial oyster harvests. The native oyster (*Ostrea lurida*) and the Japanese oyster (*Crassostrea gigas*) both occur in Puget Sound, but the Japanese oyster is far more abundant. Seeding of juvenile oysters maintains most of the populations of Japanese oyster, except in Hood Canal where natural reproduction sustains the population. Oysters are also abundant within Sequim, Discovery, Skagit, Bellingham, and Lummi bays, Drayton Harbor, and the San Juan Islands.

The commercial fishery for geoducks (*Panopea generosa*) is closely regulated by the state of Washington (DNR). In 1990, the value of the 1,800 to 2,300 metric tons (4-5 million pounds) of geoducks harvested annually was about $5 million (Parametrix 1990). Large geoduck beds, which are composed of fine-grained sediments running parallel to shore, are located in southern Puget Sound, East Passage north to Possession Sound, northern Hood Canal, near Port Townsend, both west and southeast of Dungeness Spit, and in Sequim and Discovery bays.

The majority of other clams commercially and recreationally harvested in Puget Sound include manila clams (*Tapes japonica*) followed by native littlenecks (*Protothaca staminea*). Manila clams are found intertidally throughout Puget Sound. Littlenecks, butters, and horseclams are found both intertidally and subtidally, and are common in Kilisut Harbor, Port Townsend, northern Hood Canal, Liberty Bay, Port Madison, Admiralty Inlet, and north of Guemes Island.

3.2.4 Fish

Puget Sound supports several fisheries for different groups of anadromous and marine fish species. These fisheries include salmon, groundfish, and forage fish. Most of these species are harvested commercially and recreationally. Fisheries information is summarized from the Puget Sound Environmental Atlas (Evans-Hamilton and D.R. Systems 1987), unless otherwise noted.

Commercial and recreational harvests of Puget Sound salmon continue to require many restrictions in order to provide protection to dwindling fish stocks (WDFW 1998a). The five species of salmon found in Puget Sound are chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), chum (*O.keta*), pink (*O. gorbuscha*), and sockeye (*O. nerka*). Salmon require access to the streams and rivers of the Puget Sound Basin for spawning and early development of the young. Juvenile salmon travel downstream to Puget Sound where they forage on small organisms in nearshore areas until migrating out to the open ocean. The general locations of major salmon runs are included in Figures 3-3 through 3-7.

Also present in Puget Sound waters are two species of anadromous trout, steelhead (*O. mykiss*) and searun cutthroat (*O. clarki*). While searun cutthroat normally remain in Puget Sound, the steelhead follow the same life cycle as salmon, except they spend less time in Puget Sound as juveniles (Parametrix 1990).

Groundfish are bottom-dwelling fish including hake, pollock, cod, rockfish, surf perch, flounder, sole, and spiny dogfish. While these fishes are most common in northern Puget Sound, they can be found throughout Puget Sound. They are commercially and recreationally harvested, but because of fishing pressure and degraded habitats, the abundance of many bottomfish species has critically diminished. Washington state has recently (June 20, 1998) approved actions to restore dwindling populations of bottomfish, including rockfish, sole, flounder, and Pacific cod.

Forage fish play a critical part as the prey base for other marine organisms, as recreational fishing bait, and in commercial and subsistence fisheries (WDFW 1997). The common forage fish species within Puget Sound include Pacific herring (*Clupea harengus pallasi*), surf smelt (*Hypomesus pretiosus*), Pacific sand lance (*Ammodytes hexapterus*), and northern anchovy (*Engraulis mordax*).

Pacific herring have been intensely harvested in the past, and WDFW (1997) currently manages two commercial fisheries: the sport-bait fishery and the spawn-on-kelp fishery. The sport-bait fishery occurs primarily in the south-central Puget Sound region while the spawn-on-kelp fishery occurs primarily in northern Puget Sound. Recreational anglers occasionally fish herring for salmon bait or incidentally catch them when jigging for surf smelt.

Spawning habitat for surf smelt is usually the middle to upper tidal zones on protected pea gravel or coarse sand beaches. The commercial fishery is regulated and monitored through the fish ticket system (WDFW 1997). In 1995, the commercial surf smelt landing in Puget Sound totaled 116,515 pounds. Roughly 64% of these landings were from the Saratoga/Skagit region while the remainder were from the Hood Canal and South Sound regions. Recreational fisheries occur year-round throughout Puget Sound with no monitoring except by special project.

Sand lance primarily spawn in the upper intertidal zone of sand gravel beaches throughout the Puget Sound. They are not regularly harvested in Washington, but when harvested they are commonly dip netted for salmon sport bait (WDFW 1997).

Anchovies are pelagic and thought to move inshore in the spring and summer and offshore in the fall and winter (WDFW 1997). Anchovy harvest is allowed year-round and predominately occurs outside of Puget Sound in the coastal waters of Washington.

The resident freshwater fish found throughout the streams, rivers, and lakes of the Puget Sound Basin include both native and introduced species. The most abundant native species is rainbow trout (Ecology 1988). Other native species include cutthroat trout, kokanee, Dolly Varden lake trout, and landlocked coho salmon. Brook trout, brown trout, golden trout, and landlocked Atlantic salmon are all introduced species.

3.2.5 Birds

Bird found in the Puget Sound area include seabirds, shorebirds, raptors, and waterfowl (ducks, geese, and swans). Many species may be found throughout Puget Sound, but abundance varies seasonally and with the preferred habitats of individual species (Evans-Hamilton and D.R. Systems 1987).

Speich and Wahl (1989) reported nine marine bird species nesting along Puget Sound. Of these species, only pigeon guillemots (*Cepphus columba*), glaucous-winged gulls (*Larus glaucescens*), western gulls (*Larus occidentalis*), and Arctic terns (*Sterna paradisaea*) have reported nesting sites south of Whidbey Island. The small (a few nesting pairs) Arctic tern breeding site is located on Jetty Island (Everett Harbor). The San Juan Islands and the straits of Juan de Fuca and Georgia contain breeding sites for double-crested and pelagic cormorants (*Phalacrocorax auritis*, *P. pelagicus*), tufted puffins (*Fratercula cirrhata*), and rhinoceros auklets (*Cerorhinca monocerata*). These breeding sites usually consist of small islands and exposed rocks scattered throughout larger islands.

Waterfowl and shorebirds use the Puget Sound Basin for wintering and breeding habitat as well as a primary staging ground and migration route. Human disturbance, loss of habitat, and replacement of native plants by exotic species are the major threats to most waterfowl and shorebird populations. For example, extensive marshlands formerly occurred at the mouths of all Puget Sound's major rivers. These areas supported large concentrations of waterfowl and shorebirds. Today, many of these areas are now major urban, industrial, or port areas (e.g., Seattle, Tacoma, Everett).

The terrestrial birds found in urban, suburban, and rural areas of the Puget Sound Basin include songbirds, gamebirds (such as pheasant, partridge, quail, and grouse), raptors, and others.

3.2.6 Mammals

Puget Sound shorelines and open waters provide breeding and foraging habitat for many residing and visiting marine mammals. Seals and sea lions haul out on shorelines to either rest or breed. Of the three species of seals and sea lions found in Puget Sound, harbor seals (*Phoca vitulina*) and northern sea lions (*Eumetopias jubatus*) reside in Puget Sound year round. California sea lions (*Zalophus californianus*) occur in Puget Sound during the winter months (Evans-Hamilton and D.R. Systems 1987, UPS 1998).

Both toothed whales and baleen whales have been observed in Puget Sound (Evans-Hamilton and D.R. Systems 1987). Dall's porpoise (*Phocoenoides dalli*) and harbor porpoise (*Phocoena phocoena*) are commonly found north of Admiralty Inlet. Dall's porpoise have also been noted south to southern Puget Sound while harbor porpoise sightings rarely occur within northern and central Puget Sound. Killer whales (*Orcinus orca*) travel throughout Puget Sound feeding on fish, squid, and occasionally other mammals, but are more likely to be observed in the Strait of Juan de Fuca, San Juan Islands, and Strait of Georgia. Of the baleen whales, Minke whales (*Balaenoptera acutorostrata*) are seasonal visitors to northern Puget Sound and the San Juan Islands, while humpback whales (*Megaptera novaeangliae*) and gray whales (*Eschrichtius robustus*) visit Puget Sound on rare occasions.

While primarily a freshwater species, river otters (*Lutra canadensis*) may be found in quiet marine shoreline areas where freshwater streams emerge (Evans-Hamilton and D.R. Systems 1987). Otters and their habitat can be found in southern Puget Sound, around Vashon, Whidbey, and Camano islands, in Hood Canal, around Kitsap Peninsula, along the Strait of Juan de Fuca, in Padilla and Skagit bays, and among the San Juan Islands.

The dominant large, terrestrial mammals of the Puget Sound Basin are black bear, deer, and elk. Beaver, muskrat, mink, marmot, badger, weasel, marten, cougar, coyote, fox, raccoon, skunk, and numerous other small mammals are also found in the area.

3.2.7 Threatened and Endangered Species

The United States Fish and Wildlife Service (USFWS) (50 CFR17.11; 17.12) list of threatened and endangered animal species observed in the Puget Sound Basin includes whales and birds. The fin whale (*Balaenoptera physalus*) and humpback whale (*Megaptera novaeangliae*) are endangered cetaceans that have been sited in Puget Sound. The American peregrine falcon (*Falco peregrinus anatum*) is federally listed as an endangered species. However, due to the successful recovery of peregrine falcons within the Pacific Coast region, the USFWS has issued an advance notice of a proposal to remove the American peregrine falcon from the list of threatened and endangered species (*Federal Register*, Vol. 60, No. 126, June 30, 1995). Birds listed as threatened include the bald eagle (*Haliaeetus leucocephalus*), marbled murrelet (*Brachyramphus marmoratus marmoratus*), and northern spotted owl (*Strix occidentalis caurina*).

The American peregrine falcon regularly migrates through or overwinters in northern Puget Sound, but may nest and winter throughout the Puget Sound area. Nesting sites are usually remote cliff ledges used by successive generations of peregrine falcons (USFWS 1982). In recent years, however, successful nesting has also occurred on building ledges in urban areas such as Seattle, where falcons prey on plentiful supplies of pigeons and starlings.

Bald eagles are adaptable, foraging on whatever food resources are available. Their nests are found throughout the Puget Sound basin. Population sizes are increasing to levels that may eventually allow delisting. To assure these population gains are not diminished, efforts must continue to forestall habitat loss, habitat degradation, pesticide use (notably DDT) and major disturbance factors (USFWS 1986).

Marbled murrelets occur along Washington's marine shoreline and are most prevalent from April to September. They are frequently concentrated near relatively undisturbed forested areas near productive foraging areas (Speich and Wahl 1989). Nesting areas are within older successional stands and forests of coniferous trees (USFWS 1996). The loss of suitable nesting habitat is thought to be the primary threat facing this species.

Primary habitat for the northern spotted owl includes interior portions of older, successional, closed-canopy forests. The immediate threats facing the northern spotted owl are continued loss and decline of quality nesting, roosting, foraging, and dispersal habitat, along with isolation of subpopulations (USFWS 1992).

Plant species in the Puget Sound Basin listed as threatened or endangered by USFWS (1998) include the golden paintbrush (*Castilleja levisecta*) and water howellia (*Howellia aquatilis*). The golden paintbrush grows in grasslands at elevations below 300 ft. There are eight known populations in Washington: in Thurston County on state land; in Island County, one population is on Department of Defense (DOD) land, one is on state park land, and three other populations are located on privately owned land; and in San Juan County, two populations occur on private land (USFWS 1997). The water howellia is an annual aquatic plant found in shallow water of wetland areas. Populations in the Puget Sound Basin occur in Mason and Thurston counties.

Two species of salmon, chum salmon (*Oncorhynchus keta*) and chinook salmon (*O. tshawytscha*), have been listed as candidate species. In the Puget Sound Basin this affects the summer Hood Canal population of chum salmon and the entire Puget Sound population of chinook salmon. This is of particular importance because salmon are an economically important resource for the Puget Sound area. On February 26, 1998, the National Marine Fisheries Service proposed to list the Puget Sound chinook salmon as a threatened species under the federal Endangered Species Act (ESA). This listing is expected to become final by summer 1999.

3.3 ENVIRONMENTAL HEALTH

3.3.1 Environmental Contaminants

Several environmental characteristics are monitored and can be used as baseline indicators for potential health risks to humans and other animals and plants. These characteristics include water, air, noise, shellfish beds, toxic chemical releases, and hazardous material generation.

Surface fresh water and groundwater can become contaminated by fecal waste bacteria and viruses that can cause stomach ailments and diseases such as hepatitis, salmonella, cholera, and typhoid. Contaminated water can also flow into marine waters via rivers and streams, failing sewer systems, or as stormwater runoff, and shellfish can become contaminated. People swimming, fishing (finfish as well as shellfish), or drinking contaminated water are at risk of becoming ill. Fecal waste water quality standards have been exceeded by over half of the rivers and streams regularly monitored in Washington (Ecology 1997).

Nitrates can contaminate drinking water supplies, especially groundwater. Nitrate-nitrogen levels above 10 milligrams per liter (mg/l) in drinking water are unsafe. Ecology (1997) reported that approximately 3% of tested public water supply wells in Washington had nitrate-nitrogen levels at or above 10 mg/L. Poorly managed farm operations and failing septic systems were reported as the primary cause of nitrates in groundwater.

Poor air quality can cause or worsen lung-related diseases, contribute to water pollution, lead to decreased visibility, and damage building materials, metals, trees, crops, and other living organisms. The most significant health concerns of air pollution are easily inhaled small particles called particulate matter. Motor vehicle exhaust is the primary cause of poor air quality in Washington (Ecology 1997). In addition to the exhaust, which contains carbon monoxide as well as many other toxic pollutants, motor vehicles are also a source of particulate matter. Tiny particles of soot, dust, and unburned fuel from woodstoves, fireplaces, backyard burning, agricultural burning, and industry contribute high levels of particulate matter. Air quality is discussed more in Section 3.1.3.

Ecology (1997) reported a downward trend of toxic chemical releases in Washington from 1990 to 1994. Most releases to the air, land, or water were by industrial manufacturing processes. Toxic chemicals released into the air and water can cause serious health problems when drinking water sources are contaminated and can harm fish, wildlife, and plants when entering fresh or marine water environments.

Improper handling and disposal of hazardous waste can pose human health risks and contaminate ecosystems. While large industries generate most of the hazardous waste in Washington, smaller business, such as dry cleaners, printers and auto repair shops also contribute to the hazardous waste inventory and are less easily monitored for proper handling of their hazardous waste. Since 1992, the amounts of hazardous waste generated each year have been decreasing due to efforts by industry to prevent or reduce the amount of hazardous waste generated (Ecology 1997).

3.3.2 Sediment Quality

Sediment quality throughout Puget Sound and in the major harbors and urban embayments has been well-documented (Corps 1982, PSWQA 1986, Evans-Hamilton and D.R. Systems 1987, PSWQA 1990-1994, Ecology 1996). These studies concluded that chemical contamination is associated with areas of human activity (e.g., harbors and urban embayments), while areas with little human activity, such as the deep portions of Puget Sound, remain relatively uncontaminated (see Section 1.5.2). Sediment samples from Bellingham Bay, Case Inlet, Commencement Bay, Dabob Bay, Eagle Harbor, Elliott Bay, Everett Harbor, Mukilteo, Port Madison, Samish Bay, Sequim Bay, and Sinclair Inlet have been shown to be toxic to some marine organisms, and even the relatively uncontaminated areas have contaminant concentrations significantly higher than the levels that existed before the Puget Sound area was industrialized in the late 1800s (PSWQA 1986). Map A-1 in Appendix A shows the distribution of contaminated sediment sites throughout Puget Sound based on Ecology's (1996) contaminated site list. Section 1.5.3 discusses the types of chemical contaminants that are widespread in Puget Sound's urban/industrial areas.

3.3.3 Noise

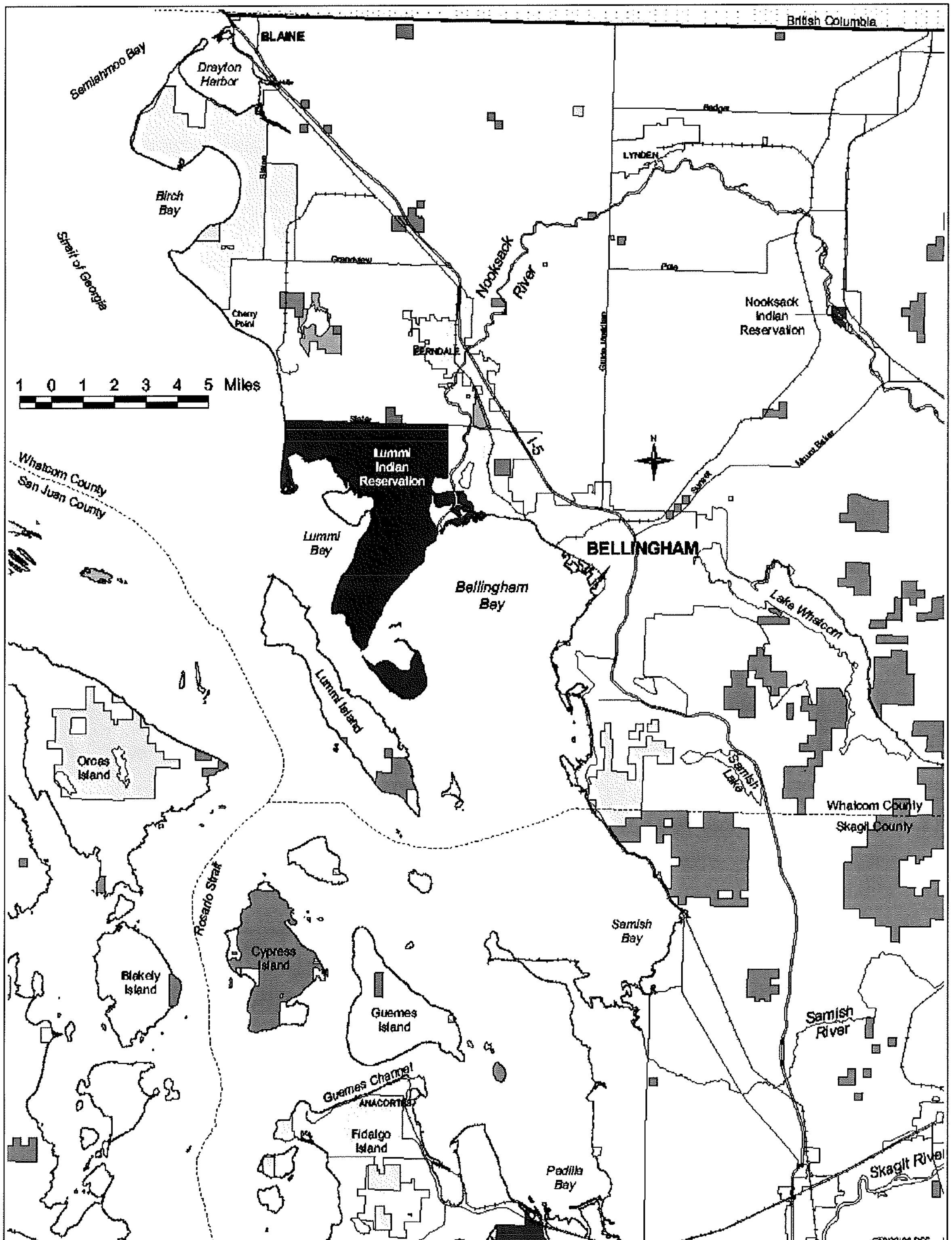
Noise levels vary with the differing land uses and overwater activities. While wind, water, animals, and other natural processes contribute to the level of noise in the Puget Sound Basin, noise is mostly a function of the 3.97 million people (summation of Washington Office of Financial Management 1998 population estimates of counties in the Puget Sound Basin: Skagit, Whatcom, Snohomish, King, Pierce, Thurston, Mason, Kitsap, Island, Jefferson, San Juan, Clallam, Grays Harbor, and Lewis) living near or along Puget Sound. The impact of noise is affected by environmental factors such as the absorption or reflection properties of the ground, vegetation and trees, and other obstructions. Additionally, many variables affect how noise is perceived and include both physical factors (e.g., level of noise, pitch of the sound, duration, predictability) and psychological factors (e.g., time of day, activities of the receiver).

Noise is measured on the decibel scale (dB), with 0 dB being the threshold of hearing and 130 dB the threshold of pain. An increase of 10 dB is scaled to the human perception as a doubling of loudness. Differences of 1 dB generally can not be detected, but a 5-dB difference is normally detectable by the human ear. Representative noise levels are 20 dB in a quiet rural area with no traffic and 80 dB on a busy urban street during the day (Corps 1995). Noise levels on and along Puget Sound have been measured to levels between 30 decibels in sheltered bays during calm weather to 70 decibels or higher in areas having considerable overwater activity and adjoining metropolitan areas (EPA 1974, Parametrix 1990).

Noise is regulated by the Washington Department of Ecology Maximum Noise Levels (WAC 173-60). While absolute noise limits are established for some sources (for example, truck noise cannot exceed 86 dB at 50 ft), other noise limits are relative to background levels. In addition, most major urban areas around Puget Sound (including Seattle, Tacoma and Everett) have local noise ordinances and zoning regulations that limit the level and duration of noise crossing property boundaries. EPA has no regulations governing environmental noise but has established noise guidelines to protect the public health (EPA 1974).

3.4 LAND AND WATER USE

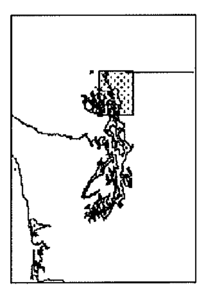
Figures 3-8 through 3-12 show the distribution of major public lands for the five Puget Sound geographic areas of interest defined in Appendix A. Land use in the Puget Sound Basin can be grouped into three major categories: urban, agricultural, and forest (EPA 1998b). Urban and suburban areas cover about 11% of the Puget Sound Basin. The extent of urban land use area has been rapidly increasing as large agricultural farmlands are being converted to more industrial and urban uses. Commercial farmlands (cropland and rangeland) cover approximately 16% of the



Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

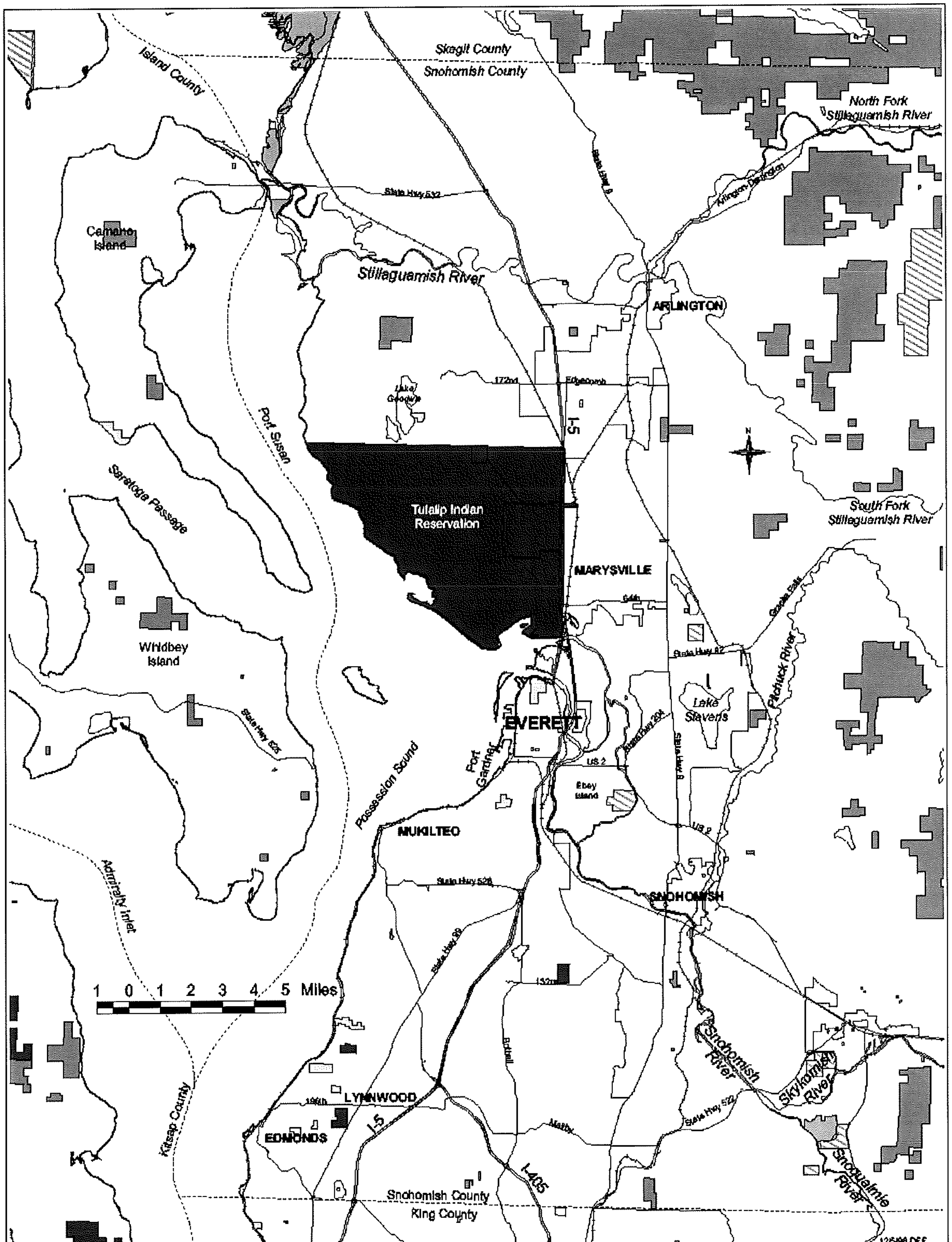
Figure 3-8. Bellingham Bay - Major Public Lands

U.S. Forest Service
DNR State Trust
Municipal Watershed
Military and Tribal Reservations
Wildlife Refuge
Parks and Recreation
Other Public Land
Urban Area (for reference)



U.S. Army Corps of Engineers

Striplin Environmental Associates



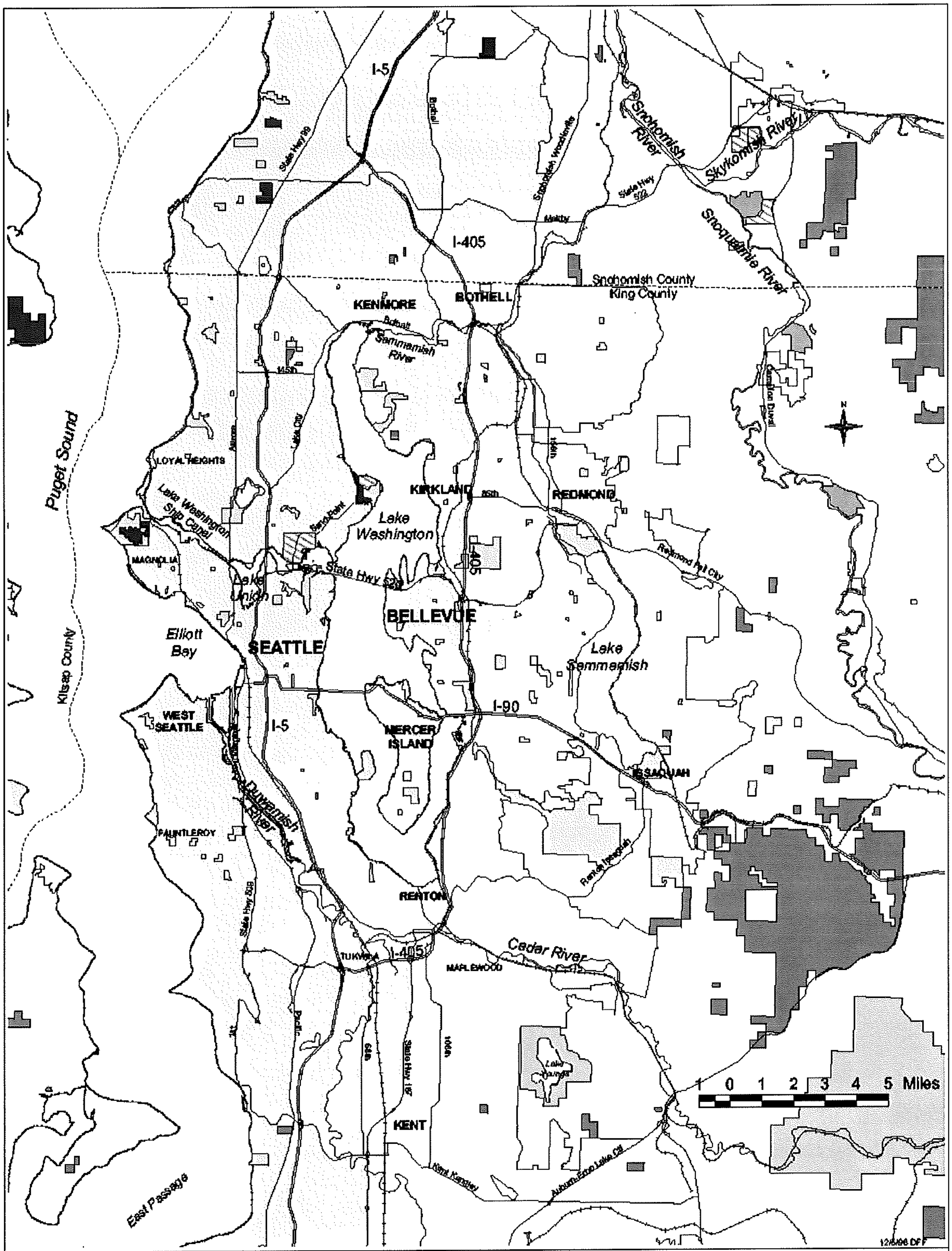
Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Figure 3-9. Port Gardner - Major Public Lands

- U.S. Forest Service
- DNR State Trust
- Municipal Watershed
- Military and Tribal Reservations
- Wildlife Refuge
- Parks and Recreation
- Other Public Land
- Urban Area (for reference)

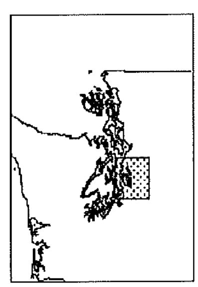
U.S. Army Corps of Engineers

Striplin Environmental Associates



Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

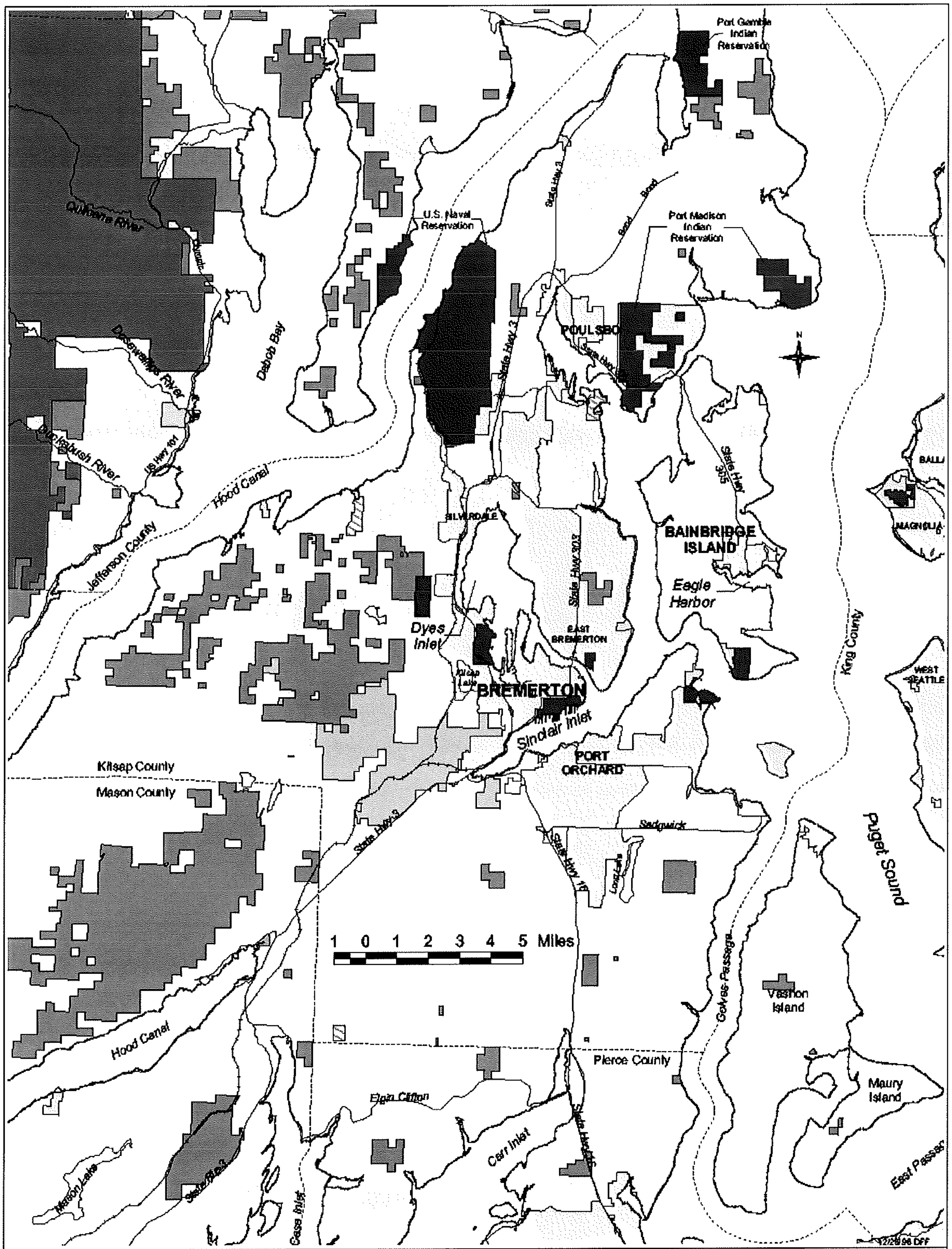
Figure 3-10. Elliott Bay - Major Public Lands



- U.S. Forest Service
- DNR State Trust
- Municipal Watershed
- Military and Tribal Reservations
- Wildlife Refuge
- Parks and Recreation
- Other Public Land
- Urban Area (for reference)

U.S. Army Corps of Engineers

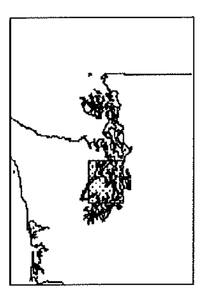
Striplin Environmental Associates



Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

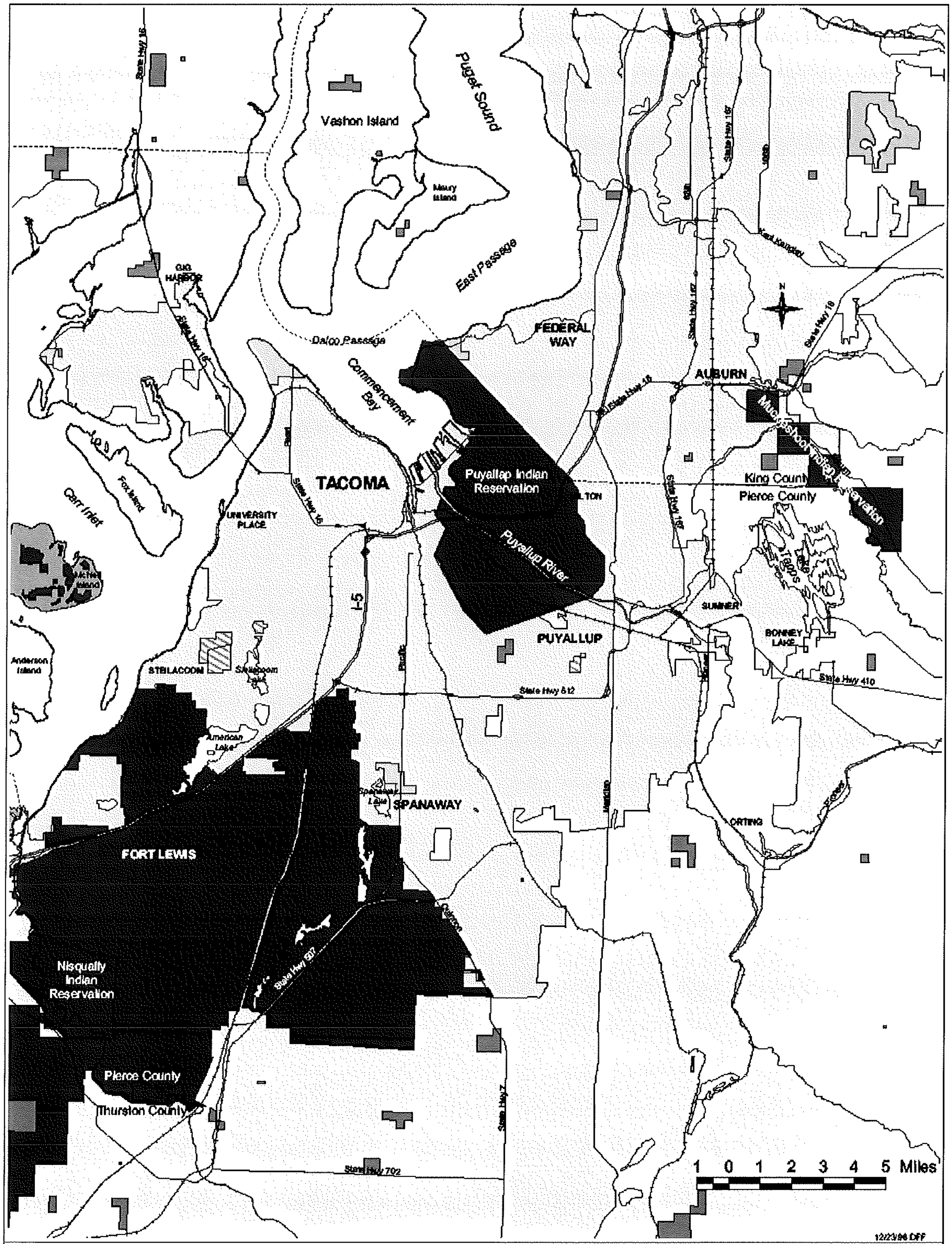
Figure 3-11. Sinclair Inlet - Major Public Lands

- U.S. Forest Service
- DNR State Trust
- Municipal Watershed
- Military and Tribal Reservations
- Wildlife Refuge
- Parks and Recreation
- Other Public Land
- Urban Area (for reference)



U.S. Army Corps of Engineers

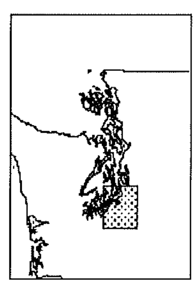
Striplin Environmental Associates



Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Figure 3-12. Commencement Bay - Major Public Lands

- U.S. Forest Service
- DNR State Trust
- Municipal Watershed
- Military and Tribal Reservations
- Wildlife Refuge
- Parks and Recreation
- Other Public Land
- Urban Area (for reference)



U.S. Army Corps of Engineers

Striplin Environmental Associates

Puget Sound Basin. While commercial farmland acreage has been declining, the number of small noncommercial farms has been steadily increasing. As additional roadways are built, the rural human population can commute to urban areas. During the 1950s and 1960s more than 200,000 acres (nearly 3% of the total Puget Sound Basin) of forest land was converted to other uses, with 20% to roads, 20% to farms and pasture, and 40% to urban or industrial use (PSWQA 1987). The amount of managed forest land remaining covers about 62% of the Puget Sound Basin.

Water use in the Puget Sound basin includes both recreational and commercial uses. Recreational use is described in Section 3.4.2. Commercial use of Puget Sound waterways ranges from small fishing boats to large ocean-going bulk cargo and container ships. Commercial use is mostly limited to well-established navigation lanes and routes. Navigation charts have clearly marked shipping lanes for large ships, and the vessels in the state ferry system follow predetermined routes. However, many commercial vessels do not have established routes. These include commercial fishing vessels and tugboats, whose courses tend to vary depending on the location of the current fishery or to find protection from wind and strong currents.

3.4.1 Aesthetics

Views in the Puget Sound region vary considerably. In addition, different people may perceive the same view differently. In particular, man-made structures may be regarded as favorable and interesting by some viewers, but judged to be intrusive by other observers. In this section, the common types of views within the Puget Sound Basin are broadly generalized. There are many unique or distinct views that can only be addressed on a site-specific basis.

Probably the most famous view in Washington state is that of Mount Rainier. From many locations within the Puget Sound Basin, especially in the southern area, Mount Rainier's snow-capped peak stands out above the rest of the Cascade Mountains to the east. Between Puget Sound and the Cascade Mountains is a broad, hilly area of lowlands, except in the north where the foothills extend to the water just south of Bellingham. To the west of Puget Sound, on the southern shore of the Strait of Juan de Fuca, the Olympic Mountains rise up quickly.

The bays, channels, and islands of Puget Sound form an intricate landscape where the view from the shoreline varies with the distance of the opposite shoreline. The considerable distance between shorelines along the Straits of Juan de Fuca and Georgia leave a broad expanse of sky and water. Changes in weather bring changes in the view, from all gray to all blue reflections of the sky on calm days to the ever-moving patterns of waves and white-caps on windy days.

In most other areas of Puget Sound, the shorelines and nearby islands dominate the view. These views include tree-covered slopes, rocky headlands, steep bluffs, and, at low tide, long expanses of beaches. The tidal beaches have various colors and textures depending on whether they are muddy, gravely, or cobbly, and also on the types of plants and animals living on them.

Evidence of human activity is absent from view in very few areas of Puget Sound. The structures and activities associated with metropolitan areas vary and dominate the view in and around cities and ports. Even away from dense metropolitan areas, docks, boats, houses, buoys, and bridges are among the signs of human presence and have become part of the scenery of Puget Sound.

3.4.2 Recreation

Recreational water use in the Puget Sound region includes boating, fishing, scuba diving, waterskiing, and windsurfing. Recreational boating includes all types of boats, ranging from kayaks and canoes to jet skis and speedboats to large sailboats and yachts. The marine and fresh waters throughout Puget Sound can become quite crowded with recreational boaters, especially during nice weather. Areas offering easy public access and amenities or those near population centers are more heavily used.

Some of the many recreational opportunities at shoreline and upland areas in the Puget Sound region are hunting, fishing, hiking, camping, running, beachcombing, biking, and birdwatching. These activities may take place on both privately owned land, but are more common on publicly owned land (including local and state parks and state and federally owned forests), with easy access, amenities, trails, facilities or services.

3.4.3 Tribal Fishing

Native Americans harvest finfish and shellfish in commercial and subsistence fisheries throughout the fresh and marine waters of the Puget Sound Basin. The finfish fisheries are co-managed by the Tribes and the State in accordance with fish harvesting rights established by the treaties between the United States and the Tribes in Washington. Tribal and state fisheries managers jointly address issues affecting the sustainability of the fisheries resource, such as harvest management and natural and artificial (i.e., hatchery) production. The amount of harvestable shellfish on Washington beaches is determined by population surveys conducted by the Tribes. On January 28, 1998, the Ninth Circuit Court of Appeals upheld the Tribes right to 50 percent of the harvestable shellfish from unleased state-owned tidelands and 50 percent of the harvestable shellfish that would occur naturally on state leased or privately owned beaches if shellfish bed enhancement had not been done.

The largest management effort is associated with the salmon fishery. The abundance and seasonality of the five species of salmon vary in areas of Puget Sound, so harvest management periods must accommodate these variations. A management plan for each salmon species is established annually by the Tribes and the State. This plan defines harvestable amounts and the opening and closure dates for each salmon species.

3.4.4 Cultural Resources

Cultural resources in the Puget Sound region include historical, cultural and archaeological features such as prehistoric sites, historic buildings, and sites of traditional or religious importance to Native Americans. Hundreds of prehistoric archeological sites have been identified and surveyed in the Puget Sound region. Most are located in coastal and lowland areas and include artifacts such as shell middens and rock shelters (USFWS et al. 1996). Many historic buildings or sites (including bridges and ships) in the region are included on the National Register of Historic Places under the National Historic Preservation Act. Submerged sites and artifacts (e.g., shipwrecks) have been identified in Puget Sound. Native American Tribes historically occupied the Puget Sound basin, and many locations have long-term cultural or religious significance. Specific cultural resources are identified on a site-specific basis.

3.5 TRANSPORTATION AND UTILITIES

3.5.1 Transportation

The Washington State Department of Transportation (WDOT) is responsible for planning and maintenance of traffic movement and safety. The regions of the WDOT that might be affected by a MUDS are the Northwest and the Olympic regions. The organizations within these two regions responsible for regional transportation planning and growth management include Whatcom County Council of Governments, Island/Skagit counties, Puget Sound Regional Council, Thurston Regional Planning Council, and Peninsula county (WDOT 1998). These regional transportation planning organizations (RTPOs) are responsible for, among other things, certifying that transportation elements of local comprehensive plans within their jurisdictions are in compliance with the State's Growth Management Act and conform to statewide transportation plans. In the development of a site-specific MUDS plan, resources from the WSDOT and the appropriate RTPOs would be consulted to determine the current state of the local transportation systems. These resources include maps of the existing infrastructure, current traffic statistics, and growth plans.

3.5.2 Utilities

In 1997, the Washington Utilities and Transportation Commission (WUTC 1998a) produced a report "to describe telecommunications infrastructure in the state, the capabilities and limitations of that infrastructure in the provision of telecommunications services, and estimate the dollar amounts invested by owners to expand and upgrade their telecommunications infrastructure" (WUTC 1998a). A previous report of this nature was produced in 1990 when 24 Local Exchange Carriers (LECs), maintaining approximately 2.4 million access lines, reported to WUTC. Forty-three LECs now report to WUTC; however, only 22 LECs responded to the most recent survey preventing full characterization of the State's telecommunications.

According to WUTC (1998b), roughly a third of retail electricity sales in Washington are from three investor-owned utilities. The remaining two-thirds of electricity sales are transacted by a number of consumer or government-owned utilities (currently 60 in all): municipalities, county-wide public utility districts, co-ops, irrigation districts, the Bonneville Power Administration, and port districts.

WUTC certifies and regulates garbage and refuse collection companies within Washington state. According to the Department of Ecology, there are over 120 solid waste facilities (e.g. landfills, transfer stations, recycling centers) in the Washington state counties that lie partially or entirely within the Puget Sound Basin. Facilities which handle toxic or hazardous materials must be specifically certified to handle those types of wastes.

4.0 ENVIRONMENTAL CONSEQUENCES

This section focuses on the potential environmental impacts of the alternatives relative to pertinent elements of the environment (e.g., water and sediment quality) and measures to avoid, minimize, or mitigate these impacts. Adverse environmental effects that cannot be avoided are noted. For the constructed alternatives, the potential environmental impacts associated with each type of confined disposal facility are discussed relative to conceptual designs presented in Section 2 (Alternatives).

The environmental consequence discussions presume that sediment evaluation procedures for determining dredged material suitability for MUDS disposal will be defined as part of a future element of the Puget Sound Confined Disposal Site Study (see Section 1.6). This evaluation process will go beyond existing PSDDA and SMS testing, will be consistent with existing national guidance (Corps/EPA 1992, 1998) and regional experience in dredged material testing for confined disposal, and will be developed prior to or along with establishment of a MUDS. Contaminant thresholds and interpretive criteria will be defined in conjunction with the testing procedures. The lower contaminant limit for MUDS disposal is often the SMS CSL or the PSDDA ML. For upland CDFs, the upper threshold is set by the MTCA standards. For LBC/CAD and nearshore CDFs, the upper limits need to be established during future efforts. To some extent, however, the anticipated thresholds are reflected in the conceptual designs for each alternative (see Section 2).

Proper sediment testing and suitability determination, along with siting and design considerations, operational controls, and post-closure monitoring, can minimize potential environmental impacts from contaminated sediment handling, placement, and confined disposal. While a small percentage of tested sediments may fail MUDS suitability, the following sections assume that the dredged material placed in each MUDS facility has been determined to be suitable for such disposal.

4.1 CONTAMINANTS IN SEDIMENTS - AN OVERVIEW

Before describing the environmental impacts associated with each alternative, a brief discussion of the geochemical properties and processes that control the distribution and potential release of contaminants in sediments is provided. The purpose of this discussion is to aid the reader in understanding the environmental impacts discussions that follow for each MUDS alternative.

The majority of contaminated sediments in Puget Sound that might be dredged and disposed of at a MUDS facility are fine-grained (mostly silts and clays), saturated (inundated), have a relatively high organic content, and are reduced (anaerobic or devoid of oxygen). Trace metals have a strong affinity for clay particles, and many organic contaminants associate with organic carbon. Conversely, coarse-grained sediments (i.e., sands) typically have low clay and organic fractions and generally bind contaminants to a lesser degree than fine-grained sediments.

Although suspended sediments and sediments at the sediment surface (top 1 cm) exist in an aerobic (oxidized) setting, most contaminated sediment particles below the immediate sediment surface exist in a reducing (anaerobic) environment. The reducing environment favors the immobilization of particle-bound metals and organic contaminants. Complete sediment reworking by the benthic infaunal assemblage ("the biologically active zone") typically reaches a maximum depth of about 10 cm in nearshore areas. Because particles can be subject to oxidizing or less reducing conditions in the biologically active zone, this sediment reworking provides a mechanism for remobilization and dispersion of contaminants into the water column and biological uptake by marine organisms. Once contaminated sediments are buried below the biologically active zone, however, they remain in a reducing environment unless disturbed by a large-scale natural or anthropogenic physical disturbance such as storm-generated waves, dredging, or vessel propeller wash, or a biological disturbance factor, such as large, deep-dwelling infauna (e.g., geoducks, burrowing shrimp). The latter disturbance factor is unlikely to occur widely in disturbed or contaminated areas.

The behavior of contaminants in sediments is controlled by the geochemical conditions to which the sediment particles are subjected. These conditions are strongly influenced and can be controlled by the dredging, handling, transport, and disposal techniques used. As a general rule, the release (remobilization) and potential loss of contaminants is minimized when sediments remain saturated, reduced, saline, and at near neutral pH levels. These are the *in situ* conditions typical for subsurface marine sediments in the urban/industrial embayments of Puget Sound. Conversely, contaminant remobilization and potential loss is favored by any process that causes desorption/dissolution of the material, (e.g., oxidation) (Palermo et al. 1998a). For example, metals (e.g., copper), which form sediment-bound insoluble sulfide compounds under reducing conditions, will enter an aqueous (dissolved) mobilized phase under aerobic conditions. Similarly, organic complexes become oxidized and decompose as sediments dry; these chemical changes can release organic contaminants to porewater, surface runoff, and leachate (Palermo et al. 1998a). Finally, the transfer rate for organics such as PAHs from water to air is generally much slower than from sediments to air (Thibodeaux 1989); therefore, volatile loss of contaminants is much less likely from saturated or inundated dredged material than from dried sediments exposed to the air.

4.2 NO-ACTION ALTERNATIVE

Under the no-action alternative, contaminated sediment dredging and disposal would proceed under the framework of regulations and disposal options that exists in the Puget Sound region (see Section 6.2). No new multiuser disposal facility or rehandling facility would be established.

4.2.1 Current Contaminated Sediment Disposal Options

Under current regulations and authorities, contaminated sediment dredging and disposal occurs as part of 1) contaminated site cleanup, 2) navigation or maintenance dredging projects, and 3) waterfront development and habitat restoration projects that require removal of contaminated sediments. Contaminated Puget Sound sediment sites are identified and cleaned up primarily under the authority of CERCLA, MTCA, and the Clean Water Act The enforcement authority for most cleanups conducted under the SMS rule (173-204 WAC) comes from MTCA or the Washington Water Pollution Control Act. Voluntary cleanups can also be conducted under the SMS.

Currently, contaminated sediments (e.g., those that do not meet PSDDA disposal guidelines) are managed and disposed of in three major ways. They are either left in place, taken to an upland landfill, or confined on-site. The practice of capping contaminated sediment in-place or allowing it to naturally recover will likely become less common as a result of increasing pressure from the federal Endangered Species Act and state natural resource agencies to protect, enhance and restore aquatic habitat. It is still fairly common for relatively small volumes of contaminated sediment to be periodically dredged, dewatered at the project site, and disposed of at existing upland landfills. Occasionally, on a project-by-project basis, some resourceful proponents develop their own single-user confined disposal facilities for larger volumes of contaminated sediment.

In general, however, most entities (e.g., small ports, marinas, and other waterfront operations) lack viable disposal options if they need to dredge contaminated sediments. Only the federal government (e.g., Corps, U.S. Navy), major regional ports, and large industries have initiated the remediation of contaminated sediment sites, either voluntarily as part of water construction projects or under environmental enforcement actions. These entities possess the financial and/or real estate resources to either construct their own confined disposal facilities or dredge and transport sediments to existing landfills. This pattern would continue under the no-action alternative.

Another consequence of no action is that dredging proponents would continue to avoid contaminated sediment during maintenance dredging projects. This is shown by examining the fate of sediments failing to qualify for disposal at PSDDA sites. Between 1988 and 1997, 25 proposed dredging projects reported sediments that failed to qualify for unconfined, open-water disposal (Fox 1997). These projects, and the fate of the contaminated sediment, are summarized in Table 4-1. The contaminated material was either disposed at a private upland location or landfill (approximately 24%), or it was left in place (approximately 76%). Decisions to leave this material in place involved several factors, including disposal difficulties, changes in project plans, budget constraints, or some combination of these factors. Based on available information, all of the contaminated material that was originally left in place remains in place, awaiting dredging and confined disposal. Only one of the projects eventually proceeded, but only after reconfiguring the dredge plan so dredging of the contaminated sediment was no longer required.

Under the existing regulatory framework, cleanup investigations at contaminated sites can be uncertain, lengthy and contentious. In addition, the region has relatively few environmentally sound and cost-effective confined disposal options. These factors result in delayed cleanup of contaminated sediment. Rather than initiate remedial plans/actions, liable parties may try to minimize the volume of contaminated sediment they must dredge and dispose of (or avoid dredging contaminated sediment altogether) by conducting years of site investigations.

Table 4-1. Proposed Dredging Projects with Sediments that Failed PSDDA (1988-1997) (Fox 1997)[1].

PROJECT	DATE	CONTAMINATED SEDIMENTS (cy)	FATE	DISPOSAL LOCATION	COMMENTS
USACE Bellingham	Nov 1990	66,035	Left in place		Plan to include with Bellingham Bay remediation.
Boyer Alaska	April 1992	3,600	Dredged	Upland, on owner's property	
US Coast Guard Pier 35	Sept 1992	2,400	Left in place		
Chevron USA	Jan 1990	3,700	Left in place		
USACE Duwamish	Aug 1990, Sept 1996	20,000	Left in place		Volume does not include material that passed later PSDDA retesting.
Duwamish Yacht Club	Nov 1988	3,000	Dredged	Unknown	
US Navy Everett Homeport	Sept 1990	6,296	Left in place		An alternate configuration was selecected so dredging in this area was not required.
Hurlen Construction	May 1990	4,000	Left in place		
USACE Kenmore	Feb 1996	8,000	Left in place		
Konoike Pacific	Feb 1993	10,520	Left in place		
Metro Emergency Bypass	June 1992	8,100	Left in place		
USACE Olympia Harbor Study	Nov 1988	9,000	Left in place		
Port of Everett Piers 1 & 3	Nov 1993	41,000	Dredged	Nearshore fill on port property	
Port of Everett Marina	Jul 1988	4,300	Left in place		
Port of Everett Marine Improvement Project	Oct 1996	10,200	Dredged	Nearshore fill on port property	
Port of Seattle Terminal 91	Nov 1991	11,000	Dredged	Upland solid waste landfill	
Port of Seattle Terminal 30	June 1993	5,376	Dredged	Upland solid waste landfill	
Tristar Marine	Feb 1990	3,500	Left in place		
U.S. Navy Bremerton - Pier D[2]	August 1993	53,400	Dredged	Upland solid waste landfill	
US Oil & Refining	April 1990	11,100	Dredged	Bioremediated at upland site	
Port of Seattle Terminal 18	1996	268,810	Left in place		Other disposal options being considered.
Lonestar Northwest Kaiser Dock Upgrade	June 1995	9,375	Dredged	Upland solid waste landfill	
Capitol Lake	1995	90,000	Left in place		Future retesting for PSDDA disposal is anticipated.
Crowley Marine Services	July 1995	9,750	Dredged	Upland - location not reported	
Meydenbauer Outfall	Feb 1996	2,600	Dredged 150 cy	Upland, on private property	Remaining 2,450 cy left in place.

[1] This summary includes projects listed or to be entered in the U.S. Army Corps of Engineers database (DAIS). Dredging projects that were not tested for PSDDA or were withdrawn from PSDDA consideration are not included.

[2] Original characterization in 1991 showed 102,300 cy failing PSDDA. Resampling in 1993 in the same vicinity, but with different configuration alternatives, resulted in 53,400 cy failing PSDDA. Results for the revised project are reported in this table.

4.2.2 Potential Impacts of No Action

As indicated by the preceding discussion, under the no-action alternative, many areas with contaminated surface sediments will remain unremediated for some time. Many of these contaminants (i.e., those in near-surface sediments) are bioavailable and affect local and regional ecosystem functions (e.g., see Malins et al. 1984, Myers et al. 1995b, Stein et al. 1992). In addition to acute impacts, the bioaccumulation of contaminants throughout the aquatic food web often has wide-ranging ecological and human health implications. Finally, if sediments at these sites are resuspended by natural or anthropogenic factors, these unremediated areas can be an uncontrolled source of contamination to adjacent areas (Ecology 1995).

Constructing a single user confined disposal facility site is difficult. Numerous technical studies must be conducted, there are extensive requirements before all necessary permits can be issued, and construction costs are high. Under the existing regulatory framework, for each proposed confined disposal action, proponents must develop, gain approval, and execute project-specific sediment evaluation procedures and disposal facility design elements. In addition, regulatory review of specific projects can be inefficient when the review is conducted by both regulatory programs (e.g., Section 404 of the CWA) and cleanup programs (e.g., CERCLA). This approach is costly, time-consuming, uncertain, and there is no formal mechanism to document, review, or build upon previous experience. This would likely remain the case under the no-action alternative.

As noted in Section 1.6, if a MUDS facility is established, a framework for project evaluation and permitting would be developed. Based on the successful DMMP model, this framework might include:

- Documentation of specific testing and evaluation procedures for the confined disposal of dredged material
- A consistent, interagency technical review process for each proposed dredging project leading to a consensus suitability decision
- Periodic review of the sediment evaluation and confined disposal site management practices by a coordinated group of interagency technical representatives to evaluate the program's effectiveness, assimilate new information, and modify procedures, as warranted.

Under the no-action alternative, no such framework would be developed.

Finally, dredging and confined disposal of contaminated sediment that has been conducted under existing local, state, and federal laws and regulations has been environmentally protective (e.g., see Hotchkiss 1988). Thus, the major consequence of no action is not that environmentally sound sediment cleanup cannot be accomplished under the existing system, but that the lack of environmentally sound and economically feasible confined disposal options for contaminated sediments results in the following:

- Fewer overall cleanup and dredging project actions

- Significant cleanup and dredging project delays
- Continued pressure to cap sediments in-place or consider natural recovery as preferred cleanup alternatives
- Continued harm to aquatic habitat, benthic communities and higher organisms from contaminated sediments that remain exposed unnecessarily
- Possible legal action against responsible entities for not addressing the contaminated sediment problem
- Possible proliferation of many, smaller, privately developed confined disposal sites constructed on a project-by-project basis.

4.3 IMPACTS COMMON TO ALL ACTION ALTERNATIVES

4.3.1 Dredging of Contaminated Sediments

The potential environmental consequences associated with the dredging of sediments for MUDS disposal are the same for each action or constructed alternative. Potential environmental impacts and controls associated with the dredging of contaminated sediments are site-specific and therefore are discussed only in general terms in this PEIS. Features such as local hydrodynamics, water depths, and sediment characteristics need to be considered when evaluating contaminated sediments. Project-specific sediment characterization results would determine the most suitable dredging technique and required operational controls. Potential environmental impacts, mitigation, and the significance of the impacts associated with dredging of contaminated sediments are summarized in Table 4-2 and discussed below.

Dredging or the removal of sediments from the bottom is accomplished by two basic methods - mechanical or hydraulic (Corps/EPA 1992):

- Mechanical dredges remove loose or hard compacted sediments by some sort of articulated bucket (e.g., a clamshell dredge). Mechanical dredging removes material from the bottom in discrete portions at nearly the in-place density and water content. Mechanical dredged sediments are typically placed bucket-by-bucket into a barge or scow for transport to a disposal or other offloading site.
- Hydraulic dredges remove loosely compacted material by use of a pump and suction pipe that pulls sediments in a liquid slurry from the bottom and either directly discharges them to a disposal area via a pipeline or pumps them into a hopper or container at the dredge site. In contrast to mechanical dredges, up to four times as much water as sediments is moved by hydraulic dredges in the sediment slurry. Hydraulic dredges can be equipped with an active, rotating excavating device, or cutterhead, which surrounds the intake suction pipe and loosens material for entrainment into the pipeline. Alternatively, hydraulic dredges can operate without a cutterhead, using straight suction to remove sediments. Typically, water jets located near the suction pipe entrance are used to fluidize the bottom, thereby enhancing the entrainment of material into the intake pipeline. Hydraulically dredged material can be discharged by pipeline directly to the disposal site, into a transport barge, or into storage chambers (hoppers) on the dredge itself. When the hoppers are full, the dredge is transported

Table 4-2. Summary of Potential Environmental Consequences and Mitigation Measures: Dredging and Transport[1].

Activity	Pathway	Potential Impact	Mitigation: Siting	Mitigation: Technology	Mitigation: Operations	Expected Significance of Impact with Mitigation
DREDGING						
Resuspension Contaminant releases - Dissolved - Particulate phase	Water column	Short-term exposure of biota to: - Suspended solids - Low DO - Dissolved contaminants	NA	- Silt curtains - Watertight buckets - Mechanically dredge	- Comply with WDFW closed dredging window - Comply with appropriate WQS - Minimize dredging period - Control speed of bucket - Carefully place materials in barge	- Short-term/insignificant
	Benthos	Long-term exposure of benthos to: - Resettled contaminated sediments	NA	"	- Control speed of bucket - Carefully place materials in barge	- Minimal loss expected/ insignificant
Physical removal of dredged materials	Benthos	Loss of habitat Destruction of benthos	NA	NA	NA	- Site-specific, depends on local communities, dredging frequency but recolonization expected
TRANSPORT						
Leakage of contaminants - Dissolved - Particulate phase	Water column	Short-term exposure of biota to: - Suspended solids - Dissolved contaminants	- Minimize distance between dredging sites and disposal sites	- Mechanically dredge	- Designate navigation and truck routes to maximize safety - Inspector oversight	- Minimal loss expected/ insignificant
	Benthos	Long-term exposure of benthos to: - Resettled contaminated sediments	"	- Mechanically dredge	"	- Minimal loss expected/ insignificant
Uptake of contaminants	Birds	Food chain effects or toxicity	"	- Mechanically dredge	- Maintain cover of water over sediment	- Potentially significant
Volatilazation of organics	Air	Inhalation of toxic contaminants	- Minimize distance between dredging sites and disposal sites	- Mechanically dredge	- Keep sediment saturated - Comply with appropriate air quality standards	- Minimal loss expected/ insignificant
Leakage of contaminants - Dissolved - Particulate phase	Upland routes	Exposure to contaminants	- Minimize distance between dredging sites and disposal sites	- Dewater and transpor in sealed vehicles	- Designate navigation and truck routes to maximize safety	- Minimal loss expected/ insignificant

[1] Assumes contaminated dredged material and capping materials have been tested for suitability. Sediment testing and evaluation procedures will be developed as part of a future element of the Puget Sound Confined Disposal Site Study.

NA - not applicable

to the disposal area and the sediment/water slurry can either be directly bottom-dumped or pumped out through a pipeline.

The pathways and mechanisms for release of contaminants during dredging (either mechanical or hydraulic) include:

- Contaminants associated with solids that are dislodged but not captured by the dredging equipment
- Contaminants released in dissolved form by desorption from suspended solids and the dispersal of interstitial (pore) water
- Direct biological uptake of dissolved and particulate forms by benthic invertebrates and fish
- Consumption of contaminated benthic invertebrates and other prey by birds and aquatic predators at the dredge site or from the barges
- Volatilization of contaminants not bound to solids directly into the atmosphere.

In Puget Sound, the conceptual designs developed for each alternative in Section 2 assume that mechanical bucket dredging would be used because 1) this is the method typically used in Puget Sound; 2) it involves less mixing/bulking of sediments with water than hydraulic methods, thereby minimizing the volume of material that requires transport and disposal; and 3) the method more closely maintains sediments in their *in situ* state, minimizing the opportunities for contaminant remobilization.

The dredging process resuspends some solids that are not captured by the dredging equipment and may be transported away from the dredging site. This physical disturbance also promotes oxidation of some of the resuspended materials that can result in the loss of some soluble contaminants to the water column. Released contaminants potentially affect the surrounding water, biota, and sediment quality. While some dispersion of solids and release of soluble contaminants should be expected when dredging contaminated sediments, mechanical dredging generally maintains most of the dredged volume in its *in situ* state. Cohesive marine sediments are moved in dredged bucket-sized clumps directly into a barge. The surface area of sediments that contact aerobic water column conditions is increased relative to the undisturbed sediments, but most of the disturbed sediment volume remains saturated and anoxic. Loss of contaminants by volatilization into the air is not a significant dredging pathway of concern.

4.3.2 Barge Transport of Contaminated Sediment to Disposal or Rehandling Sites

As part of the aquatic, nearshore, and upland MUDS alternatives, contaminated sediments would be transported by barge to the disposal facility. The contaminant pathways and mechanisms for release of contaminants during overwater transport by barge include:

- Loss of contaminants to the air
- Loss of dissolved and particulate contaminants from the vessel to the water along the barge route
- Biological uptake by birds foraging in the transport barge.

Because sediments dredged for confined disposal will remain saturated during barge transport to the disposal or rehandling site, loss of volatile contaminants directly to the air is not a significant pathway of concern.

Barges will not be allowed to overflow during dredging or transit to the site; however, leakage of contaminated sediments and water from the transport barge or accidental spills would result in sediment release to the water column. Released contaminants could affect water, biota, and, once settled to the bottom, sediment quality. Although some leakage is possible, the impacts of minor sediment and water losses along the transport route would likely be insignificant.

Another potentially important impact of barge transport of contaminated sediments is the exposure of birds to contaminants contained in the dredged materials. Water birds, primarily gulls, are attracted to sea-going vessels such as a tug and barge, especially if the barge contains exposed small fish and crustaceans. This impact is unavoidable and potentially significant.

4.3.3 Barge and Vessel Traffic

Dredging and transporting the dredged material to an LBC/CAD site, nearshore CDF, or upland dewatering facility would increase barge traffic. Increased tug and barge traffic could impact noise levels; air quality; aesthetics; foraging patterns of birds, mammals, and fish; vessel safety; and the timely operation of local vessel traffic. A detailed quantitative evaluation of these impacts cannot be performed at the programmatic level; however, general conclusions can be drawn from the assumed dredging volumes and disposal rates.

As discussed in Section 2, two 10-year conceptual design capacities were considered for each action-based alternative: 500,000 cy and 2,000,000 cy. For the 2,000,000-cy capacity site, up to 240,000 cy could be disposed of at a CAD site annually (200,000 cy *in situ* volume plus 20% bulking factor). Assuming a single barge capacity of 1,500 cy of material, much less than one barge-load of material (about 900 cy) per day, on average, would be disposed at the large CAD site over an assumed 9-month dredging and disposal period. Even assuming a 6-month dredging and disposal window (e.g., resulting from the pending ESA listing of Chinook salmon), still less than one barge-load of material (about 1,300 cy) per day would be disposed of at the site. The level of increased tug and barge traffic would not significantly impact noise levels, air quality, fish and wildlife, aesthetics, and normal vessel traffic in Puget Sound's urban embayments.

4.3.4 Mitigation

Measures to mitigate the environmental consequences of dredging and transporting contaminated sediment are described in the following sections.

4.3.4.1 Dredging of Contaminated Sediments

Sediment testing procedures, predictive computer models, dredging technologies and operational controls, and monitoring programs would be used to minimize the environmental consequences associated with dredging contaminated sediments. Contaminant release is a function of the dredged material characteristics and dredging operation. Project-specific operational and monitoring requirements would be identified during regulatory permitting. The dredged material characterization data would be used to determine the initial level of operational control and any specialized equipment needed for the dredging operation. Evaluation and control measures are discussed below.

Dredging and Elutriate Testing (DRET)

DRET is a modification of the standard elutriate test and is designed to predict the dissolved contaminant release during dredging (EPA 1996). According to EPA (1996), this approach is preliminary and needs to be tested at a number of sites and across a range of contaminant concentrations and dredging technologies before its general applicability can be determined.

Computer Models

A computer model that predicts contaminant releases during dredging is now available as a module (DREDGE) of the Automated Dredging and Disposal Alternatives Management System (ADDAMS) provided by the Corps Waterways Experiment Station (Averett et al. 1998). The software determines particulate and dissolved contaminant concentrations resulting from a given suspended sediment concentration. These results can be used with standard dredged material testing techniques to predict environmental impacts at the dredging site.

Technologies

Several technologies have been developed that allow contaminated sediments to be dredged accurately and with minimal environmental impact (NRC 1997). For example, watertight clamshell buckets can be used to minimize sediment resuspension in the water column (Ecology 1990a). Silt curtains can be deployed downstream of the dredging operation to prevent or minimize the transport of suspended sediments away from the dredging site. Cable-arm clamshell buckets have been developed that remove sediments in horizontal layers, rather than the cratered bottom left by typical dredge buckets; this device both minimizes overdredging (excess volume) and allows discrete sediment layers to be handled separately. Even without specialized equipment, straightforward operational changes, such as slowing the bucket's descent and retrieval rate, can effectively reduce sediment resuspension and turbidity during dredging. These equipment and operational options also can be used to minimize the total volume that will require confined disposal and ensure accurate site cleanup.

Policies, Regulations, and Monitoring Requirements

The potential environmental impacts of contaminated sediment dredging in Puget Sound are addressed by current regulations and policies (see Section 6.2). Federal permits (under the Clean Water Act and Rivers and Harbors Act) and state agency certifications [Ecology's Water Quality Certification and Department of Fish and Wildlife's Hydraulic Project Approval (HPA)] can dictate operational controls and monitoring requirements for dredging operations on a project-specific basis to ensure that adverse effects are avoided or minimized. Water quality monitoring for turbidity, dissolved oxygen, and contaminant concentrations in resuspended sediments can be required. If unacceptable contaminant releases, turbidity levels, or other water quality criteria are exceeded during "real-time" water quality monitoring, dredging would be terminated until operations or equipment can be altered to ensure environmental compliance. Immediate post-dredge sediment quality monitoring can be conducted to document the extent of any contaminant release and potential environmental impact at or adjacent to the dredge site.

In addition, to protect critical life-cycle periods of key resources, dredging operations are prohibited during some portions of the year. In Puget Sound, the Washington State Department of Fish and Wildlife does not allow dredging between March 15 and June 15 each year to protect outmigrating juvenile salmon and steelhead trout populations. This closed dredging window, currently applied in the PSDDA program, also would apply to MUDS dredging. Additional site-specific closures or restrictions would be identified by the Department of Fish and Wildlife HPA permit. For example, the proposal to list the Chinook salmon as a threatened species per the Endangered Species Act may lead to additional temporal dredging activity restrictions (e.g., to protect returning adult salmon and steelhead trout in late summer and fall) (WDFW 1998b).

Coordination with Tribal fishing activities would also be conducted. Dredging operations would not be allowed during any period of significant tribal fishing activity in a given area.

The overall result of temporal restrictions on dredging and/or disposal would be to increase the number and frequency of barges placing sediments of the CAD site during the time when dredging and disposal are allowed.

4.3.4.2 Barge Transport of Contaminated Sediment to Disposal or Rehandling Sites

Although environmental impacts associated with minor operational releases of contaminated sediments during transport are not expected to be significant, several precautionary measures can be utilized to minimize the risk of contaminant releases and exposure:

- Use of tightly sealed transport barges, restrictions on vessel operations in marginal weather conditions, and proper vessel operational practices during transport. Also, project-specific navigation routes from the dredge site to the disposal or rehandling site would be chosen to maximize safety and minimize environmental risk.
- If specific dredged material characteristics or operational constraints result in a concern for air quality impacts during transport, additional equipment or operational controls (e.g., shortfilling the barge to maintain ponded water) could be instituted on a project-specific basis.
- Maintaining some ponded water in the barge over the sediments may be an operational method of keeping foraging bird activity to a minimum.
- Siting the MUDS facilities as close to the contaminated sediment sources as possible should result in relatively short barge hauls and minimize exposure time.

4.3.4.3 Barge and Vessel Traffic

Although no significant impacts of increased barge traffic to noise levels, air quality, fish and wildlife, aesthetics, and normal vessel traffic are expected, regulations and siting controls are in place to reduce the effects of increased barge traffic. These include the following:

- Predicted noise levels would be compared to applicable county, state, or federal noise standards (see Section 4.4.9.6).
- Predicted contributions to the local, ambient air contaminant loads would be compared to applicable air quality standards. Federal actions are also regulated under the Federal General Conformity Rule for direct and indirect air pollutant emissions. These activities must be considered for conformity with the State Implementation Plan (see Section 3.1.3).
- Sites would not be selected in critical habitat areas and would avoid fisheries nursery areas, migration routes, and feeding grounds.

4.3.5 Unavoidable, Adverse Impacts

The loss or disruption of the benthic community in the dredging area is an unavoidable impact of dredging contaminated sediments that cannot be mitigated. While no specific research has been conducted in Puget Sound on benthic community recovery following dredging operations, several factors influence the pattern and rate of recovery. These include pre- versus post-dredge sediment types, time of year, recruiting fauna reproductive cycles, sediment/organic-matter flux to benthos, and changes to the habitat caused by the initial colonizing species (Jones & Stokes 1998). In the absence of future dredging or other disturbance factors, such as vessel prop wash or significant chemical recontamination, the benthic community can be expected to recover within one to three years (Rhoads and Germano 1986, Jones & Stokes 1998). Depending on substrate composition, the replacement of a pre-dredge contaminated area with an uncontaminated post-dredge substrate could potentially result in a reestablished benthic community that is more diverse than the community disrupted by the dredging operation.

A second unavoidable, adverse impact associated with the dredging of contaminated sediments is the loss of some contaminants in particulate or dissolved form to the environment. Released contaminants could affect water, biota, and, once settled to the bottom, sediment quality in the vicinity of the dredge site. The biological uptake of some of these contaminants by algae, invertebrates, and higher trophic level organisms (e.g., gulls foraging at the dredge site) is also possible. Construction and post-dredge site monitoring could be required as part of project authorization to assess the level of these potential impacts.

4.4 LEVEL BOTTOM CAPPING AND CONTAINED AQUATIC DISPOSAL ALTERNATIVE

As stated previously, the environmental impacts associated with each constructed alternative are discussed relative to the conceptual designs presented in Section 2. For the aquatic disposal alternative, a set of excavated CAD cells was developed as the conceptual design, and the environmental issues associated with this design are detailed in the sections that follow. However, another aquatic disposal option, level bottom capping, is a viable MUDS design that could be considered in future site-specific efforts. While a LBC operation would share many of the same environmental issues associated with a CAD site, there would be some differences. These differences are noted below but are not specifically addressed in the consequences discussion that follows:

- The area of sea floor required for an LBC site would be greater than for a CAD site due to the lack of lateral containment (see Figure 2-2)
- The required volume of capping material per volume of contaminated material would be greater and the level of verification monitoring needed to confirm that the contaminated material was effectively capped would be greater
- LBC sites could be constructed only in areas with minimal sea floor slopes (0-3%); CAD cells could be built in areas with up slopes up to 6% (Palermo et al. 1998a)
- LBC sites have been successfully constructed in up to 200 ft of water (Wiley 1995), CAD sites, while considered feasible to this depth, have not been constructed in depths greater than 100 ft
- Because interim capping would be difficult, a multiuser LBC site would require greater coordination between individual projects than a CAD site to ensure that all contaminated material is effectively placed and capped.

The aquatic site conceptual design described in Section 2 consists of a series of excavated CAD cells located between 65 and 100 ft MLLW. The site is located in an area with a maximum slope of 6 percent. Each cell is excavated to a depth of 35 ft and is capable of holding one dredging year's volume of contaminated sediments. The dimensions of each cell depend on the design volume. A sequenced CAD facility with a 500,000-cy capacity over a 10-year period has cell dimensions of 260 ft by 520 ft (slightly over 3 acres). Using this design, each cell holds 60,000 cy of contaminated dredged material (50,000 cy with 20% bulking factor). A larger facility capable of holding 2,000,000 cy over a 10-year period has cell dimensions of 440 ft by 880 ft (almost 9 acres). Using the larger design, each cell holds 240,000 cy of contaminated dredged material.

CAD cell use is sequenced such that materials excavated from one cell could be used for capping material for an adjacent cell. Volumes of dredged sediments in excess of the required capping volume could be used as part of a beneficial use project or the materials could be disposed of at a PSDDA unconfined open-water disposal site. Each cell is excavated and filled with alternating layers of mechanically dredged contaminated materials and clean cap sediments. The final elevation of the material contained in the cell is 2 ft lower than the surrounding bottom elevation. In a single year, 30,000 cy of clean materials are used as both interim and final cap materials for the 500,000-cy facility. For the larger 2,000,000-cy facility, 92,000 cy of clean materials are used as interim and final cap materials in a single year. Interim caps are placed over the contaminated material within four weeks of disposal. Both contaminated dredged material and capping material are placed in the CAD cell by bottom-dump barge.

4.4.1 Contaminant Pathways

Contaminant pathways associated with the CAD alternative are illustrated in Figure 2-3. Materials released from the barge enter a convective descent phase, followed by dynamic collapse on the bottom and the formation of a horizontal base surge (Figure 4-1). The spread of material in this surge will largely be contained within the CAD cell walls. In an LBC operation, the material would spread farther laterally, covering a larger sea floor area. Following the rapid dynamic collapse phase, diffusive processes begin and materials mix with the lower water column, become diluted, and settle to the bottom (Koh and Chang 1973; Gordon 1974; Brandsma and Divoky 1976; Johnson and Holliday 1978; Bokuniewicz et al. 1978; Pequegnat et al. 1978; Pequegnat et al. 1981).

Estimates of the amount of dredged material remaining in suspension in the upper water column after disposal range from 1 to 5 percent (Gordon 1974; Sustar and Wakeman 1977; Bokuniewicz et al. 1978; Tavalaro 1982, 1984; Truitt 1986; SAIC 1987; Johnson et al. 1993, Johnson and Fong 1993; Thevenot and Johnson 1994). Small fractions of suspended materials would settle outside of the constructed pit as a thin veneer (a few cm or less) of accumulated sediment. During cap placement, the thin layer of sediments occurring outside of the CAD cell would likely be covered by a thin layer of clean material (Palermo et al. 1998a). Most suspended materials would typically settle out within 1 to 1.5 hours of disposal (Hartnack et al. 1997).

Prior to the placement of capping material, contaminant pathways for the conceptual-sequenced CAD design are either via water column or biological uptake as shown in Figure 4-1. The contaminant pathways, potential environmental impacts, mitigation, and the potential significance of impacts associated with the construction and operation of a CAD site are summarized in Table 4-3.

4.4.2 Potential Impacts to Water and Sediments

4.4.2.1 Water

Under the conceptual CAD site design, materials (that have passed contaminated dredged material suitability guidelines) are dredged by mechanical means and placed in a bottom-dump barge. Sediments are then transported via tug and barge to the designated disposal site. Once onsite, the materials are released from the bottom of the barge, as shown in Figure 4-1. The placement of mechanically dredged sediments by bottom-dump barge is a favored means of contaminated sediment disposal because the materials normally maintain a high degree of cohesion throughout the dredging, transport, and disposal process, resulting in less water column dispersion (Wiley 1995, Palermo 1997, Palermo et al. 1998a). Despite these designed controls, the release of dredged material would temporarily cause total suspended solids concentration increases, thereby influencing turbidity. Dissolved oxygen levels would temporarily decrease and water column nutrients and contaminant levels would increase.

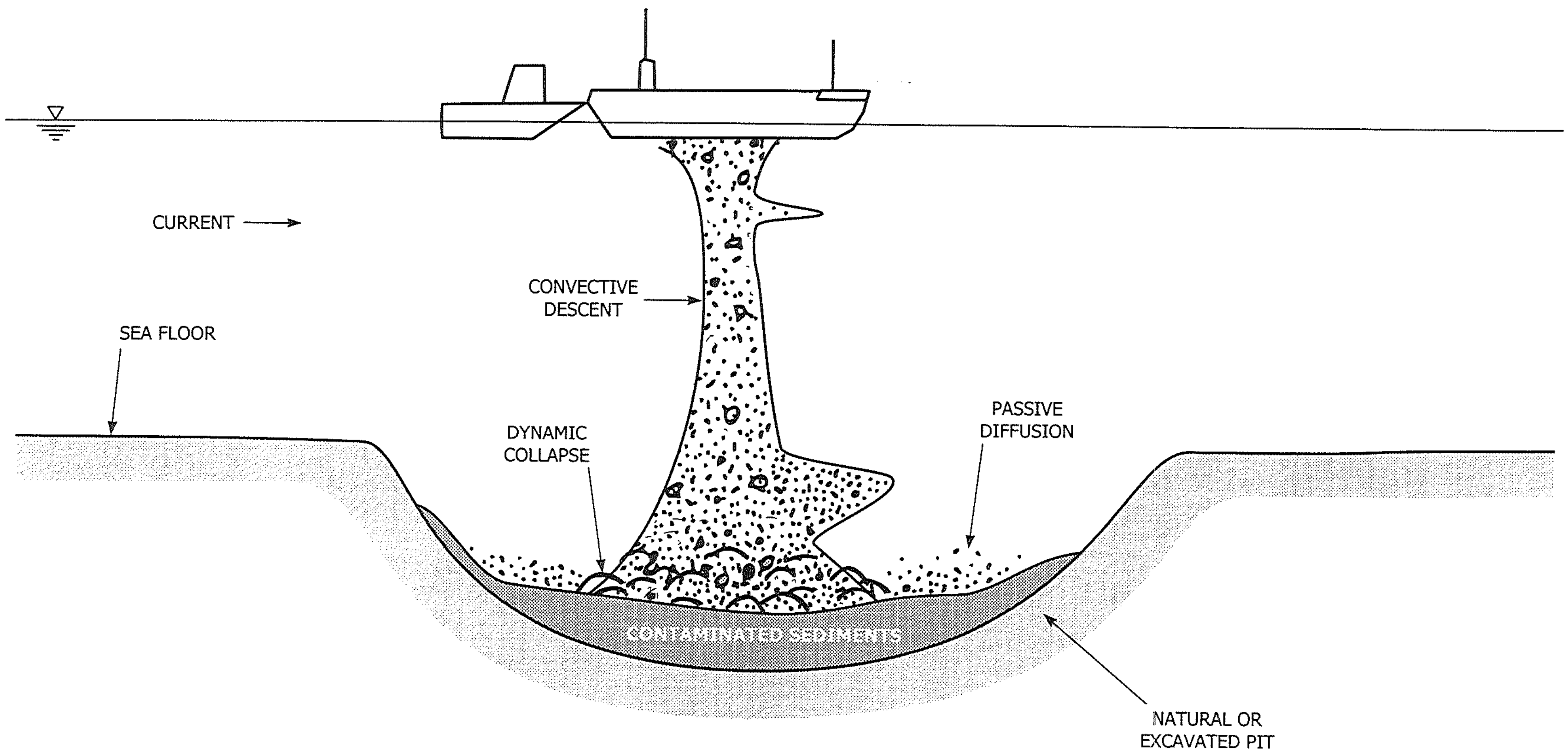


Figure 4-1	Bottom-dump Barge Placement of Dredged Material at a Contained Aquatic Disposal (CAD)	MUDS Draft PEIS	
		Feb 99	MPEIS Figure 4-1.xar

Table 4-3. Summary of Potential Environmental Consequences and Mitigation Measures: Sequenced CAD Conceptual Design[1].

Activity	Pathway	Potential Impact	Mitigation			Expected Significance of Impact with Mitigation
			Siting	Technology	Operations	
CAD CONSTRUCTION						
Physical removal of dredged materials	Water column	Short-term exposure of biota to: - Suspended solids - Low DO	NA	- Watertight buckets - Mechanically dredge	- Comply with WDFW closed dredging window - Comply with appropriate WQS	- Temporary/insignificant
"	Benthos	Loss of habitat Destruction of benthos	- Exclude critical habitat - Avoid areas proximal to critical habitats	NA	- Perform pre-excavation benthic survey to confirm siting	- Long-term benthic recovery/insignificant - Short-term/significant
DISPOSAL						
Resuspension Contaminant releases: - Dissolved - Particulate phase	Water column	Short-term exposure of biota to: - Suspended solids - Dissolved contaminants - Low DO Short-term impact to: - Aesthetics Health risks to humans: - Food chain contaminant - Uptake from fish and shellfish consumption	- Exclude critical habitat - Avoid areas proximal to critical habitats - Site in low current environment - Avoid public use areas - Avoid nursery areas, migration routes, feeding grounds	- Mechanically dredge - Use bottom-dump barge - Use downpipe if warranted - Place interim caps 4 weeks after disposal - Place 3 ft+ cap at end	- Inspector oversight - Use accurate & precise positioning - Optimize tidal currents - Comply with WDFW closed dredging window - Comply with appropriate WQS - Monitor bioaccumulation	- Water quality impacts/ insignificant
Uptake of contaminants	Benthos Fish Waterfowl	Food chain effects or toxicity	"	"	"	- Biological uptake/ potentially significant
Placing dredged material in CAD cell	Benthos	Loss of habitat Burial of benthos	- Exclude critical habitat - Avoid areas proximal to critical habitats	NA	- Inspector oversight - Use accurate & precise positioning - Optimize tidal currents - Monitor benthos	- Benthic recovery expected after final cap placement/ - Possible enhanced habitat/ insignificant
CAP PLACEMENT						
Physical placement of cap	Water column	Short-term exposure of biota to: - Suspended solids - Low DO Short-term impact to: - Aesthetics Exposure of biota to: - Resuspended and redeposited contaminated material	- Site in low current environment	- Mechanically dredge - Use bottom-dump barge to place cap or, if warranted, submerged discharge	- Monitor for effectiveness	- Short-term/insignificant

Table 4-3. Summary of Potential Environmental Consequences and Mitigation Measures: Sequenced CAD Conceptual Design[1].

Activity	Pathway	Potential Impact	Mitigation: Siting	Mitigation: Technology	Mitigation: Operations	Expected Significance of Impact with Mitigation
	Benthos	Burial of benthos followed by recolonization	NA	NA	- Inspector oversight - Use accurate & precise positioning - Optimize tidal currents - Monitor benthos	- Benthos will recolonize short-term/significant long-term/insignificant
POST-CAP PLACEMENT						
Loss of cap integrity (erosion or bioturbation)	Water column	Exposure of biota to: - Suspended solids - Dissolved contaminants	- Site in low current environment	- Construct cap of effective thickness and stability	- Monitor cap - Develop contingency plan	- Insignificant if properly designed and constructed

[1] Assumes contaminated dredged material and capping materials have been tested for suitability. Sediment testing and evaluation procedures will be developed as part of a future element of the Puget Sound Confined Disposal Site Study.

NA - not applicable

The magnitude of water column effects is dependent on several site-specific factors, including the chemical composition of the dredged material (i.e., presence of iron and manganese oxides and hydroxides, redox potential or oxidizing potential of sediments, nature of organics, etc.), initial mixing, type of clay particles present, particle size, the amount of time water and sediment are in contact, pH, salinity, temperature, and other site-specific conditions. Based on numerous studies performed during the Corps Dredged Material Research Program (DMRP) and the Field Verification Program in the 1970s, alterations in water quality parameters caused by disposal are generally restricted to the dredged material plume and are short in duration (Pequegnat et al. 1978, cited in Herbick and Brahme 1991; Sustar and Wakeman 1977).

In general, organic contaminants contained in the dredged material have a low solubility and a high affinity for organic matter. Similarly, metals stay strongly bound to the solid phase (i.e., clay particles and organics), especially under anaerobic conditions. Soluble contaminants are considered to be readily available for biological uptake, while those associated with detrital material can be consumed by filter-feeding organisms and certain types of algae. Metal cations, nutrients, and other chemicals vary in terms of their toxicity and bioavailability (which is generally dependent on local physicochemical conditions). If the contaminants in the dredged material were highly soluble or weakly adsorbed to the sediment or organic material, the contaminants would be more readily released to the water column and be more bioavailable.

In comprehensive reviews of the potential impacts of open-water dredged material disposal, both Pequegnat et al. (1978) and Stern and Stickle (1978) concluded that biological water column impacts associated with contaminated dredged material disposal are localized and temporary. The greatest potential for impacts occurs once the material is placed on the bottom and is both physical (smothering and suffocation of benthic organisms) and biological (the sorption and direct biological uptake by benthic organisms). Lee (1976, cited in Herbich and Brahme 1991) also concluded that effects of contaminant releases on the water column are short term, primarily causing the stimulation of plant growth and, to a lesser degree, toxicity to water column organisms. His studies pointed out that the potential long-term chronic toxicity effect was more of a concern than short-term effects due to the transfer of contaminants from sediments to benthic organisms, fish, and other organisms (i.e., the food web pathway). Some amount of contaminant releases during disposal is unavoidable. Controls to minimize dispersion and contaminants releases are discussed in Section 4.4.9.

4.4.2.2 Sediment

Seafloor sediments will unavoidably be physically disturbed during the construction of each CAD cell. Existing bottom habitat located where CAD cells are constructed - an area up to 9 acres based on the large-sized design - will be lost. The site, situated in water depths ranging from 25 to 100 ft, would be comprised of uncontaminated, fine-grained silts and clays. Materials expected to be disposed of at the site could range from sandy sediments to silty clays with elevated levels of metals and organic contaminants. Clean capping materials (both interim and final) would cover the contaminated materials. Eventually, the final cap itself would be covered by ambient silts and clays resulting from natural sedimentation processes as the CAD site would be located in a depositional environment. Sedimentation rates in the nearshore environment are more highly variable than in the deep basins of Puget Sound; however, sedimentation rates ranging from 0.5 cm per year to greater than 2 cm per year have been reported for various nearshore areas in Puget Sound. In offshore basins of Puget Sound, average sedimentation rates range from 1 to 2 cm per year (Carpenter et al. 1985).

Small fractions (i.e., 1 to 5 percent) of contaminated suspended materials may settle and accumulate as a thin veneer (up to a few cm) on the bottom surrounding the pit (Palermo 1997). If not capped by subsequently placed clean materials, local benthic organisms and bottom-feeding fish would be exposed to these sediments, potentially bioaccumulating contaminants.

4.4.3 Potential Impacts to Ecological Health

4.4.3.1 Habitat

The excavate-and-cap sequence proposed for the conceptual CAD design would have unavoidable impacts on the local benthic community and affect its habitat value. *In situ* infauna would be removed during cell construction. Pioneering species that recolonize the CAD site during periods of disposal inactivity would then be buried during the next disposal event. Once an excavated cell is at capacity, clean sediment would be used to cap the uppermost layer of dredged and interim cap materials. If final cap materials differ substantively from the ambient sediment texture, the new benthic community, in terms of species composition, could likely be very different from the original community. Species that are sensitive to physical disturbance might be displaced by species from surrounding areas. Changes in the benthic community caused by excavation and capping would temporarily alter the prey population as near-surface benthic species initially recolonizing the site could be readily exploited as a food source by bottom-feeding fish. This could result in enhanced short-term feeding benefits (Rhoads et al. 1978; Rhoads and Germano 1986; Becker 1984; Lunz 1986; cited in PSDDA 1989).

Rhoads et al. (1978) reported rates of benthic recolonization following disturbances caused by dredged material disposal. One aspect of the study was to monitor benthic communities at a dredged material disposal site that received weekly loads of dredged material over a 7-month period. Some of the materials were considered highly contaminated; all sediments were covered by a final cap of clean sand. Peak faunal densities were estimated to occur approximately 200 days (28 weeks) after disposal operations ceased. Colonizing species peaked in terms of abundance between 128 and 344 days (or 4 to 49 weeks) following dredged material placement. Pioneering species tend to be near-surface suspension feeders and, as indicated above, are vulnerable to predation. However, pioneering species that are located in areas subject to disturbance have short life spans, high reproduction rates, and are likely to disperse to other areas. If disturbances are stopped (e.g., after final cap placement at a site), species with longer mean life spans and lower recruitment rates eventually return. Benthic assemblages that represent an equilibrium community on mud bottoms typically feed on buried detrital material. It can take several years to establish an equilibrium community after a major disturbance (Rhoads et al. 1978, Jones & Stokes 1998).

4.4.3.2 Plants

In Puget Sound, aquatic plants are not typically found in habitats having fine-textured sediments at water depths greater than 25 ft, the minimum potential design depth for a MUDS CAD. In addition, as a CAD site would not be sited in an area with valuable aquatic plants (e.g., eelgrass beds, see Appendix B), the CAD alternative would not be expected to impact aquatic plants.

4.4.3.3 Invertebrates

As discussed above, local benthic infaunal and epifaunal communities would be altered by the physical removal of sediment during cell construction and by burial during disposal and cap placement. Physical impacts would largely be restricted to the dimensions of the excavated cell. The critical depth of burial for many marine invertebrates is 10 cm (Kranz 1974, Maurer et al. 1978). For sediment accumulations greater than 10 cm, resident infauna cannot reestablish contact with the overlying water column and therefore perish. As noted above, recolonization of dredged materials by opportunistic species begins soon after placement operations are completed, but reestablishment of a mature benthic community assemblage would likely take as long as 3 years (Rhoads et al. 1978, Jones & Stokes 1998). The reestablishment of the benthic community would be dependent on the types and numbers of individuals and species present at the site, the similarity of the cap sediment to the surrounding sediment, and the habitat value of the cap sediment in terms of physical and nutritional properties.

Organisms living outside of the CAD cell and in contact with the thin layer of residual disposal plume materials would be exposed to contaminated sediments. During the 4-week period between contaminated sediment disposal and cap placement, benthic infauna inside the CAD cell would also be exposed to contaminated dredged material. Exposed benthic organisms could suffer from either toxic effects or effects associated with the bioaccumulation of contaminants.

The accumulation of nonessential chemicals (i.e., contaminants) by natural processes can reach levels that may be detrimental to aquatic plants and animals. Accumulation of contaminants can occur from direct ingestion or from absorption from sediments and water, called bioconcentration. The total process of bioconcentration and ingestion is termed bioaccumulation. Biomagnification occurs when the dietary intake of food leads to increasing concentrations of substances at each successively higher trophic level (Kay 1984, cited in Kay 1985).

Kay (1984) concluded that increased biomagnification potential was not likely when placing dredged material in the aquatic environment when there were no significant long-term changes in the chemical characteristics of the sediments or bioavailability of the contaminants in those sediments. There is greater concern for biomagnification when food webs incorporate both aquatic and nonaquatic environments (i.e., birds preying on fish) and biomagnification potential is measured by factors on the order of tens, hundreds, or thousands (Kay 1984, cited in Kay 1985).

4.4.3.4 Fish

Any bottom-feeding fish in the area, such as English sole or slender sole, could be removed during cell construction or buried during disposal operations. Benthic infaunal assemblages normally available for consumption would be absent or greatly altered in terms of species diversity, abundances, and densities. Initially, bottom-feeding fish would likely avoid feeding in the disturbed areas. However, during periods of disposal inactivity (including interim cap placement) and following final cap placement, pioneering, opportunistic benthic infauna would recolonize the impacted area and bottom-feeding fish would likely be attracted to the area to forage on these recolonizing, surface dwelling assemblages. Bottom-feeding fish could be exposed to contaminants inside of the CAD cell before the placement of an interim cap (a 4-week period) and outside of the CAD cell where small amounts of contaminated sediments suspended in the dredged material disposal plume have settled out.

Among pelagic fish, such as the Pacific herring, increased suspended material in the water column could interfere with respiration or feeding habits, impede mobility, or irritate tissues, leaving the organism susceptible to infection (Barnard 1978, cited in Thackston and Palermo 1998). Pequegnat et al. (1978, cited in Herbich and Brahme 1991) also reported that increased turbidity caused mobile organisms to migrate out of the area affected by disposal. As reported for water quality impacts, Lee (1976, cited in Herbich and Brahme 1991) concluded that effects of contaminant releases on the water column are short-term and cause minor toxicity to water column organisms. His studies pointed out that the potential long-term chronic toxicity effect was more of a concern than short-term effects due to the transfer of contaminants from sediments to benthic organisms, fish, and other organisms. Pelagic fish could accumulate contaminants present in their prey sources resulting from exposure to contaminants at lower trophic levels (see Table 4-3).

4.4.3.5 Birds and Mammals

Predicted impacts to specific bird and mammal populations would depend on the species present and the location of the selected site. Potential impacts to diving birds would be temporary loss of access to prey sources caused by the dredged material disposal plume, potential exposure to benthic organisms and fish at and adjacent to the CAD site, and exposure to dredged materials contained in the barges. Dredged material disposal plumes and barged sediments can be an attraction to gulls and other sea birds. Cormorants, loons, scoters, pigeon guillemots, oldsquaws, and common murres have been documented at 65 ft or deeper. Rhinoceros auklets and some grebes also probably forage at project depths. Based on Lee's work during the DMRP (Lee 1976, cited in Herbich and Brahme 1991), organisms such as birds, directly exposed to contaminants released from the disposal plume, would experience minor impacts. However, several of these species are benthivores and could potentially feed on benthic organisms located at and adjacent to the CAD site. As noted above, biomagnification is a concern when contaminants in the aquatic food web are incorporated into the nonaquatic foodweb (Kay 1984, cited in Kay 1985). Waterfowl could potentially accumulate contaminants to significant levels (see Table 4-3).

Marine mammals could experience localized loss of access to prey sources, potential exposure to benthic organisms and fish at and adjacent to the CAD site, increased boat noise, and potential collisions with the tug and barge activities. Impacts associated with increased boat noise and potential collisions are considered minor because tug and barge operations would be occasional, disposal operations would be short in duration, and marine mammals have the ability to avoid vessels. Compared with ongoing boat and ship traffic in Puget Sound, dredged material disposal operations would be a small additional contribution. Like fish and diving birds, marine mammals directly exposed to any contaminants potentially released from the disposal plume could experience minor impacts. Of greater concern would be the potential for accumulation of contaminants from ingestion of impacted benthic organisms and fish (Lee 1976, cited in Herbich and Brahme 1991; Kay 1984; cited in Kay 1985).

4.4.3.6 Threatened and Endangered Species

In generic terms, the marine mammals, fish, and birds listed as threatened or endangered or listed as candidates (e.g., Chinook salmon) would suffer from the same or similar impacts described above for fish, birds, and mammals. However, threatened and endangered species are further protected by the Endangered Species Act of 1973 (ESA). Aquatic areas critical to listed and proposed endangered and threatened species will be removed from consideration during the siting process (see Appendix B). In addition, a biological assessment of the area proximal to a proposed CAD site would include the level of use by affected threatened or endangered species, how primary food stocks and foraging areas would be influenced by the project, and a discussion of the potential short- and long-term impacts of disposal operations that may disturb or result in avoidance of the project area by those species. The assessment would then be reviewed by applicable state and federal agencies for compliance with the ESA, as amended.

4.4.4 Potential Impacts to Human Health

The potential impacts to human health are exposure to contaminated sediment located in the barge (via direct contact or inhalation) during transport and the possible ingestion of fish or crustaceans that have accumulated contaminants to unacceptable levels as a result of contaminated sediment disposal. As noted above, the potential for biomagnification is greater when contaminants are passed from aquatic organisms to terrestrial organisms. The potential for contaminant uptake occurs when contaminated sediments are dispersed beyond the boundary of the disposal site and when they are exposed prior to capping. Despite mitigation, some food web biomagnification of contaminants could be possible.

4.4.5 Potential Impacts to Land and Water Use

Use of a CAD site would impact water use in terms of pit construction activities, increased vessel traffic, and potential conflicts with Tribal, commercial, or recreational fisheries. As noted in Section 4.3.3, tug and barge traffic is expected to be intermittent, localized, and temporary. The construction of a potential 9-acre site would take place over a period of 4 months. During this time, use of this area might be off limits to recreational or other commercial vessels. Also, if dredging or disposal operational periods are further restricted seasonally by new ESA-based salmon limitations, barge and tug traffic could be temporarily heavy during authorized periods.

4.4.6 Potential Impacts to Transportation and Utilities

Use of a designated CAD site would unavoidably affect both navigation and anchorage use within the disposal zone. Although disruption to local navigation would be intermittent and temporary, a designated CAD site would become a no-anchor zone to prevent any future disturbance of the sediment cap.

Actual disposal activity is difficult to predict and depends on the dredging site locations relative to the CAD site. As discussed in Section 4.3.3, assuming dredge quantities were the same each year, less than one barge-load of material per day, on average, would be disposed at the 2,000,000-cy capacity site. In actuality, periods of higher site use during active dredging would be interspersed with periods of no activity. As an example, a single dredging project of 100,000 cy occurring over a 30-day period would result in approximately two barge trips to the site per day. Even at an anticipated higher use level, tug and barge activities are not expected to interfere with normal commercial and recreational vessels in Puget Sound (PSDDA 1989).

Actual placement of contaminated dredged material using tug and barge would take approximately 5 to 10 minutes, although an additional 10 to 20 minutes may be required to precisely position the tug/barge combination prior to release of the dredged material. Computer modeling will dictate operational constraints, and modeling predictions will be verified by a monitoring program. State-of-the-art equipment (i.e., differential global positioning system or microwave systems interfaced with a helmsman's display) and techniques would be employed to release the material within a prescribed radius of the designated target (e.g., within 1 to 3 meters) in a timely manner. These technological controls and barge disposal inspections would ensure consistency and accuracy of placement for both the contaminated sediments and clean cap materials (Palermo et al. 1998a). The PSDDA monitoring program has shown that these technological controls are effective in ensuring the accurate placement of dredged material at open-water disposal sites.

4.4.7 Potential Impacts to Air, Noise, and Aesthetics

Air, noise, and aesthetics would be impacted by dredged material disposal depending on the location of the designated CAD site. In generic terms, air emissions (carbon monoxide, nitrogen oxide, particulates, hydrocarbons, or volatiles), associated odors, and noise levels at the site would likely increase during construction and operation. Assuming the selected site is situated in an urban bay, these levels may not exceed ambient conditions (PSDDA 1989). Increased air and noise levels can impact both wildlife and humans, predominantly site workers. However, for all potential disposal sites, adverse air and noise quality impacts resulting from site construction, transport, and disposal would be short-term, ceasing upon completion of the project.

Noise generated by equipment constructing the CAD site and hauling barge loads of sediment to and from the site would probably not exceed sound pressure levels typically experienced at a factory (80 decibels). In comparison, heavy truck traffic generates sound pressure levels of 90 decibels, and normal conversation generates sound pressure levels of 60 decibels. Construction of the CAD facility and its operation are not expected to significantly impact noise levels in Puget Sound; however, these activities would comply with applicable noise standards such as county ordinances and local city requirements.

In Section 4.3.3, it was noted that impacts of barge transport and disposal are not expected to be significant because only one to two barge trips to a CAD site are predicted to occur, on average, each day. The potential effects of dredged material transport and disposal activities are not unlike the tug and barge activities currently underway and authorized by the established DMMP program.

In terms of aesthetics, an increase in tug and barge activity observed from the shoreline is not expected to impact local aesthetic properties because the number of disposal events would be occasional. Boaters in the general vicinity of the disposal zone at the time of dredged material discharge could observe a localized turbidity plume that could last for minutes to hours.

4.4.8 Potential Impacts to Cultural Resources

An in-depth literature search and underwater reconnaissance surveys for historically significant shipwrecks were completed during the original PSDDA siting process (PSDDA 1988, PSDDA 1989). As part of the designation process, PSDDA open-water disposal sites were evaluated relative to Section 106 of the National Historic Preservation Act (36 CFR 800), in cooperation with local governments, the Washington State Office of Archaeology and Historic Preservation, and the National Advisory Council on Historic Preservation. Because all archaeological or cultural sites would be excluded from possible site selection (see Appendix B) and site selection must comply with applicable historic preservation laws, it is not anticipated that cultural resources would be impacted by the construction of a CAD site.

4.4.9 Mitigation

Measures to mitigate the environmental consequences of implementing the LBC/CAD alternative are described in the following sentences.

4.4.9.1 Water and Sediments

The CAD siting process, site design, predictive computer models, regulations and policies, disposal technologies and controls, and monitoring programs would reduce the water quality impacts of the disposal of contaminated sediments at a potential CAD site. Measures to reduce impacts to sediments are the same as those identified for water. Minimizing the dispersion of sediments upon release from the barge and during all phases of descent would minimize potential impacts to sediments located beyond the CAD cell boundaries.

Site Design

Several elements of the conceptual CAD design minimize impacts:

- Materials would most likely be dredged mechanically, thereby reducing the fluidity of the dredged material and, consequently, its dispersion during disposal. The majority of contaminants present in the dredged material are expected to remain bound to the solid phase, minimizing impacts to the water column.
- Each CAD cell as designed incorporates 35-ft deep walls, minimizing the spread of materials during the dynamic collapse of the disposal plume.
- As part of the site-specific phase, the interim caps and the final cap would be designed to physically isolate the contaminated sediments from benthic infauna and to control flux of contaminants through the cap (Palermo et al. 1998a). Appropriate cap thickness would depend on the physical and chemical properties of the contaminated sediments and cap materials, local hydrodynamics, the potential for bioturbation of the cap by aquatic organisms, cap consolidation, and operational constraints (Palermo et al. 1998a). A final 3-ft cap is a reasonable estimate at this time based on other Puget Sound capping projects.
- The final elevation of the materials contained inside each cell could be up to 2 ft below the surrounding bottom elevation, reducing the potential for erosion and encouraging the potential for sediment deposition.

Siting

During the siting process, only those areas having a relatively flat bottom (e.g., less than 6 percent slope) would be considered for a CAD site. During disposal, water column and near-bed current velocities would not exceed 1 ft per second and 0.5 ft per second, respectively. Geological hazards such as earthquake and slope failure impacts would also be assessed. In addition, only subtidal areas with low habitat value would be considered (see Section 4.4.3).

Computer Modeling

The fate of dredged material released in open water from several minutes to a few hours after barge disposal is commonly predicted using the model STFATE (Short Term FATE). Developed by Koh and Chang (1973), the original model has been updated to incorporate new information from research performed by Brandsma and Divoky (1976), Johnson and Fong (1993), and Johnson et al. (1994). The computer-implemented model is a module of ADDAMS and is included in the Ocean and Inland Testing manuals (Corps/EPA 1991, Palermo et al. 1998a). The model simulates the dispersion of disposed dredged material in water. Basic output includes the concentration of total suspended solids at various depths in the water column (considering initial mixing) and the areal extent of the deposit on a level bottom (Palermo et al. 1998a). The results of this model are used in conjunction with other site-specific test results such as toxicity tests. The degree of dispersion and the potential for releases of contaminants to the water column, including potential toxicity, determines the acceptability of water column impacts. If water column impacts are predicted with the model, then alternative disposal methods or disposal sites must be considered (Palermo et al. 1998a).

Regulations and Policies

The potential impacts of disposal on fish and wildlife would be evaluated as part of the federal Clean Water Act's Section 404 permitting process and Ecology's Water Quality Certification. Although not yet defined, the Puget Sound Confined Disposal Site Study testing procedures would be consistent with the existing national guidance on dredged material testing (Corps/EPA 1992, 1998). The guidance provides proper sediment testing procedures, suitability determination guidelines, disposal site design considerations, operational controls, and monitoring recommendations. State water quality standards, toxic effluent standards, and marine sanctuary requirements must be met to ensure that disposal does not cause or contribute to significant degradation of surface waters. Section 404 is jointly administered by the Corps and the EPA, with Section 401 water quality certification for the discharge of dredged material authorized by Ecology. Materials not likely to pass applicable Puget Sound Confined Disposal Site Study testing and evaluation guidelines would not be released in an aquatic environment.

Water quality standards for the State of Washington are presented in WAC 173-201A, *Water Quality Standards for Surface Waters of the State of Washington*. Water quality standards were established to protect public health, recreation, fish, shellfish, and wildlife. WAC 173-201A identifies different classes of surface waters throughout the state and provides appropriate characteristic uses criteria (e.g., water supply type, recreation uses, fish and shellfish rearing, spawning, migration, and harvesting uses, etc.) and water quality criteria (e.g., fecal coliform, dissolved oxygen, total dissolved gas, temperature, pH, turbidity, etc.) for each class. Toxic substances criteria are also provided and apply to all surface waters in Washington State. An appropriate water quality monitoring plan would be adopted prior to using the disposal site. The plan would specify the water quality parameters to analyze, water depths, and monitoring sites in relation to the release area (i.e., within, at the boundary zone, and possibly beyond the boundary of the mixing zone).

Tug and Barge Disposal Operation Controls

Disposal operations would be designed to optimize the placement of a level surface within the confines of the cell. Materials would be released from the barge at a rate suitable for the materials (physical properties) and site conditions (water depth, tidal current speed and direction). Using accurate positioning instrumentation, the tug and barge would release materials along closely spaced disposal lanes instead of release points (Palermo 1997). The long axis of each CAD cell would be oriented in the direction of the predominant tidal or ambient current direction, and releases would be made from the upstream end of the cell, depending on the immediate tidal conditions (Palermo et al. 1998a).

Monitoring and Engineering Controls

Monitoring the CAD cell and the area adjacent to the cell would be performed prior to, during, and after disposal to delineate the areal extent of the dredged material to ensure that the dispersion of materials is minimized and that capping acts as an effective control measure. Monitoring of the site over the long term would focus on the integrity of the final cap and its ability to isolate the contaminants. During disposal operations, if the thickness of the contaminated sediment settling outside of the CAD cell at a given distance from the cell exceeds some defined trigger value (e.g., 2 cm), placement operations could be modified to reduce dispersion or remedial capping of these areas could be planned. Controls that reduce dispersion placement of contaminated dredged material include controlled rates of release and specialized submerged discharge equipment such as downpipes and diffusers.

4.4.9.2 Ecological Health

Measures taken to mitigate the impacts to ecological health encompass all mitigation described for water and sediment impacts but include additional siting restrictions, monitoring objectives, and laws that protect fisheries and threatened and endangered species. Elements of the conceptual design are also critical in mitigating the effects of CAD to ecological health.

Site Design

Because clean cap materials will be placed over contaminated sediments within 4 weeks of disposal, some bioaccumulation of contaminants by recolonizing benthic organisms is expected, but is not expected to be significant. In east coast studies, colonizing species peak in abundance between 28 and 343 days (or 4 to 49 weeks) following dredged material placement (Rhoads et al. 1978). Although these species tend to be near-surface suspension feeders and vulnerable to predation, they also have short life spans and are less likely to bioaccumulate contaminants to unacceptable levels. Benthic assemblages that represent an equilibrium community on mud bottoms typically feed on buried detrital material, but can take 1 to 3 years to become established following a major disturbance (Rhoads et al. 1978, Jones & Stokes 1998). Because a final 3-foot cap is planned, chronic exposure to dredged material would be avoided and over time a mature benthic community would become established in the area.

Capping operations would also help cover those contaminated materials dispersed offsite during disposal. The extent of capping of dispersed materials would be monitored, and management actions would be taken to ensure adequate isolation from the environment.

Siting

Habitat critical to foraging and breeding would be excluded from possible site selection, and areas proximal to critical habitat would also be avoided during site selection. Important fish migration routes and feeding grounds would be avoided as much as possible during the siting process. Critical fish nursery areas would be avoided (Appendix B).

Regulations and Policies

Closed dredging windows currently observed in the PSDDA program would also apply to the MUDS program. The Washington Department of Fish and Wildlife has designated a closed dredging window between March 15 and June 15 each year to protect outmigrating juvenile salmon and steelhead trout populations. In Bellingham Bay, no disposal activities are allowed during the spring molting/mating period for Dungeness crab.

Additional dredging and disposal timing restrictions may be implemented due to the proposed listing of adult Chinook salmon as threatened and/or endangered relative to the Endangered Species Act. The WDFS may require that dredging activities cease in late summer and early fall throughout Puget Sound (WDFW 1998b).

Disposal activities would also be scheduled to minimize impacts to sensitive larval stages of any commercially or recreationally important invertebrate groups in the disposal area.

Monitoring

The objectives for biological monitoring would be to determine if the final cap is effective in isolating contaminated material and to confirm adequate benthic recolonization of the site. Management actions based on site monitoring results would be defined in a site management plan that would include action threshold values and criteria.

4.4.9.3 Human Health

Measures taken to mitigate the impacts to human health risks are the same as those described for barge transport, water, and ecological resources described above.

4.4.9.4 Land and Water Use

Use of the site during construction and operation would require close coordination with local port authorities and the U.S. Coast Guard (see Transportation and Utilities below). Fish and shellfish harvest areas and sensitive habitats would be excluded from the potential list of CAD sites, and migration routes and feeding grounds would also be avoided to the fullest possible extent during siting. Use of a potential CAD site in view of Tribal fishing rights, potential gear damage, and vessel conflicts would be coordinated with the appropriate Puget Sound Tribes during the site permitting process. Tribal stakeholders would be invited to participate in the CAD siting process and the development of site management plans to avoid or minimize conflicts (Appendix B).

4.4.9.5 Transportation and Utilities

As shown in Appendix B, siting criteria for the site-specific selection of the CAD alternative would exclude major shipping lanes and anchorages as well as areas with buried public utility lines. Tug and barge activity would increase above normal daily activities while dredging and disposal are taking place, but would not be markedly different than the dredging and disposal activities currently conducted for PSDDA projects. Like the PSDDA open-water disposal sites, the CAD site would be marked on all navigational charts, and vessel traffic would be coordinated with the U.S. Coast Guard. These measures would minimize the risk for vessel collision (PSDDA 1989).

4.4.9.6 Air, Noise, and Aesthetics

Although air quality is not expected to be significantly affected, measures taken to minimize the impacts of air quality during the construction and operation of a CAD site consist of predicting pollutant loads, complying with air quality standards, and maintaining good operating practices.

During the specific site selection process, projected air quality, noise levels, and aesthetic properties would be compared to ambient conditions. Contributions to local, ambient contaminant loads on air quality would be predicted and evaluated relative to applicable standards, and predicted noise levels would be compared to applicable federal and state adopted noise standards.

Puget Sound air quality is regulated by the EPA, Ecology, and PSAPCA. EPA has established upper allowable limits for carbon monoxide, particulate matter (less than 10 micrometers in size), ozone, sulfur dioxide, lead, and nitrogen oxide, all of which are intended to protect human health. Within Puget Sound, geographical areas exist that are not expected to attain some or all of these allowable limits due to ambient levels of air pollutants. These nonattainment areas would be considered during the site-specific process.

Under federal regulations, federal actions are subject to the Federal General Conformity Rule for direct and indirect emissions of criteria pollutants or their precursors. Carbon monoxide, ozone, and nitrogen oxide are pollutants, and volatile organic compounds and nitrogen oxide are precursors of ozone. During the site-specific phase, burdens to air quality would be predicted and compared to emission amounts cited in 40 CFR 51.853 (the Federal General Conformity Rule) to determine conformity. Air emissions generated by equipment operating at the CAD site would be monitored and evaluated relative to these applicable air quality standards. Management actions would be included in an overall site monitoring plan that would specify threshold levels for air quality.

4.4.10 Unavoidable Adverse Impacts

Unavoidable, adverse impacts of disposal at the conceptual CAD site are primarily short term and are described below:

- The construction of CAD cells would unavoidably alter bottom topography and eliminate local benthic communities existing within the boundaries of each cell. Once disposal activity begins, benthic organisms recolonizing the site would then be buried by successive disposal events of both contaminated dredged material and interim capping sediments. The lack of benthic organisms in the designated disposal area would temporarily affect epifaunal and fish foraging habits. Once the cell is at capacity, a final 3-ft cap of clean sediment would be placed over the deposited materials, and local silts and clays would ultimately cover the cap sediment. The process of recolonization by opportunistic species may begin almost as soon as cap material placement operations are completed (Rhoads and Boyer 1982, Rhoads and Germano 1982). As new benthic communities become established over time (approximately 1 to 3 years), benthic-pelagic food web interactions similar to pre-disposal conditions would be restored (Rhoads et al. 1978, Jones & Stokes 1998).
- The release of dredged material from the barge would unavoidably increase turbidity in the short term (minutes to hours) in the immediate vicinity of the disposal site. These conditions may affect foraging behavior of anadromous and marine fishes, marine mammals, and waterbirds if both the prey and the predators avoid the turbidity plume. Based on the

requisite sediment testing, contaminant releases would not exceed levels permissible by regulating criteria, and water column effects would be transient.

- Air emissions and noise levels would increase temporarily but would not exceed county, state, and federal guidelines.

Long-term, unavoidable, adverse impacts are as follows:

- The designation of a CAD site as a no-anchorage zone would unavoidably affect local anchorage patterns. All future disturbance of the cap site would be precluded to ensure contaminants are isolated from water column and benthic pathways. For example, future dredging or deepening of the CAD site would not be permitted.
- Some loss of contaminated dredged material settling outside of the CAD pit is unavoidable. The capping procedure would be designed to cover the contaminated material with clean layers of sediment. Monitoring would be conducted to confirm this or to direct additional capping outside the CAD cell as some bioaccumulation of this dispersed material could occur.
- The placement of contaminated sediments in an area where uncontaminated sediments once existed would unavoidably impact those subsurface areas. However, interim caps and a final 3-foot cap would effectively isolate contaminants from the water column and biological resources (Sumeri et al. 1991, Murray et al. 1994, Wilson and Romberg 1996).

4.5 NEARSHORE CONFINED DISPOSAL ALTERNATIVE

Nearshore CDFs are directly connected to land but within the area influenced by normal tidal fluctuations. As described in Section 2, the conceptual design assumes the shore forms one side of the rectangular facility while sand and gravel dikes form the other three sides. The facility is sited in an appropriate location offering the stability needed for construction. The lifespan of the facility is 10 years.

Two site capacities were considered in the conceptual nearshore CDF design: 500,000 cy and 2,000,000 cy. In a single year, 240,000 cy of contaminated material could be disposed of in the larger facility. The exterior dimensions at the dike toe of the small facility are 1,270 by 645 ft, covering 19 acres. The exterior dimensions of the large-capacity facility are 2,070 by 1,045 ft, covering 50 acres. For either design volume, the depth of contaminated dredged material inside the dikes is 40 ft.

Mechanically dredged materials transported to the nearshore CDF by barge are offloaded by clamshell directly into the CDF. A small hydraulic dredge is used later inside the CDF to redistribute materials as needed. Contaminated sediments are placed no higher than +7 ft MLLW so that sediments remain saturated and anaerobic. Engineered structures, if required to control release of water exceeding MHHW (this includes water associated with the dredged material itself, storm surges, and surface runoff), will consist of an adjustable decant weir for clarified surface waters and a gravity discharge system. Once the CDF is filled to capacity, a cap of clean sand is placed over fill materials. Monitoring wells are installed to evaluate leachate moving through the fill and dikes.

4.5.1 Contaminant Pathways

Possible contaminant pathways from a nearshore CDF (for all of or a portion of its use) include effluent discharges to surface water during filling operations and subsequent settling and dewatering, rainfall surface runoff, leachate into groundwater, soluble convection through the dike in the partially saturated zone, soluble diffusion from the saturated zone through the dike, volatilization to the atmosphere, and uptake by plants and animals (see Figure 2-8).

The dredged material initially placed in a nearshore CDF is in a saturated and anaerobic condition. Contaminated material placed in the bottom of the CDF remains in this saturated and anaerobic condition and contaminants remain bound to fine-grained sediment. During placement operations, some near-surface (e.g., the top one centimeter) contaminated material would be exposed to aerobic conditions and could release contaminants to the overlying water. The surface water could also become anoxic, promoting sulfides production. As dredged material is placed in the fill up to fill elevation (i.e., +7 ft MLLW), the sediments consolidate and compress due to gravity and there is a concurrent upward and outward movement of water and some subsequent lateral seepage of water through the dike. Monitoring of nearshore CDFs in Puget Sound have shown that the dike can act as a filter for any contaminants mobilized in the lateral seepage (Boatman and Hotchkiss 1997). A final cap of uncontaminated sediments, placed over the contaminated fill, further restricts contaminant movement.

The area located between saturated and unsaturated materials forms a transition zone adjacent to the dike that can be influenced by tidal pumping. It is this area of tidally fluctuating groundwater that receives the most scrutiny in a pathways analysis. The dimensions of this zone and the volume of material affected depend on the difference in tide levels and the permeability of both the dike and the dredged material. The intertidal and subtidal zones represent two distinct pathways. The intertidal zone is characterized by a variably saturated zone that periodically fills and partially drains with the tides. The subtidal zone is marked by a much less dynamic tidal effect, but also experiences much weaker groundwater movement due to the combined effect of low permeability dredge fill and high density seawater encountered below the tide level. During low tide, a higher potential exists for contaminant releases through the dikes; however, no contaminant releases occur during high tide (Corps/EPA 1992, Palermo et al. 1998a).

The contaminant pathways, potential environmental impacts, mitigation, and the potential significance of the impacts associated with the construction and operation of a nearshore CDF are summarized in Table 4-4.

Table 4-4. Summary of Potential Environmental Consequences and Mitigation Measures: Nearshore CDF Conceptual Design[1].

Activity	Pathway	Potential Impact	Mitigation			Expected Significance of Impact with Mitigation
			Siting	Technology	Operations	
CDF CONSTRUCTION						
Site preparation and construction	Water column	Short-term exposure of biota to: - Suspended solids - Low DO	NA	- Runoff controls	- Comply with WDFW closed dredging window - Comply with appropriate WQS - Avoid construction during storm events	- Temporary/insignificant
"	Plants, animals, and habitat	Loss of intertidal and subtidal habitat/species Long-term impacts to: - Aesthetics	- Exclude critical habitat - Exclude parks, preserves, refuges - Exclude sensitive habitat - Exclude fish/shellfish harvest areas - Avoid nursery areas, migration routes, and feeding grounds - Avoid areas proximal to all areas above	- Habitat replacement	- Perform pre-construction habitat assessment	- Loss of habitat/ - Potentially significant
DISPOSAL						
Runoff - Dissolved - Particulate phase Seepage through dike Effluent	Surface water	Short-term exposure of biota to: - Suspended solids - Dissolved contaminants - Low DO Health risks to humans: - Food chain contaminant - Uptake from fish and shellfish consumption	- Keep material saturated - Ensure adequate dilution - See construction above.	- Mechanically dredge - Place interim caps as a control if warranted - Construct final cap - Dikes constructed for effective containment	- Inspector Oversight - Comply with WDFW closed dredging window - Comply with appropriate WQS - Install no trespassing signs and fences	- Discharge of contaminants to surface water/potentially significant
Leachate	Groundwater	Exposure of biota & humans to: - Dissolved contaminants Degraded water quality	- See construction above.	- Construct final cap - Install groundwater barrier if warranted	- Comply with appropriate WQS	- Insignificant if properly designed and constructed
Uptake of contaminants	Plants	Food chain effects or toxicity	- See construction above.	- Place interim caps as a control if warranted - Construct final cap	NA	- Potentially significant
Uptake of contaminants	Birds	Food chain effects or toxicity	- See construction above.	- Place interim caps as a control if warranted - Construct final cap	Prevent bird access - Noise blasts - Wire mesh over CDF	- Potentially significant

Table 4-4. Summary of Potential Environmental Consequences and Mitigation Measures: Nearshore CDF Conceptual Design[1].

Activity	Pathway	Potential Impact	Mitigation			Expected Significance of Impact with Mitigation
			Siting	Technology	Operations	
Volatilization of organics	Air emissions	Inhalation of toxic chemicals and dust	- Keep min. 2 ft cover of water - See construction above.	- Place interim caps as a control if warranted - Construct final cap	- Comply with appropriate air quality standards	- Insignificant
CAP PLACEMENT						
Physical placement of cap	Plants and animals	Recolonization of plants Beneficial uses - Commercial/recreational/industrial - Habitat restoration	- Site near compatible land uses	- Construct final cap	NA	- Insignificant if properly designed and constructed
POST-CAP PLACEMENT						
Soil erosion, runoff dike failure	Surface water	Exposure of biota to: - Suspended solids - Low DO - Dissolved contaminants - Contaminated sediment	- See construction above.	- Construct cap of effective thickness and stability - Detention basins - Runoff controls	- Revegetate if appropriate - Monitor effectiveness - Develop contingency plan	- Insignificant if properly designed and constructed

[1] Assumes contaminated dredged material and capping materials have been tested for suitability. Sediment testing and evaluation procedures will be developed as part of a future element of the Puget Sound Confined Disposal Site Study.

NA- not applicable

4.5.2 Potential Impacts to Water and Sediments

4.5.2.1 Water

Impacts to nearshore marine waters would include both increases in suspended solids during construction, potential contaminant releases as sediments are offloaded, and possible releases through the dike after the nearshore CDF is constructed and materials are placed inside.

4.5.2.2 Sediment

The nearshore site would be physically disturbed and reconfigured during the preparation and construction of the CDF. Existing intertidal and shallow subtidal habitat would be eliminated, although the construction of a nearshore CDF could result in the creation of some shallow subtidal habitat and/or intertidal habitat. If the original sediments at the site were not contaminated, sediments inside the CDF would contain higher levels of chemicals of concern than these buried sediments. However, the final capping sediments placed in the facility would also be uncontaminated. Alternatively, a contaminated nearshore area could be selected as the CDF site and construction of the facility would provide the added benefit of isolating those contaminated sediments from the environment. Impacts to sediments located adjacent to the nearshore CDF would be minimized by design features and operating practices that ensure minimal contaminant release/migration from the CDF. Facility monitoring would include long-term assessment of sediment quality adjacent to the CDF.

4.5.3 Potential Impacts to Ecological Health

Habitat. The physical destruction of as much as 50 acres of nearshore habitat would be unavoidable in the construction of a nearshore CDF. The nearshore environment in Puget Sound ranges from mudflats to sand or gravel/cobble beaches (see Section 3.1). Simenstad and Thom (1992, cited in USFWS et al. 1996) have noted dramatic declines in biological resources with the changes incurred in the estuarine habitats of Puget Sound. Notably, the survivability of Pacific salmon has decreased with the loss of suitable estuarine habitat, the success of spawning Pacific herring has decreased with the loss of eelgrass beds, and shorebird numbers have decreased with the fragmentation of estuarine mudflat habitats. The intertidal and shallow subtidal zone affected by the construction of a nearshore CDF generally maintains habitat for benthic and epibenthic communities, anadromous and resident fish, and small mammals. Marsh habitats also provide nesting and roosting areas (USFWS et al. 1996).

Vegetation. Aquatic plants (including macroalgae), if present, would unavoidably be removed during construction of a 50-acre nearshore CDF. During periods of disposal inactivity, it would be possible for aquatic plants to grow inside the berm and accumulate contaminants.

Invertebrates. Infauna and epibenthic organisms would be eliminated at the nearshore CDF due to the physical destruction of intertidal and shallow subtidal habitat. During filling and prior to capping, benthic organisms that survive in the dredged sediments transported from the dredging site to the nearshore CDF could be directly exposed to contaminants inside the CDF. Some contaminants could bioaccumulate in animal tissue (e.g., marine worms) and become available to the food chain. The uptake of contaminants to unacceptable tissue levels could occur and possibly pass into the terrestrial food web via birds or mammals foraging at the CDF.

Fish and Shellfish. Nearshore CDF siting would avoid any known fish nursery areas and shellfish beds (see Appendix B). Some migratory fish habitat and feeding grounds could be lost. Benthic organisms typically consumed by bottomfish would also be destroyed. Depending on the design of the nearshore CDF, however, there could also be a gain in productive intertidal and shallow subtidal habitat.

Birds and Mammals. Predicted impacts to specific bird and mammal populations would depend on the location of the selected nearshore site. Birds and mammals could be impacted by the loss of prey caused by the construction of a nearshore CDF. Marine mammals, restricted to waters outside the CDF, would not be expected to be impacted by contaminant releases because site discharges would meet applicable water quality criteria. During filling and prior to capping, however, birds can potentially come in direct contact with contaminated sediments and overlying water located inside the CDF. The conceptual nearshore CDF is open to the air, much like a pond, and the conceptual design does not incorporate interim cap placement, although this could be used as an additional control. Birds could feed on organisms temporarily living in the dredged material or ponded water. Depending on the chemicals contained in the dredged material, birds could bioaccumulate the contaminants to potentially significant levels.

Threatened and Endangered Species. Impacts to marine mammals, fish, and birds listed as threatened or endangered, or listed as candidates (e.g., Chinook salmon), would be the same as those described above for fish and wildlife. Marine mammals and fish, restricted to waters outside the CDF, would not be impacted by contaminant releases because site discharges would meet applicable water quality criteria. During filling and prior to capping, birds, however, have the potential to come in direct contact with contaminated water and sediments located inside the CDF. By feeding on organisms temporarily living in the diked area, birds could bioaccumulate the contaminants to unacceptable levels. These birds could be preyed upon by raptors (e.g., bald eagles) which could also potentially bioaccumulate the contaminants.

4.5.4 Potential Impacts to Human Health

The potential impacts to human health are: 1) exposure to contaminated sediments located in the barge (via direct contact or inhalation) during placement and prior to capping in the CDF; 2) the possible ingestion of fish or crustaceans that have accumulated contaminants to unacceptable levels as a result of direct uptake inside the nearshore CDF; and 3) exposure to airborne emissions and dust during construction and operation of the site (although because the contaminated material is generally saturated and the facility is in the open air, the airborne emissions risk is low). As noted above, the potential for biomagnification is greater when contaminants are passed from aquatic organisms to terrestrial organisms. Despite mitigation, some food web biomagnification of contaminants could be possible depending on the contaminants present in the materials dredged.

4.5.5 Potential Impacts to Land and Water Use

Construction of a nearshore CDF would change the configuration of the shoreline. Depending on the location and pre-construction condition of the site, the construction and use of a nearshore CDF would impact local aquatic land use, shoreline use, and possibly recreational use. If constructed over a formerly contaminated area, land and water use at the site could be enhanced. The potential benefits of a post-construction nearshore CDF include the creation of new space for recreational or commercial land uses. Nearshore CDFs have been used for port expansion, redevelopment, improved public access, and habitat restoration projects.

The 2,000,000-cy facility could take 15 months to construct. During this time, the combined use of heavy equipment on shore and barge-based equipment offshore would increase traffic, noise, and air emissions. Water use would be impacted by both construction and dredged material disposal activities in terms of increased vessel traffic, noise, emissions, and potential conflicts with Tribal, commercial, or recreational fisheries. Construction of a nearshore CDF would cause a reduction in potential nearshore fishing area, primarily affecting drift net fishing.

4.5.6 Potential Impacts to Transportation and Utilities

During construction, transportation impacts of a nearshore CDF will vary depending on whether construction materials are brought to the site by truck or by barge, and the frequency of trips to the facility. An increase in truck and barge traffic on travel routes to the nearshore CDF may have a significant impact on transportation in the area. Disruption to local transportation would cease upon completion of site construction, and impacts to transportation during disposal would be primarily from in-water tug and barge activities. These impacts would be intermittent and temporary (see Section 4.3.3).

In an industrialized or developed setting, there would likely not be significant impacts to utilities by the construction or operation of a nearshore CDF. A lighting array would need to be established to allow safe and effective dredged material offloading and redistribution operations during low ambient light conditions.

4.5.7 Potential Impacts to Air, Noise, and Aesthetics

Impacts associated with air, noise, and aesthetics would depend on the location of the designated nearshore CDF. In general, air emissions (carbon monoxide, nitrogen oxide, particulates, hydrocarbons, or volatiles), associated odors, and noise levels at the site would increase during construction. Under federal regulations, direct and indirect emissions from construction activities governed by a Corps permit (as this project would be) are subject to a "conformity determination" if the emissions exceed certain levels (*de minimis* levels) (Corps et al. 1994). If emission levels from the construction activity are below these levels, then the project is considered to be in conformance with air quality rules and the action is not subject to a detailed air quality analysis. If a MUDS nearshore CDF is evaluated as part of future site-specific studies, the project-specific environmental review will assess the predicted emissions from construction activities (e.g., berm placement and armoring, pile driving, dredging) and compare them to the minimal federal standards.

During site operation, increased tug and barge disposal activities would also increase air emissions and noise levels. As noted in Section 4.3.3, tug and barge activities would be restricted to one or two barge trips per day. If the selected site is situated in an urban bay, these air emissions and noise levels will not likely exceed ambient conditions (PSDDA 1989).

During the construction of a nearshore site, noise would be generated from the use of barge- or shore-mounted cranes, front loaders, backhoes, tractors, trucks, and tugboats. The noise levels during this time could range from 70 to 95 decibels (at a range of 50 ft). In comparison, heavy truck traffic generates sound pressure levels of 90 decibels, and busy traffic generates sound pressure levels of 70 decibels.

The construction of a nearshore CDF could either benefit or damage local aesthetics. Factors such as orientation of the facility at the site, landscaping, scale of the facility in relation to surrounding use, and hours of operation (nighttime use) will all influence the level of impact of the facility. Adjacent land use will also affect the potential impacts of a facility. In an industrial setting, the nearshore CDF could easily blend into the surroundings and could improve shoreline aesthetics, public access, or habitat value through mitigation. In an undeveloped area, the structure would be an obvious man-made feature, potentially detracting from local aesthetics. Increased tug and barge activity observed from the shoreline would not be expected to impact local aesthetics as the number of disposal events would be occasional (see Section 4.3.3).

4.5.8 Potential Impacts to Cultural Resources

The site would be evaluated for the potential occurrence of historically significant buildings, shipwrecks, Native American traditional cultural sites, or prehistoric sites per Section 106 of the National Historic Preservation Act (36 CFR 800), in cooperation with local Tribes, local governments, the Washington State Office of Archaeology and Historic Preservation, and the National Advisory Council on Historic Preservation. All known archaeological or cultural sites would be excluded from possible site selection (see Appendix B), and site selection would comply with applicable historic preservation laws. Because all archaeological or cultural sites would be excluded from possible site selection and site selection must comply with applicable historic preservation laws, it is not anticipated that cultural resources would be impacted by the construction of a nearshore CDF.

4.5.9 Mitigation

Measures to minimize the environmental consequences of implementing the nearshore CDF alternative are described in the following sections.

4.5.9.1 Water

Measures to mitigate impacts to water quality are a combination of design elements, predictive pathway tests, engineering and design specifications, engineering controls, and monitoring to ensure compliance with regulations.

Design

Several aspects of the nearshore facility design would reduce impacts to water:

- The nearshore CDF would be designed to provide adequate sedimentation capacity to effectively remove suspended solids and a high fraction of the contaminants from the water column. Only clarified waters would be discharged from the site through either a flow control structure, if needed, or slowly through the berm.
- Contaminated sediments would be placed no higher than +7 ft MLLW, maintaining a saturated and anaerobic condition.
- Materials placed above mean tide level would be uncontaminated, minimizing the possibility for contaminant mobility as materials dry and oxidize.
- If needed based on site-specific design and operational considerations, engineered structures to control release of water that exceeds MHHW (resulting from water contained in the dredged material itself, storm surges, and surface runoff) would consist of an adjustable decant weir for clarified surface waters and a gravity discharge system. Alternatively, excess water could slowly exit the site through the dikes, designed to filter and clarify any discharge water.
- Direct contact with contaminated sediment would be eliminated at the completion of the fill by covering the dredged material with clean capping material. Surface runoff would be eliminated as a pathway of concern by not filling above the saturated zone.
- Mechanically filled CDFs would reduce the possibility for effluent (as compared to hydraulically placed materials).
- The geotechnical design would consider dike stability, site stability (failure of foundation sediments), dynamic stability (seismic analyses), and erosion protection. Site-specific data would need to be incorporated in these analyses. A hazard assessment would be included as part of the siting phase.
- Institutional controls (e.g., fencing, warning signs) would eliminate or minimize direct human health exposure routes by preventing access to water, sediments, and biota at the site.

Predictive Pathways Tests

Before the construction and implementation of any potential nearshore CDF, CDF pathways would be analyzed. Many site-specific conditions would be considered, including the chemical and physical characteristics of the dredged material, groundwater flow, tidal fluctuations, and other site conditions. Guidance for a CDF pathways analysis is contained in the Comprehensive Analysis of Migration Pathways (CAMP) (Corps/EPA 1992, Myers 1990). For nearshore CDFs, contaminant mobility testing for pathways analysis is tailored to anaerobic conditions because materials placed in a nearshore CDF remain saturated. The nearshore CDF pathways analysis and other effects-based Section 404 compliance tests could result in any one of the following conclusions or a combination of conclusions:

- A few controls are required, but the nearshore CDF as currently designed is environmentally protective
- Controls, such as impermeable barriers that divert groundwater flow from the shoreline into the CDF, are recommended prior to the implementation of the site
- Changes in the design are recommended
- Materials were found not suitable for disposal at the nearshore CDF.

The application of a comprehensive CDF pathways analysis would minimize significant acute and chronic environmental impacts to surrounding waters.

Engineering Controls During Construction and Post-Construction

Controls, such as the use of silt curtains, would minimize the impacts associated with suspended solids increases during construction. Water quality monitoring would be required during construction as part of the Washington State Water Quality Certification (see Section 6.2). The placement of riprap outside the dike would also minimize erosion and associated suspended solids increases.

Liners, impermeable dikes, and other leachate controls, although not generally needed for environmental protection at nearshore CDFs in Puget Sound (Palermo et al. 1998a), might be required in specific situations. These controls would be implemented as a result of the pathways analysis or from monitoring. Provisions to contain spillage and leakage from buckets used to offload materials would be incorporated in an overall site management plan.

Regulations and Monitoring

Monitoring of nearshore CDFs would be designed to determine the fate of contaminants. Monitoring programs would include detailed geohydrology over the tidal cycle, existing groundwater chemistry, and porewater chemistry for dredged materials placed in the site. Monitoring wells in the berm would monitor contaminant fluxes from the CDF to surface waters. Discharges and seepage from the site would be evaluated relative to the Clean Water Act and specifications of the Washington State water quality certification. Performance goals would include:

- During construction, dissolved tidal flow concentrations would not exceed applicable chronic water quality standards and water column toxicity criteria at the boundary of the site or designated mixing zone (Section 401 of the Clean Water Act)
- During placement of contaminated material, all effluent discharges would comply with applicable federal and state water quality standards as specified in the state's water quality certification (Section 401 of the Clean Water Act)

- Long-term dissolved effluent and/or seepage contaminant concentrations would not exceed applicable federal and state chronic water quality standards and water column toxicity criteria at the boundary of the site (Section 404 of the Clean Water Act).

Natural Processes

Several regional nearshore fill projects have identified, through both modeling and field monitoring data, that naturally occurring processes inside the CDF minimize the potential for contaminant releases:

- Organic contaminants biodegrade via aerobic and anaerobic oxidation within the dike, and mobility of both metals and organics would be inhibited by maintaining saturated, saline, and anaerobic conditions within the contaminated fill material (Boatman and Hotchkiss 1997)
- Groundwater entering the CDF, having lower salinity than the tidally influenced CDF materials, would tend to move above the saltwater, thereby minimizing contact with contaminated dredged materials located in a nearshore CDF (Riley et al. 1994).

4.5.9.2 Sediments

Predictive pathway tests, engineering and design specifications, engineering controls, and monitoring to ensure compliance with Sections 401 and 404 of the Clean Water Act that were identified as mitigation for water impacts are also mitigation for sediment impacts in the vicinity of a nearshore CDF. Also, during the siting process, only nearshore areas with relatively low habitat value or areas already contaminated or disturbed would be considered (i.e., critical habitats would be excluded; see Appendix B).

4.5.9.3 Ecological Health

Measures taken to minimize impacts of contaminated sediment disposal in a nearshore CDF to ecological health are the same as those described for water and sediment impacts. In addition, aspects of the nearshore conceptual design, siting process, regulations and policies, and monitoring are pertinent to minimizing impacts to ecological health.

Site Design and Siting

The final cover of cap material would restrict or eliminate the uptake of contaminants. Critical habitat would be excluded from the selection of potential nearshore sites. Areas proximal to critical habitat would also be avoided during site selection. Sensitive habitats (e.g., eelgrass beds), special aquatic sites, fish and shellfish harvest areas, and designated parks, preserves, sanctuaries, or refuges would be excluded. Fish nursery areas, migration routes, and feeding grounds would be avoided (see Appendix B). Restoration or creation of habitat in another nearshore area could be required as mitigation. The design of a nearshore CDF could also incorporate beneficial uses, such as the construction of adjoining wetlands, intertidal, and shallow subtidal habitat, depending on local site conditions (see Table 4-4).

Regulations and Policies

Compliance with Clean Water Act Sections 401 and 404 guidelines would greatly reduce the potential impacts from surface water, effluent and groundwater discharges, and tidal flow seepage to biological resources outside of the containment dikes. Materials exceeding acceptable interpretive guidelines would not be placed in a nearshore CDF. Outside of the dikes, dissolved contaminant concentrations in surface water, leachate, effluent discharges, or tidal flow seepage would not exceed applicable water quality standards and toxicity criteria. Suspended solids concentrations in effluent would also meet applicable water column toxicity criteria.

Critical habitat supporting threatened and endangered species would be excluded during the siting process (see Appendix B). Listed and proposed endangered and threatened species that may occur within the area of a proposed nearshore CDF would undergo a biological assessment evaluating the effects of construction and site use. A biological assessment prepared for a proposed nearshore site would include the level of use by affected threatened or endangered species, how primary food stocks and foraging areas would be influenced by the project, and a discussion of the potential short- and long-term impacts of construction and site use that may disturb or result in avoidance of the project area. The assessment would then be reviewed by applicable state and federal agencies for compliance with the Endangered Species Act.

Closed dredging windows currently observed in the PSDDA program would also be adopted by the MUDS program. In Puget Sound, WDFW has designated a closed dredging window between March 15 and June 15 each year to protect outmigrating juvenile salmon and steelhead trout populations. In Bellingham Bay, no disposal activities are allowed during the spring molting/mating period for Dungeness crab.

Additional timing restrictions may be implemented due to the proposed listing of Chinook salmon as threatened and/or endangered relative to the Endangered Species Act. If the listing occurs, WDFW (1998b) may require that dredging and disposal activities cease in Puget Sound in late summer and early fall.

Although not specifically addressed in current regulatory guidance, disposal activity might be scheduled to minimize impacts to sensitive larval stages of any important invertebrate groups in the vicinity of the nearshore CDF.

Monitoring

The objectives for biological monitoring would be to determine if biological uptake is occurring during the 10-year lifespan of the facility. Long-term monitoring would determine the effectiveness of the final cap in isolating contaminated material. Management actions would be defined in a site management plan that would include threshold values for decision-making purposes.

Part of mitigation would include actions to prevent the potential for contaminant uptake by birds. Stringing wires across the facility in a grid-like pattern has been used at sites where ponded water attracts birds. This measure in combination with the use of intermittent sound blasts could be considered. However, potential impacts associated with the noise and the potential for the birds to habituate to routine sounds would need to be addressed before implementation.

4.5.9.4 Human Health

Measures taken to mitigate the impacts to human health risks are the same as those described above for water, sediment, and ecological health. Steps to minimize the release of contaminants at unacceptable levels greatly reduces the potential for movement of contaminants (and risks for biomagnification) into aquatic and terrestrial food chains.

Other human health risks posed by construction-related air emissions dust or direct contact by site workers would be incorporated in a facility-specific health and safety plan. Volatile contaminant exposure would not be significant because the material will remain saturated and the site will be in the open air (i.e., not a confined space). The placement of the final cap will eliminate volatile releases. As a final health and safety measure, the CDF facility would be fenced and marked with warning signs indicating that trespassing, shellfish collecting, or fishing inside the diked area are prohibited.

4.5.9.5 Land and Water Use

Measures taken to reduce impacts to land and water use incorporate many of the measures taken for water and ecological health. Specific mitigation would depend on the location of the site. If the nearshore fill impacted intertidal and shallow subtidal habitat, creating nearshore habitat either on- or offsite would be required to mitigate this impact. Measures to mitigate construction impacts would be the same for transportation, air, and noise impacts.

Construction and use of a nearshore site and the resultant impacts on Tribal fishing rights, potential gear damage, and vessel conflicts would be coordinated with the potentially affected Tribes during the site permitting process. Input from affected Tribes would be solicited during the site selection process (Appendix B).

4.5.9.6 Transportation and Utilities

As shown in Appendix B, siting criteria for the site-specific selection of the nearshore CDF alternative would exclude areas critical to active shoreside and marine transportation routes as well as areas with public utility lines.

4.5.9.7 Air, Noise, and Aesthetics

Measures taken to minimize impacts to air quality during the construction and operation of a nearshore CDF are the same as those described for the CAD site (see Section 4.4). By predicting pollutant loads and comparing them with applicable air quality standards, impacts to air quality would be reduced. Puget Sound air quality is regulated by the EPA, Ecology, and PSAPCA. Federal actions are also regulated under the federal General Conformity Rule for direct and indirect air pollutant emissions. Air emissions generated by equipment constructing and operating the nearshore site would be monitored and evaluated relative to these applicable air quality standards. Management actions would be included in an overall site monitoring plan that would specify threshold levels for air quality.

When siting a specific nearshore CDF facility, the increase in traffic and equipment noise caused by construction would be evaluated to determine how significant the impact is to the region. These activities would comply with applicable noise standards, such as county ordinances and local city requirements. Increases in noise levels would cease upon the completion of site construction, and subsequent tug and barge activities would be intermittent and temporary.

Gaseous or volatile emissions from the contaminated material during and after placement could be minimized by the presence of a water layer inside the CDF. At the completion of the project, a clean sediment cap would be placed over the CDF, eliminating the possibility of volatile emissions.

4.5.10 Unavoidable Adverse Impacts

Unavoidable adverse impacts associated with the construction of a nearshore CDF that are long-term include the following:

- The loss of valuable intertidal and shallow subtidal habitat, which would affect local predator-prey patterns and further decrease habitat used by juvenile salmon for feeding and rearing purposes
- Bioaccumulation of contaminants by organisms living inside the CDF and potential food chain transfer beyond the CDF by foraging birds
- Aesthetic impacts on nearshore area, including diminished views and possible odor downwind, depending on locale
- Increase in noise levels around the site during construction and operation
- The loss of existing and future navigational use of the site.

4.6 UPLAND CONFINED DISPOSAL ALTERNATIVE

Upland confined disposal facilities contain contaminated sediments in a diked structure. The handling of contaminated sediments in the upland disposal alternative involves three steps: 1) transfer from the barge to a dewatering facility, 2) transport from the dewatering facility to the upland CDF, and 3) placement at the CDF. As described in Section 2, the conceptual design assumes that the contaminated material is mechanically dredged. Because the dredged sediments contain water, they are transported by barge to a waterfront facility for dewatering prior to placement at the upland CDF. Two design volumes are considered for the upland CDF: a 10-year total of 500,000 cy and 2,000,000 cy. On an annual basis, both the dewatering facility and the upland CDF receive 500,000 cy (small capacity site) and 200,000 cy (large capacity site).

A clamshell is used to transfer the sediments from the barge to a hopper assembly and conveyor belt at the dewatering facility. The dewatering facility is constructed of paved and lined cells with drainage and runoff collection systems to discharge the decanted water. Each cell is capable of holding up to 3,500 cy of dredged material. All collected water is treated by gravity settling and filtration to remove solids. After dewatering (about 4 to 5 days), the sediments are transported by truck to the upland CDF.

The conceptual design assumes that the upland CDF consists of a large diked confinement area divided into three sub-cells. The overall dimensions of the upland CDF for the 2,000,000-cy site option are 3,700 ft long by 1,900 ft wide including the dikes (or 162 acres). For the 500,000-cy capacity, the dimensions are 2,000 ft long by 1,000 ft wide (or 46 acres). The CDF is constructed to meet basic requirements for a municipal landfill. This includes a bottom liner, leachate collection system, rainfall runoff collection system, and a water treatment system. The dredged material is transferred from the truck and placed in the CDF by conveyor. All contaminated dredged material is placed above the water table. Upon closure, the dredged material is capped with low-permeability soils, an impermeable geotextile membrane, and a final layer of topsoil.

4.6.1 Contaminant Pathways

The possible pathways of contaminant migration from an upland CDF include effluent discharge to surface water during filling operations and subsequent settling, rainfall surface runoff, leachate into groundwater; volatilization to the atmosphere; and direct uptake (Figure 2-13). Direct uptake includes plant uptake and subsequent cycling through food webs, and direct uptake by animals that live in close association with the dredged material. The contaminant pathways, potential environmental impacts, mitigation, and the potential significance of the impacts associated with the construction and operation of an upland CDF are summarized in Table 4-5.

4.6.2 Potential Impacts to Water and Sediments

Potential water quality impacts at an upland CDF or dewatering facility could occur via effluent discharge from the facility or leachate into the groundwater. Contaminants contained in the effluent could reach adjacent surface waters. Failure of the bottom liner or leachate collection system over time could allow contaminants in the leachate to reach groundwater and be transported away from the site.

4.6.3 Potential Impacts to Ecological Health

Constructing a dewatering facility or an upland CDF (a site potentially covering 162 acres) would remove existing vegetation at the site and displace animals that reside at the site (Table 4-5). Depending on the location of the specific site, animals may migrate to adjacent habitat and survive, or they may overpopulate adjacent areas and local animal populations would have to adjust. Some plants may recolonize the area and absorb contaminants through their root systems. Animals residing close to the site may ingest these plants and cycle these contaminants through food webs. The significance of these potential impacts will depend on the characteristics of the

Table 4-5. Summary of Potential Environmental Consequences and Mitigation Measures: Upland Dewatering Facility and CDF Conceptual Design[1].

Activity	Pathway	Potential Impact	Mitigation: Siting	Mitigation: Technology	Mitigation: Operations	Significance of Impact with Mitigation
CDF CONSTRUCTION						
Site preparation and construction	Aquatic resources	Short-term exposure of biota to: - Suspended solids - Low DO - Sedimentation of streams	- Exclude 100-year floodplai - Avoid areas proximal to waterbodies - Exclude areas over sole source aquifers - Exclude areas over public drinking supplies	- Sedimentation ponds - Runoff controls	- Comply with appropriate WQS - Avoid construction during storm events	- Temporary/insignificant
"	Plants, animals, and habitat	Loss of upland habitat Long-term impacts to: - Aesthetics	- Exclude critical habitat - Exclude parks, preserves, refuges - Exclude wetlands - Avoid areas proximal to all areas above	NA	- Perform pre-construction habitat assessment	- Loss of habitat/ potentially significant
DISPOSAL						
Effluent Surface runoff (applies to CDF and dewatering facility)	Surface Water	Exposure of biota to: - Suspended solids - Dissolved contaminants Health risks to humans: - Food chain cycling	- See construction above	Mechanically dredge Treatment technologies	- Inspector Oversight - Comply with appropriate WQS	- Insignificant if properly designed and constructed
Leachate	Groundwater	Exposure of biota & humans to: - Dissolved contaminants Degraded water quality	- Avoid areas with <10' between CDF bottom and high groundwater level - Exclude areas over sole source aquifers - Exclude areas over public drinking supplies - See construction above	- Install liners - Install leachate collection and removal system - Construct cap and cover - Runon controls - Treatment technologies	- Monitor water (via wells) - Comply with appropriate WQS	- Insignificant if properly designed and constructed
Uptake of contaminants	Plants and animals	Food chain effects or toxicity	- See construction above - Establish buffer zones	- Place interim covers if warranted - Construct cap and cover	- Install fences	- Insignificant if properly designed and constructed
Volatilization of organics	Air emissions	Inhalation of toxic chemicals and dust	- See construction above	- Erect wind fences - Construct cap and cover	- Comply with appropriate air quality standards - Spray dust supressant	- Insignificant
CAP PLACEMENT						

Table 4-5. Summary of Potential Environmental Consequences and Mitigation Measures: Upland Dewatering Facility and CDF Conceptual Design[1].

Activity	Pathway	Potential Impact	Mitigation			Significance of Impact with Mitigation
			Siting	**Technology**	**Operations**	
Physical placement of cap	Plants and animals	Recolonization of plants Creation of habitat for birds and animals Beneficial uses	- Site near compatible land uses	- Construct cap and cover	- Revegetate if appropriate - Monitor	- Insignificant
POST-CAP PLACEMENT						
Soil erosion Liner failure	Groundwater	Exposure of biota to: - Suspended solids - Low DO - Dissolved contaminants - Contaminated sediment	- See construction above	- Construct cap and cover of effective thickness and stability - Detention basins - Runoff controls	- Monitor effectiveness - Develop contingency plan	- Depends on severity of failure/ ranges from insignificant to significant

[1] Assumes contaminated dredged material and capping materials have been tested for suitability. Sediment testing and evaluation procedures will be developed as part of a future element of the Puget Sound Confined Disposal Site Study.

NA - not applicable

dredged material, management and operation of the site during and after filling, and the proximity of the upland CDF to potential receptors of the contaminants.

4.6.4 Potential Impacts to Human Health

The health of workers at the upland CDF could be potentially impacted by inhalation, ingestion, and direct contact with the contaminated sediments. The significance of these potential impacts would depend on the management and operation of the landfill, sediment characteristics, and operating procedures.

4.6.5 Potential Impacts to Land and Water Use

The land use impacts of constructing and operating a dewatering facility or an upland CDF would depend on adjacent land uses. The 2,000,000-cy upland facility could take as long as 17 months to construct, and the dewatering facility as long as 12 months to construct. There would likely be minor impacts to the adjacent area if a facility is sited in a commercial/industrial area. If not sited in a commercial/industrial area, some land uses for adjacent areas would be foreclosed. Local comprehensive plans, shoreline master plans, and zoning regulations do not specifically address contaminated sediment disposal facilities.

4.6.6 Potential Impacts to Transportation and Utilities

Transportation impacts of an upland CDF would vary depending on whether sediments are brought to the site by truck or rail cars, and the frequency of trips to the facility. An increase in truck traffic on travel routes to the upland CDF may have a significant impact on transportation in the area.

Rail cars would have less impact on transportation than trucks because local streets would not be used for transporting the sediments. Some increase in existing rail line use would occur. Rail cars can cause congestion to local transportation patterns by blocking local traffic at grade crossings. The number of at-grade crossings, the length of time during which traffic is blocked, and the time of day the blockage occurs will all be factors in determining the significance of any impact on local transportation. Timing for shipping sediments over the rail lines would likely be flexible (cars could be filled with sediments and sit on a rail spur until convenient to ship), so only minor impacts would be anticipated on existing rail operations.

There would not likely be impacts to utilities by the construction or operation of an upland CDF placed at an existing industrialized area. If the CDF is constructed in an outlying non-commercial/industrial region, then impact to local utilities is likely and would need to be assessed during site-specific alternative evaluations.

4.6.7 Potential Impacts to Air, Noise, and Aesthetics

Construction and operation of an upland CDF or dewatering facility would entail noise and emissions from heavy equipment at the site. As discussed in Section 4.5.7, impacts associated with air, noise, and aesthetics would depend on the location of the designated upland CDF. In general, air emissions (carbon monoxide, nitrogen oxide, particulates, hydrocarbons, or volatiles), associated odors, and noise levels at the site would increase during construction. Under federal regulations, direct and indirect emissions from a construction activities governed by a Corps permit (as this project would be) are subject to a "conformity determination" if the emissions exceed certain levels (*de minimis* levels) (Corps et al. 1994). If emission levels from the construction activity are below these levels, then the project is considered to be in conformance with air quality rules and the action is not subject to a detailed air quality analysis. If a MUDS upland CDF is evaluated as part of future site-specific studies, the project-specific environmental review will assess the predicted emissions from construction activities and compare them to the minimal federal standards.

The aesthetic impact of a dewatering facility or upland CDF will depend upon the design of the facility within the context of the specific site chosen for the facility. Truck and rail traffic transporting sediments to the site would also increase emissions and the level of noise in the area. Factors such as orientation of the facility at the site, landscaping, scale of the facility in relation to surrounding use, and hours of operation (nighttime use) will all influence the level of impact of the facility. Adjacent land use will also affect the potential impacts of a facility. If an upland CDF is sited in an industrial area where adjacent uses are compatible, or if it is sited in a forest with an adequate buffer of trees around the perimeter of the site, there may not be any aesthetic impacts. If a facility is sited in a flat area with little vegetation and landscaping, where all the activities can be viewed, it may be perceived as having an aesthetic impact.

4.6.8 Potential Impacts to Cultural Resources

The presence or absence of historically significant buildings, Native American traditional cultural sites, or prehistoric sites at a proposed upland CDF construction site would be evaluated for compliance with Section 106 of the National Historic Preservation Act (36 CFR 800), in cooperation with local tribes, local governments, the Washington State Office of Archaeology and Historic Preservation, and the National Advisory Council on Historic Preservation. Because all archaeological or cultural sites would be excluded from possible site selection (see Appendix B) and site selection must comply with applicable historic preservation laws, it is not anticipated that cultural resources would be impacted by the construction of an upland CDF.

4.6.9 Mitigation

Measures to minimize the environmental consequences of implementing the upland CDF alternative are described in the following sections.

4.6.9.1 Water and Sediments

Any effluent from the site would be required to meet state and federal water quality standards, so any substantive impact to surface waters would be unlikely. An upland CDF or dewatering facility would also have to meet state groundwater standards. That could require a design having a double liner, impermeable clay layer, or paving over the site to minimize the risk of contaminated material infiltrating the groundwater at the site. In addition, groundwater monitoring wells would be required to ensure the performance of operations at the site in protecting groundwater. Siting criteria would likely prevent an upland CDF or dewatering facility from being sited over a sole source aquifer (Table 4-5).

4.6.9.2 Ecological Health

Any effluent discharged from a dewatering facility or upland CDF would have to meet state and federal water quality guidelines for discharge and therefore would have minimal impact on aquatic life in nearby streams, rivers, and marine waters. Siting a specific facility would require evaluating the site for threatened or endangered species following established ESA procedures, which would preclude and/or greatly minimize impacts on those species.

4.6.9.3 Human Health

Measures taken to mitigate the impacts to human health risks are the same as those for water and ecological resources described above. Other risks would be addressed by management and operation of the landfill.

4.6.9.4 Land and Water Use

Measures taken to reduce impacts to land and water use incorporate many of the measures for water and ecological health. Specific mitigation would depend on the location of the site.

4.6.9.5 Transportation and Utilities

When siting a specific upland CDF facility, the increase in traffic caused by trucks carrying sediments to the facility would be evaluated to determine how significant the impact is to the region. Siting criteria for the site-specific selection of the upland CDF alternative would likely exclude areas with significant transportation route impacts as well as areas with critical public utility structures (Appendix B). Sites not in the general proximity of existing roads or rail would also likely be eliminated from consideration.

4.6.9.6 Air, Noise, and Aesthetics

Air quality and noise impacts would be evaluated against existing conditions and regulations for specific sites to determine whether predicted impacts comply with the appropriate local, state, and federal standards. Site-specific siting, design, and operational controls would be used to ensure compliance with existing regulations. Aesthetic impacts would be considered in the design of the facility. Landscaping features and eventual redevelopment goals for the MUDS facility could mitigate for aesthetic impacts.

4.6.10 Unavoidable Adverse Impacts

The potential unavoidable long-term impacts associated with construction and operation of a dewatering facility or an upland CDF would include the following:

- Loss of vegetation and habitat at the site
- Displacement of animals from the site
- Increase in transportation congestion near the site
- Decrease in air quality (dust, volatile emissions) near the site
- Aesthetic impacts, including odor downwind of the site
- Increased noise levels near the site
- Potential for organisms to be exposed to contaminants and the transfer of those contaminants through the food chain.

4.7 SOLID WASTE LANDFILL ALTERNATIVE

Because this alternative uses existing landfills as a disposal site, a conceptual design is not included in this report. As described in Section 2, the solid waste landfill alternative is placement of contaminated sediments within an existing solid waste landfill. Solid waste landfills in the state of Washington are regulated primarily by the *Minimum Functional Standards for Solid Waste Handling* (WAC 173-304), *Criteria for Municipal Solid Waste Landfills* (WAC 173-351), and the Resource Conservation and Recovery Act (RCRA Subtitle D). These regulations were established by the state and federal governments to ensure protection of human health and the environment and include locational, collection, transportation, and landfilling standards; general facility requirements; and closure/post-closure requirements.

Because of the water content in dredged material, the sediments must be dewatered prior to transport to a landfill. Dewatering includes rehandling of the contaminated sediments at a nearshore facility and is typically included and permitted as part of a project dredging plan. The dewatering facility is commonly a bermed containment area, although storage tanks have also been used. Dewatering methods are similar to those used at CDFs, and depending on the facility design, may include active dewatering (e.g., using trenches to collect effluent for discharge to receiving waters) and/or passive dewatering (e.g., settling and desiccation). Sediments have also been dewatered by adding Portland cement and fly ash (U.S. Navy 1994). For the solid waste landfill alternative evaluated here, it is assumed that contaminated sediment dewatering/rehandling occurs at a constructed multi-user shoreside facility as described for the upland CDF alternative (see Section 2.4.4).

4.7.1 Contaminant Pathways

The possible pathways and contaminant migration from a solid waste landfill are similar to those for the upland alternative and include effluent discharge to surface water during shoreline rehandling and dewatering, rainfall surface runoff, leachate into groundwater, volatilization to the atmosphere, and direct uptake. Direct uptake includes plant uptake and subsequent cycling through food webs and direct uptake by animals that live near the rehandling facility and the solid waste landfill. Effects on surface water, groundwater, air, plants, and animals depend on the characteristics of the dredged material, management and operation of the rehandling site during dewatering, and the proximity of the rehandling facility to potential receptors of the contaminants. Effects on surface and groundwater quality and other environmental elements at the solid waste landfill are controlled through design regulations.

4.7.2 Potential Impacts to Water and Sediment

Existing solid waste landfills must comply with state and federal water quality regulations. They are designed to meet those standards through the use of leachate collection and treatment systems, siting design standards, and performance monitoring. No water quality impacts are anticipated from adding contaminated sediments to an existing landfill.

4.7.3 Potential Impacts to Ecological Health

A potential impact of disposing contaminated sediments at existing landfills is the possible uptake of contaminants by plants and animals near the facility. Birds such as gulls and crows frequently congregate near landfills and could come into contact with contaminated material. Small mammals may also visit the site and come into contact with the sediments. The significance of this impact would depend on the characteristics of the dredged material, the operation of the site during and after filling, and the proximity of potential receptors.

4.7.4 Potential Impacts to Human Health

There could be potential human health impacts by inhalation, ingestion, and direct contact with the contaminated sediments at the landfill. The significance of these potential impacts would depend on the management and operation of the landfill, sediment characteristics, and training of landfill staff.

4.7.5 Potential Impacts to Land and Water Use

Potential land use impacts caused by existing landfills have been addressed during the siting process for the landfill. The addition of contaminated sediments to landfills would likely not create additional land use impacts. However, over the long-term, it may possibly hasten the closure of existing landfills by using up capacity and thereby accelerate pressure to establish new solid waste disposal facilities.

4.7.6 Potential Impacts to Transportation and Utilities

Potential transportation impacts from disposing of sediments at solid waste landfills would depend on the type of delivery system (truck or rail), the frequency of trips to the site, and the relationship between the additional trips compared to existing traffic patterns. Transportation impacts could occur if the number of trips to the site delivering sediments is significantly higher than existing conditions. Rail delivery to a solid waste landfill would have less impact than trucks because local streets would not be used. However, depending on existing rail system capacity, there could be an impact on regional rail transportation.

4.7.7 Potential Impacts to Air, Noise, and Aesthetics

Adding sediments to an existing landfill could create impacts to air quality through volatilization of contaminants when sediments are exposed to the air. In addition, contaminants could be carried into the air as dust by wind. The significance of these potential impacts would depend on sediment characteristics and the operation of the landfill. Additional noise would be created during the delivery and management of the sediments at the landfill. It is unlikely that the activity associated with the contaminated material would be a significant increase over the level of noise already occurring at the landfill. Similarly, delivery of sediments to an existing landfill would not likely have an impact on the aesthetics of the landfill (and possibly might reduce odors if the sediments can be used effectively as interim solid waste cover).

4.7.8 Potential Impacts to Cultural Resources

Disposing contaminated sediments at existing landfills would not create any impacts on cultural or historical resources.

4.7.9 Mitigation

The solid waste landfill alternative uses existing facilities, and mitigation has already been applied during landfill siting, construction, and operation. Mitigation required for disposing of contaminated sediment at the landfill could be similar to existing measures for addressing other solid waste. If the potential release of volatile compounds in the contaminated sediments is shown to be a concern for certain disposed materials, then mitigation could include covering the material with less contaminated material on a project-specific basis.

Mitigation for the dewatering/handling facility, established as part of the landfill alternative, is discussed in conjunction with the upland CDF alternative in Section 4.6.9.

4.7.10 Unavoidable Adverse Impacts

Unavoidable adverse impacts associated with the disposal of contaminated sediments at an existing landfill are expected to be minimal.

4.8 MULTIUSER ACCESS TO PRIVATELY-DEVELOPED CONFINED DISPOSAL FACILITIES

The potential impacts of allowing multiple users to access one facility are related in part to multiple disposal events occurring over a period of time. If the disposal alternative is a nearshore fill, there may be water quality impacts in the area every time a new user disposes of sediments at the facility. The potential need to cap after every disposal event to reduce potential impacts would also reduce the overall capacity of the facility, reducing its efficiency.

Allowing multiple users to access one site would reduce the proliferation of numerous small sites and their respective impacts. Instead of potential impacts to water quality, habitat, or transportation in many areas, the potential impacts would be focused and could be mitigated for at one site.

4.9 COMBINATIONS OF ALTERNATIVES

The potential impacts of combining two or more of the MUDS alternatives into one facility would be similar to the impacts of the individual alternatives comprising the facility. For example, if a nearshore and upland CDF were combined into one facility, the potential impacts of the combined site would be similar to the combined impacts of a nearshore CDF and an upland CDF.

4.10 CUMULATIVE CONSEQUENCES OF THE ACTION ALTERNATIVES

Contributions to cumulative impacts would be minimized by the siting process for a MUDS facility. Decisions on proposed facilities would be made with consideration and knowledge of other similar or proposed facilities. The site-specific EIS would consider other programs and projects that have a reasonable likelihood of interacting with the proposed project in terms of environmental impacts.

Discussion of cumulative environmental impacts in this programmatic EIS is limited to general considerations. With respect to the alternatives that require construction of a new facility (as opposed to regulatory changes or use of an existing solid waste landfill), the concerns are similar in nature and, based on current conditions, are briefly described in the following sections.

4.10.1 Contained Aquatic Disposal and Level Bottom Capping

Contributions to cumulative impacts on a variety of resources from implementation of the LBC/CAD alternative could be significant. Although CAD disposal sites are being evaluated by several sediment cleanup programs (e.g., the Thea Foss Waterway and Hylebos Waterway remediation projects in Commencement Bay and a navigation improvement/clean up project in Seattle's East Waterway), DNR does not readily authorize the disposal of contaminated sediments on state-owned aquatic land (nearly all bedland below MLLW is owned by the state and managed by DNR). Therefore, few individual CAD projects with environmental impacts similar to the MUDS LBC/CAD alternative are likely to be approved.

4.10.2 Nearshore Confined Disposal

Evaluation of cumulative impacts from implementation of the nearshore confined disposal alternative would have to consider similar programs and proposals. Currently, some of the types of programs or projects that would be considered include the Corps/Port of Seattle East Waterway project and the Bellingham Bay pilot study. However, as stated above, contributions to cumulative impacts would depend on the specific MUDS facility type relative to comparable projects in the same region. While considerable cumulative loss of nearshore aquatic areas could result from construction of several CDFs in one region, project approvals would be unlikely without mitigation requirements that take into account regional cumulative impacts.

4.10.3 Upland Confined Disposal

Contributions to cumulative impacts from an upland CDF would need to consider similar proposed and existing facilities, including solid waste landfills. Decisions during the siting and environmental review process would include consideration of cumulative environmental impacts from these facilities on regional habitats and resources.

4.10.4 Multiuser Access to Privately-developed CDFs

Contributions to cumulative impacts associated with the multiuser access to large CDFs would be similar to the cumulative impacts of the disposal alternative chosen for the multiuser facility (e.g., nearshore or upland).

4.10.5 Combinations of Other Alternatives

Contributions to cumulative impacts resulting from a combination of two or more of the alternatives would need to consider all nearby projects and programs that would result in environmental impacts similar to those from each disposal alternative.

5.0 PROBABLE IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The irreversible and irretrievable commitment of resources is the use of materials, resources, or land during implementation of an alternative that makes these resources unavailable for other uses, given known technology and reasonable economics. All action alternatives for development of a MUDS facility would require some irreversible and irretrievable commitment of materials, resources, and/or land. However, any alternative that results in increased contaminated sediment cleanup offers the potential long-term benefit of environmental improvement. Implementation of an alternative that includes productive use of otherwise abandoned property (i.e., brownfield) also offers potential long-term economic benefit. For these reasons, all of the action alternatives evaluated in this PEIS offer the potential for improvements over the no-action alternative.

All action alternatives involve the use of both industrial and environmental resources. Industrial resources required by all alternatives include fossil fuels, energy, and construction-related materials, as well as labor and capital. The amount of resources that would be consumed depends on specific site and facility design characteristics and cannot be accurately determined at this stage.

Environmental resources potentially used or impacted by the alternatives have been discussed in detail in Section 4 of this PEIS. These resources include habitat and natural resources, and existing land and water uses, and are summarized briefly below.

HABITAT

The LBC/CAD alternative would result in irreversible loss of existing habitat. However, similar habitat could be provided for fish and invertebrates if the cap material and sediments deposited by currents resulted in conditions similar to those present prior to construction. The overall habitat type would remain the same, and complete recolonization of the site by benthic organisms would occur within a few years of site closure.

For the nearshore CDF alternative, disposal could cause changes in land use, and habitat, and existing vegetation and wildlife would be lost. The loss of nearshore intertidal and shallow subtidal habitat at a nearshore CDF is significant and irreversible. Mitigation, either the development of new habitat or improvement of existing habitat, would probably be required.

Depending on the location, there could also be irreversible loss of upland habitat at an upland CDF. If the upland CDF was located in an existing industrial area there would be minimal loss of habitat. However, a CDF on undeveloped land would result in habitat loss. In the later case, mitigation, such as the development of new habitat or improvement of existing habitat, could be required. Disposal of contaminated sediment at a solid waste landfill would result in no additional land or habitat alteration.

NATURAL RESOURCES

In the aquatic, nearshore, and upland alternatives, subsurface sediment and soil quality would be altered by placing contaminated dredged material in areas where uncontaminated materials were formerly present. However, control measures would effectively isolate contaminants from the environment . In this regard, all the action alternatives may be considered improvements over the no-action alternative if additional contaminated sediment cleanup and environmental improvement results.

Implementation of the upland alternative in a forested area could result in the loss of a renewable timber resources. While this is a long-term commitment, it is not necessarily irreversible. Mitigation would probably be require for this impact.

LAND AND WATER USE

Placement of contaminated dredged material in the aquatic and nearshore environments could result in irreversible changes in water and land uses in the aquatic, nearshore, and upland alternatives. The LBC/CAD alternative would preclude future dredging and could affect local anchorage patterns, resulting in changes in water use and transportation. Similarly, construction of a nearshore CDF could result in loss of existing and future navigational use and, depending on the location of the site, could permanently alter local aquatic land and shoreline use. The land use impact of constructing a dewatering facility or an upland CDF depends on existing land uses. While long-term changes could result, these changes are not necessarily irreversible in terms of future use of the land.

6.0 COORDINATION WITH OTHER PROGRAMS, PLANS, AND REGULATORY AUTHORITIES

There are many federal, state, Tribal, and local programs and regulations potentially applicable to the Puget Sound Confined Disposal Site Study alternatives. In this section, coordination with other programs and plans is described first, followed by brief descriptions of potentially applicable federal and state laws. Local laws and regulations would be addressed in the site-specific phase.

6.1 COORDINATION WITH THE PUBLIC, REGULATORY AGENCIES, AND PROGRAMS

The following coordination efforts were conducted by the Corps and Ecology to obtain input, comments, and direction on the PEIS from all interested parties.

6.1.1 Project Scoping

Project scoping is conducted near the beginning of the NEPA/SEPA process to gather input from affected Tribes, agencies, and the public on the range of alternatives and potential impacts to be discussed in the EIS. The goal is to ensure that the EIS is complete and addresses all significant environmental, social, legal, political, and technical issues related to the proposed action. The scoping process for this PEIS included a public comment period and public meetings. The process and resulting scope are summarized below (Striplin Environmental Associates and Parametrix 1996).

6.1.1.1 Public Notice and Comment Period

The scoping process began on November 30, 1995 when a SEPA Determination of Significance (DS) was issued. A NEPA Notice of Intent (NOI) was published in the *Federal Register* on 4 December 1995. The DS and NOI presented preliminary disposal alternatives that would be addressed in the PEIS and a list of areas identified for analysis. Public comments, verbal or written, on the scope of the PEIS were solicited at public meetings.

6.1.1.2 Scoping Meetings

Scoping meetings were held to give the public an opportunity to provide input early in the process about what issues should be included in the scope of the PEIS. Public meetings were held in Tacoma and Everett in December 1995. A single verbal comment was received for the formal record. In addition, there was informal discussion on a range of MUDS-related topics.

6.1.1.3 Comment Summary

Scoping comments received during the written comment period or at the public scoping meetings are presented in the Scoping Document for the PEIS (Striplin Environmental Associates and Parametrix 1996). Significant comments or issues identified during the scoping process are summarized in Table 6-1. All comments within the scope of the study are addressed in the PEIS.

6.1.2 Work Group Meetings

With the signing of the project cost-sharing agreement by the Corps and non-federal project sponsors in July 1997, the feasibility phase of the Puget Sound Confined Disposal Study and the preparation of this PEIS began. Beginning in September 1997, interagency work group meetings were held every one or two months during the preparation of the PEIS. Staff from the Corps, Ecology, WPPA, US Fish & Wildlife Service, DNR, PSWQAT, and EPA participated in these meetings.

6.1.3 Public Participation and Outreach

A public participation plan was outlined in September 1998 to coincide with the distribution of the Draft PEIS to the public in the winter of 1999. Elements of this plan are described in Appendix E.

6.1.4 PEIS Public Review and Comment

Following public release of this draft PEIS, the public will have 45 days to review the report and provide comments to the lead agencies. Opportunities for verbal comment will be provided at public meetings to discuss the PEIS. Comments may also be submitted in writing to the Corps.

6.1.5 Coordination with Other Programs

This Puget Sound Confined Disposal Study PEIS was coordinated with one other sediment program: the Bellingham Bay Demonstration Pilot Project. The Bellingham project is a baywide planning program using a cooperative approach to expedite sediment cleanup and associated habitat restoration in Bellingham Bay. Representatives of federal, state, and local agencies, as well as Tribes and private industry, participate in the Bellingham program. In their effort to identify cleanup alternatives and disposal options, the Bellingham Bay project is addressing many of the same issues included in this PEIS, such as how to site a disposal facility and what disposal options are available. This PEIS aimed for consistency with the ongoing Bellingham effort by using similar assumptions and addressing many of the same issues and concerns (e.g., siting criteria).

Table 6-1. Summary of Issues Raised during PEIS Scoping in 1995.

Area of Concern	Comment	Discussed in the PEIS
Schedule	1. The schedule for the MUDS process	✓
Funding	2. Funding mechanisms for MUDS	✓
Alternatives	3. The process for selecting a preferred alternative	✓
Scope	4. A siting study to ensure identification of sufficient	✓
	5. Cap construction and effectiveness	✓
	6. Long term monitoring and maintenance	✓
	7. Dilution effect of dredging process on contaminated sediments in relation to potential open-water disposal	Out of scope, not addressed in PEIS
	8. Bioassay Methods	Out of scope, not addressed in PEIS
	9. Use of existing studies	✓
	10. Disposal impacts	✓
Siting Criteria	11. Legal, social and policy aspects; land use, coastal zoning, tribal and fisheries use	✓
	12. Salmon migration routes	✓

6.2 APPLICABLE LAWS AND REGULATIONS

Following an overview of the regulatory structure for contaminated sediments management and disposal in Puget Sound, this section lists and describes the primary laws and regulations that apply to the Puget Sound Confined Disposal Site program. Any MUDS facility would have to comply with all applicable laws, regulations, and standards. Environmental consequences are discussed in Section 4 of this programmatic EIS and, where appropriate, include general discussion of consistency of the proposed alternatives with applicable regulations. Specific compliance issues will be addressed in greater detail in site-specific studies.

6.2.1 Existing Regulatory Structure for Contaminated Sediments Management

Much of the summary information that follows is based on a legal analysis prepared as part of the S-4 Confined Disposal Standards Study (Ecology 1990b). Which agencies are involved in contaminated dredged material management depends upon the level of contamination in the dredged material and whether it will be disposed of in-water (either aquatic or nearshore) or upland (Ecology 1990a). In-water disposal (both aquatic and nearshore) is regulated by the following agencies:

- Corps (Clean Water Act, Section 404, and Rivers and Harbor Act, Section 10 permits)
- EPA (Clean Water Act, CERCLA)
- DNR (State-owned Aquatic Land Use Authorization)
- Ecology (Section 401 Certification, Sediment Management Standards and MTCA/WPCA, Coastal Zone Management Act [CZMA] Consistency Certification, Local Shoreline Program Approval, Shoreline Conditional Use and Variance permits
- Washington State Departments of Fisheries and Wildlife (Hydraulic Project Approval)
- Affected local governments (shoreline and other development permits).

Upland disposal is regulated by the following agencies:

- Affected local health departments and Ecology (disposal of a problem waste);
- Ecology (NPDES/state waste discharge permits);
- Affected local government (building code, grading, stormwater runoff, utility and zoning permits)
- Other government agencies depending on the site (for example, Tribal land or out-of-state).

Upland disposal would also be regulated by Ecology in the rare instance that the dredged material is determined to be a dangerous waste. In addition, upland disposal may be subject to a Corps Section 404 nationwide permit and Ecology's Section 401 water quality and CZMA certifications if there is a return flow from the disposal site into navigable waters or into wetlands adjacent to navigable waters.[1] Finally, upland disposal within the shoreline zone is also regulated by the affected local government through a shoreline development permit.

Cleanup activities involving contaminated sediments are regulated by Ecology and EPA through the federal and state Superfund laws. These activities can involve the dredging and confined disposal of contaminated sediments as part of the remediation plan.

Existing regulatory programs provide few specific standards for disposing of dredged sediments that cannot be disposed at unconfined open-water disposal sites (i.e., PSDDA sites). In the absence of such standards, individual regulatory agencies must collaborate to handle proposals for confined disposal of contaminated sediments on a case-by-case basis, relying on their general authority and on the best professional judgement of technical staff to minimize potential adverse environmental impacts resulting from the disposal.

Existing regulations adopted under the different regulatory programs may conflict. For example, confined disposal along the shoreline may be prohibited under existing shoreline master programs. Confined upland disposal may be prohibited or severely restricted under existing local health regulations. Other regulatory (and policy) conflict areas may need to be addressed as part of the Puget Sound Confined Disposal Study.

6.2.2 Primary Laws and Regulations

National Environmental Policy Act

42 USC 4321 *et seq.*; 40 CFR 1500 *et seq.* (CEQ); 33 CFR 230 & 235 (Corps)

The National Environmental Policy Act (NEPA) is intended to assist the federal lead agency in making decisions based on an understanding of the environmental consequences of their actions and taking actions that protect, restore, and enhance the environment. Any federal project, or a private or state project requiring a permit from a federal agency, must meet the NEPA requirements. If a proposal is determined by a federal lead agency to have a "significant impact on the human environment", that agency must prepare an EIS. The EIS is a public disclosure document that analyzes alternative means of attaining the agency's or private applicant's goal for the proposal, and analyzes the environmental consequences of each alternative and the potential options for mitigating environmental impacts.

State Environmental Policy Act

RCW 43.21C; WAC 197-11

The State Environmental Policy Act (SEPA) is the state equivalent of NEPA. Like NEPA, SEPA is intended to ensure that environmental values are considered by state and local

[1] The Corps Upland CDF alternative presented in Section 2 of this PEIS would be regulated under a Corps Section 10/404 permit.

government officials when making decisions. The SEPA process begins when someone submits a permit application to an agency or an agency proposes to take some official action. Prior to taking any action on a project, agencies must follow specific procedures to ensure that appropriate consideration has been given to the environment. The severity of potential environmental impacts associated with a project determines whether an EIS is required.

Growth Management Act

RCW 36.70A; RCW 36.70.A.150; RCW 36.70.A.200

The Growth Management Act requires high-population and high-growth counties and cities to adopt comprehensive plans and development regulations regarding land use within their jurisdiction. In particular, each plan must identify land within the jurisdiction that is useful for public purposes, and include a process for siting essential public facilities, including solid waste handling facilities.

Federal Clean Water Act, Washington Water Pollution Control Act

33 USC 1251 *et seq.*; 40 CFR 116-117, 122-123, 230-233, plus 33 CFR 320
RCW 90.48 *et seq.*

The federal and state clean water acts generally regulate pollution in navigable waters and waters of the state. These regulations include a prohibition of any unpermitted discharges of hazardous substances, including oil, into water. The acts also establish regulations for permitting point source and non-point source discharges. Section 404 of the federal Clean Water Act requires permits from the Corps for discharges of dredged or fill material into waters of the United States, including wetlands. Section 404(b)(1) requires a comprehensive evaluation to determine a project's compliance with the 404(b)(1) guidelines. These guidelines require a rigorous alternatives analysis and do not permit discharge of dredged or fill material if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, so long as that alternative does not have other significant adverse environmental impacts. The 404 permit program is co-administered by the Corps and EPA. Ecology has the authority, through Section 401 of the Clean Water Act, to issue a water quality certification that a proposed discharge will comply with the applicable provisions of state and federal water quality laws. A Section 401 certification is usually a precondition to receiving a Section 404 permit.

Washington Water Quality Standards

WAC 173-200; 173-220 to -255

Ecology has promulgated state-wide water quality standards under the Washington Water Pollution Control Act. Under these standards, all surface waters of the state are first divided into classes (AA, A, B, C, and Lake) based on the beneficial uses of that water body. The water quality criteria are defined for different types of pollutants and the characteristic uses for each class of surface water.

National Pollution Discharge Elimination System (NPDES), State Waste Discharge Program

33 USC 1432; 40 CFR 21-125; RCW 90.48.260; WAC 173-226.

The NPDES and state waste discharge programs implement permit systems applicable to industrial and commercial operations that discharge to groundwater, surface water, or municipal sewerage systems.

Rivers and Harbors Act

33 USC 403; 33 CFR 322

The Rivers and Harbors Act prohibits the creation of any obstruction to navigation in any waters of the United States. Section 10 of the Rivers and Harbors Act requires a permit from the Corps for any structures or work in navigable waters of the United States.

Puget Sound Water Quality Management Plan

RCW 90.70

The Puget Sound Water Quality Management Plan is a state plan first developed in 1987 which state and local agencies follow to protect water quality and habitat in Puget Sound. In March 1988, the administrator of the EPA formally designated Puget Sound as an estuary of national significance under Section 320 of the Clean Water Act. Section 320 requires developing a comprehensive conservation and management plan for any designated estuary, and the Puget Sound Plan was the first federally approved plan for such an estuary. Federal agencies must act consistently with the Puget Sound Plan. The Puget Sound Plan identifies specific goals related to many state agency programs such as stormwater, contaminated sediment, fish and wildlife, and wetlands.

Dredged Material Management Program Guidelines

RCW 79.90; WAC 332-30

The Dredged Material Management Program (DMMP), formerly Puget Sound Dredged Disposal Analysis (PSDDA), is a federal-state program that classifies and governs what dredged material can be put back into open water. The collaborative program provides a consistent and predictable approach to disposing of dredged sediments in unconfined open water and monitoring the condition of the PSDDA open water disposal sites.

State Sediment Standards

WAC 173-204; WAC 173-204-120

The Sediment Management Standards (SMS) were established by Ecology to help reduce and ultimately eliminate both the adverse effects on biological resources and significant health threats to humans that could result from surface sediment contamination. The regulations accomplish this by establishing standards for the quality of surface sediments, applying these standards as the basis for management and reduction of pollutant discharges, and providing a management and decision process for the cleanup of contaminated sediments. The SMS derives its authority from MTCA and the CWA.

Federal Superfund (CERCLA)

42 USC 9601 *et seq.*; 40 CFR 300 (National Contingency Plan excerpts, including natural resource damages)

CERCLA is the key federal law governing the overall investigation and cleanup process for contaminated sites. The law establishes liability for the release or threatened release of hazardous substances. Under this liability scheme, owners of the facility are liable for the release or threatened release of hazardous substances. CERCLA also requires both property owners and operators to report releases of hazardous substances that may be a threat to human health or the environment.

Model Toxics Control Act

RCW 70.105D; WAC 173-340

The Model Toxics Control Act (MTCA) is the Washington state equivalent of the federal Superfund law. The MTCA regulations establish administrative processes and standards to identify, investigate, and cleanup facilities where hazardous substances are located. These regulations are intended to provide a workable process to accomplish effective and expeditious cleanups in a manner that protects human health and the environment.

Resource Conservation and Recovery Act,

42 USC 6901; 40 CFR *et seq.*

Hazardous Waste Management Act, and Dangerous Waste Regulations

RCW 70.105; WAC 173-303

The dangerous waste regulations and the Resource Conservation and Recovery Act (RCRA) Subtitle "C" establish the requirements for handling certain types of waste that are designated as "dangerous waste" under state law and "hazardous waste" under federal law. Washington has been delegated the authority to implement RCRA through the dangerous waste regulations.

These regulations establish a permit program for hazardous waste treatment, storage, and disposal facilities. In addition, Subtitle D of RCRA provides for developing and encouraging methods for the disposal of solid wastes that are environmentally sound and conserve valuable resources.

State Solid Waste Management Act

RCW 70.95; WAC 173-304; WAC 173-351

The Washington State Solid Waste Management Act and its regulations, among them the Minimum Functional Standards (WAC 173-304), establish minimum state-wide standards for solid waste handling facilities, including municipal landfills (WAC 173-351). These regulations include location, collection and transportation, and landfilling standards, and general facility requirements and closure/post-closure requirements.

Coastal Zone Management Act

16 USC 1451 *et seq.*; 15 CFR 923

Under the Coastal Zone Management Act, any applicant for a federal permit for activity in a state's coastal zone must certify that the proposed activity will comply with the state's coastal zone management program.

Shorelines Management Act

RCW 90.58; WAC 173-16

The Shoreline Management Act (SMA) establishes a comprehensive land and water use planning and regulatory program for the management of state waters and their adjacent shorelines and wetlands. Any person proposing to build a substantial development in the state's shorelines must obtain a Substantial Development Permit under the Shoreline Management Act. Responsibility for the implementation of this program is divided by Ecology and local governments. Local governments are primarily responsible for the day-to-day management, and Ecology is responsible for oversight and technical support. The SMA establishes a framework for local governments to develop local shoreline master programs that contain their specific regulations and permit requirements. With some exceptions (i.e., single-family home), a Substantial Development Permit must be obtained for any proposed project valued over $2,500 within 200 ft of the shoreline, or any project that interferes with public use of the water. This permit may impose restrictions to protect the shoreline and aquatic habitat.

State Aquatic Lands Management Laws & Public Trust Doctrine

Washington State Constitution Art. XV
RCW 79.01 *et seq.*, especially RCW 79.90; WAC 332-30

The Washington State Constitution, statutes, aquatic lands management regulations, and DMMP (PSDDA) guidelines set forth the requirements for open water disposal sites on state-owned land, including application for use of a site. The public trust doctrine protects public ownership interests in certain uses of navigable water and underlying lands. The public trust doctrine thus preserves a public property interest in these lands and the water flowing over them. The public trust doctrine, as interpreted by the state judiciary, addresses the use and management of Washington's coastal and shoreland resources. It also imposes restrictions on state government and state agencies use of these lands.

Indian Treaty Rights

Treaty of Point Elliott (12 Stat. 927), Treaty of Medicine Creek (10 Stat. 1132)

In 1854 and 1855, Native American Tribes, in what is now the state of Washington, signed treaties with the United States government conveying their right, title, and interest in and to the lands occupied by them. In return for giving up these rights, designated land and certain rights were allocated to the Tribes. These treaties and subsequent court decisions protect Indian Tribes' property and water rights, including their rights to fish and co-manage fishery and shellfish resources in Puget Sound.

State Hydraulics Act

RCW 75.20; WAC 220-110

The Hydraulics Act establishes regulations for the construction of any hydraulic project or the performance of any work that will use, divert, obstruct, or change the natural flow or bed of any of fresh or saltwater of the state. The Hydraulics Act also creates a program requiring permits for any activities that could adversely affect fisheries and water resources. The Hydraulics Act is administered by the WDFW.

Federal and State Clean Air Acts

42 USC 7401 *et seq.*; 40 CFR 50-75; RCW 70.94; WAC 173-400, 420-422, 460

The Clean Air Act regulates emissions of hazardous pollutants to the air; controls for emissions are implemented through federal, state and local programs. The Clean Air Act is implemented in the state of Washington through the Washington Clean Air Act (RCW 70.94). The regional air pollution contract authorities, activated under the Washington Clean Air Act, have jurisdiction over regulation and control of the emission of air contaminants and the requirements of state and federal Clean Air Acts in their districts. In 1993, the EPA issued a rule that requires federal agencies to demonstrate that projects they are involved with are in compliance with federally approved Clean Air Act state implementation plans.

Endangered Species Act

16 USC 1531 *et seq.*; 50 CFR 17; RCW 77.12 *et seq.*

The Endangered Species Act (ESA) provides a process for determining whether a species should be "listed" as threatened or endangered, and it prohibits the "taking" of designated species unless the take is considered "incidental." The Act also imposes a requirement for agencies to consult with federal resource agencies regarding actions that may adversely affect listed species and a duty to ensure that a federal action is not likely to jeopardize a listed species or adversely modify critical habitat.

Fish and Wildlife Coordination Act

16 USC 661 *et seq.*

The Fish and Wildlife Coordination Act requires federal agencies to consult with fish and wildlife agencies on activities that could affect fish and wildlife.

Federal and State Wetlands Protection Executive Orders

E.O. 11990; E.O. 90-04

Executive Order 11990 and the state Executive Order (90-04) requires that actions be taken to avoid adverse impacts to wetlands with a goal of "no net loss of function or acreage." The federal agencies implement these considerations through existing federal and state requirements, such as NEPA and SEPA and Section 404 and 401 permits.

Protection of Upper Aquifer Zones

WAC 173-154

Upper aquifers and upper aquifer zones must be protected to the extent practicable to avoid depletion, excessive water level declines, or reductions in water quality. Such protection is necessary in order to preserve the water for domestic use, livestock, and to preserve spring and stream flow.

Environmental Justice

E.O. 12898

Environmental justice concerns arise from environmental impacts on minority populations, low-income populations, and Indian Tribes. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations", requires that each federal agency research, collect data and analyze the environmental effects (which may be cumulative and multiple) of federal actions on low-income populations, minority populations, and Indian Tribes. Environmental and human health impacts must be evaluated to ensure that any federal actions do not have disproportionately high or adverse effects on the populations of concern.

Environmental justice issues are addressed during the NEPA process. Agencies are required to work to ensure effective public participation, community and Tribal representation, and information access. EIS preparation must consider both impacts on the natural or physical environment and interrelated social, cultural, and economic impacts on low-income and minority populations or Indian Tribes. Mitigation measures may include steps to avoid, reduce, or eliminate impacts.

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8.0 INDEX

9.0 ACRONYMS AND ABBREVIATIONS

ADDAMS	Automated Dredging and Disposal Alternatives Management System
CAD	Contained Aquatic Disposal
CAMP	Comprehensive Analysis of Migration Pathways
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
Corps	United States Army Corps of Engineers
CSL	Cleanup Screening Level
CSMP	Cooperative Sediment Management Program
CWA	Clean Water Act
cy	cubic yards
DAIS	Dredged Analysis Information System
dB	decibel
DEM	Digital Elevation Model
DMMP	Dredged Material Management Program (formerly PSDDA)
DMRP	Dredged Material Research Program
DNR	Washington Department of Natural Resources
DO	Dissolved Oxygen
DOD	Department of Defense
DRET	Dredging Elutriate Testing
DS	Determination of Significance
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft	feet
GAI	Geographic Areas of Interest
GIS	Geographic Information System
GMA	Growth Management Act
gpm	gallons per minute
HPA	Hydraulic Project Approval
LBC	Level Bottom Capping
LEC	Local Exchange Carrier
LS	Lump Sum
MFS	Minimum Functional Standards
MHHW	Mean Higher High Water
ML	Maximum Level
MLLW	Mean Lower Low Water
MPL	Major Public Lands
MTCA	State of Washington Model Toxics Control Act

MTL	Mean Tide level
MUDS	Multiuser Disposal Site
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Association
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resources Damage Assessment
NWAPA	Northwest Air Pollution Authority
NWI	National Wetlands Inventory
OAPCA	Olympia Air Pollution Control Authority
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEIS	Programmatic Environmental Impact Statement
PRP	Potentially Responsible Party
PSAPCA	Puget Sound Air Pollution Control Authority
PSDDA	Puget Sound Dredged Disposal Analysis Program (now DMMP)
PSP	Puget Sound Management Plan
PSWQA	Puget Sound Water Quality Authority
PSWQAT	Puget Sound Water Quality Action Team
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RTPO	Regional Transportation Planning Organization
sec	second
SEDQUAL	Washington State Department of Ecology Sediment Quality Database
SEPA	Washington State Environmental Policy Act
SIP	State Implementation Plan
SL	Screening Level
SMA	Shorelines Management Act
SMS	Sediment Management Standards (WAC 173-204)
TCLP	Toxicity Characteristic Leaching Procedure
UPS	University of Puget Sound
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	Ultra-Violet
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WES	Waterways Experiment Station
WPCA	Water Pollution Control Act
WPPA	Washington Public Ports Association
WQS	Washington Water Quality Standards
WRDA	Water Resources Development Act
WSDOT	Washington State Department of Transportation
WUTC	Washington Utilities and Transportation Commission
yr	year

10.0 GLOSSARY

Absorption. A process in which one material takes up and retains another, resulting in a homogeneous mixture.

Adsorption. The adhesion of molecules to the surfaces of solids or liquids with which they are in contact. Many chemicals adsorb to sediment particles and are transported by these particles.

Aerobic. Living in the presence of oxygen.

Anadramous. Migrating up river from the ocean to breed in fresh water.

Anaerobic. Living in the absence of oxygen, or the condition of being without oxygen.

Anoxic. Lacking or without oxygen.

Aquifer. A geologic formation, group of formations, or part of a formation capable of yielding a significant amount of groundwater.

Baffle Plate. A device or structure for deflecting water flow.

Benthic. The bottom of an aquatic environment.

Benthic Infauna. Animals that live within the bottom sediment in an aquatic environment.

Berm. A barrier or embankment erected to contain fill material (see **dike**).

Bioaccumulation. The accumulation of chemicals in the tissues of an organism.

Bioassay. A laboratory test used to evaluate the toxicity of a material by measuring behavioral, physiological, or lethal responses of organisms.

Biodegradation. The conversion of organic compounds into simpler compounds through biochemical activity. Toxic compounds can sometimes be converted to simpler compounds through biodegradation.

Biological Treatment. A treatment process that utilizes microorganism growth for the purpose of oxidizing, absorbing, and adsorbing organic and inorganic chemicals.

Biologically Active Zone. Depth of surface sediments inhabited and mixed frequently by benthic organisms.

Biomagnification. The process by which concentrations of contaminants increase (magnify) as they pass up the food chain. The result is that animals higher on the food chain have higher tissue concentrations than those lower on the food chain.

Biota. The animals and plants that live in a particular area or habitat.

Bioturbation. Mixing and reworking of marine sediments and porewaters by the activities (e.g., feeding, respiration) of benthic organisms.

Bottom Dump Barge. Barge used to transport material to a dumpsite where it is released through doors in the bottom hull of the barge.

Bottomfish. Fish that live and feed primarily near the bottom of an aquatic environment.

Capping. The controlled placement of a covering or cap of clean sediments or fill over contaminated material.

Carbon adsorption. A treatment method for removing chemical contaminants through adhesion of contaminant molecules to carbon.

Characterization. The process of identifying a particular sediment's attributes, especially the types, levels, and distribution of contaminants.

Conceptual Design. A representative site design used in this PEIS to discuss environmental consequences and generate a cost estimate. The conceptual design is not intended to establish site design, operational, or management requirements.

Contained Aquatic Disposal (CAD). The subaqueous placement of contaminated material and subsequent covering of the material with relatively clean sediment. CAD is similar to Level Bottom Capping but has the additional provision of some form of lateral confinement (e.g. placement in bottom depressions, or behind subaqueous berms) to minimize spread of the materials on the bottom (see Fig. 2-2).

Confined Disposal Facility (CDF). Engineered, diked disposal sites inside of which dredged material is placed. CDFs may be constructed as upland sites, nearshore sites, or as island containment areas.

Confined Disposal. A disposal method that contains sediment contaminants by isolating the dredged material from the environment. Confined disposal may be in aquatic, nearshore, or upland environments.

Contaminant. A chemical or biological substance that can, depending on its toxicity and concentration, cause serious harm to aquatic organisms or users of the aquatic environment.

Contaminant Control Measures. Activities, structures, or operations to prevent or reduce the transport or uptake of contaminants.

Contaminant Flux. The amount of contaminant moving across a given area per unit time.

Contaminant Pathways. Potential migration routes of contaminants from a confined disposal site.

Contaminated Sediment. A sediment that contains measurable levels of contaminants or sufficient concentrations of chemicals to produce unacceptable adverse environmental effects. According to Washington State regulations, contaminated surface sediments are designated under the procedures of WAC 173-204.

Conventional Pollutants. Conventional pollutants as specified under the Clean Water Act are total suspended solids, fecal coliform bacteria, pH, oil and grease, and biological oxygen demand. In sediments, sulfides, organic carbon, and ammonia may also be measured, and are referred to as conventional parameters.

Cover Layer. Layer of relatively clean material, sediments, or fill. See capping.

Critical Habitat. Specific area or environment of importance for breeding, foraging, or habitation of species.

Decibel. Unit of sound measurement.

Dewatering. Removal of water or moisture from sediment using passive (e.g., natural evaporation) or active (e.g., filtration) methods.

Differential Global Positioning System. Navigation and positioning system using satellite technology that provides accuracy on the order of $\pm$1-5 meters.

Dike. A bank, usually of earth, erected as a barrier to contain fill material, provide stability, or contain floodwaters.

Discharge. The release of either a solid or liquid into the aquatic environment.

Disposal Site. The area that receives discharged dredged material.

Downpipe. Type of submerged discharge equipment for release of sediment slurry.

Dredger. Private developer or public entity (e.g., federal or state agency, port or local government) responsible for funding and undertaking dredging projects. This is not necessarily the dredging contractor who physically removes and disposes of dredged material.

Dredged Material Management Program (DMMP). The regional inter-agency (Corps, EPA, Ecology and DNR) program that manages and regulates dredged material characterization and the unconfined disposal of dredged material at designated disposal sites. The DMMP oversees dredging and disposal projects in the Lower Columbia River, the Grays Harbor and Willapa Bay estuaries, and Puget Sound (see **PSDDA**).

Dredging. The physical removal of bottom sediments by digging, cutting or hydraulic scour and suction.

Effluent. Treated or untreated wastewater that is discharged from a treatment plant, sewer, or constructed facility into surface waters.

Epibenthic. In aquatic environments, the surface of bottom sediments.

Epifauna. In aquatic environments, animals living on the sediment surface, or closely associated with the sediment surface (rather than being buried in the sediments).

Erosion. Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical and chemical forces.

Flocculation. Aggregation of fine suspended particles into a loose, cloudlike mass, often caused by ionic changes due to contact with higher salinity waters.

Geotextile Membrane. A woven or nonwoven fabric made from synthetic fibers, designed to serve as a continuous barrier between soil layers.

Groundwater. All subsurface water, especially that in the saturation zone (i.e., area where water fills all space between soil particles).

Habitat. The specific area or type of environment in which a particular plant or animal lives.

Hazardous Waste. Any solid, liquid, or gaseous substance which, because of its source or measurable characteristics, is classified under state or federal law as hazardous, and is subject to special handling, shipping, storage, and disposal requirements. Washington State regulations identify and define dangerous waste in WAC 173-303.

Hopper Dredge. A type of hydraulic dredge that uses water jets and suction to pump sediment slurry directly into hoppers (i.e., storage compartments) on the vessel for transport to the dump site. The sediment slurry is offloaded by pumping or bottom-dumping.

Hydraulic Dredge. Dredges that employ centrifugal pump and suction pipe systems to remove and transport sediments in a slurry form.

Hydraulic Pipeline. Pipeline that carries sediment slurry away from the dredgehead or transports sediment slurry between two locations.

Infauna. Animals buried or living primarily within the bottom sediments.

In situ. In its original place or position.

Intertidal Area. The area between high and low tide levels. The alternate wetting and drying of this area makes it a transition between land and water and creates special environmental conditions and habitats.

Ion Exchange and Precipitation. A treatment method in which contaminants are removed through chemical reactions in which one type of ions (charged atoms or molecules) are exchanged with other ions in solution, resulting in a solid phase that can be separated from the liquid.

Leachate. Waters (often precipitation) that has flowed through soil or sediments and therefore may contain dissolved, soluble chemicals.

Leachate Collection System. Most commonly a network of pipes placed in high-permeability material that collect leachate by gravity flow and transport it to a treatment system or discharge location.

Level bottom capping (LBC). The subaqueous placement of contaminated material in a discrete mound on an existing flat or very gently sloping natural bottom and the subsequent covering of the mound with relatively clean sediment.

Liner. A low-permeability barrier to prevent vertical migration of leachate at a disposal facility, typically made of geotextile material or very low permeability clay.

Mean. The average; obtained by dividing the sum of a set of values by the number of values.

Mechanical Dredge. Dredges that remove bottom sediment through the direct application of mechanical force (e.g., with buckets) to dislodge and excavate the material.

Median. The middle value of a set of values when the values are arranged in numerical order.

Mitigation. The process of avoiding, reducing, or compensating for adverse environmental impacts associated with an action.

Mobilization. The process of bringing construction equipment to the work site.

Monitor. To systematically and repeatedly measure something in order to detect changes or to verify continued compliance with regulatory standards or requirements.

Nearshore Disposal. Disposal of dredged material in the nearshore zone, i.e., between upland and subtidal areas.

Overdepth Material. Dredged material removed incidentally from below the desired dredging depth due to limited precision of dredging equipment.

Parameter. A quantifiable or measurable characteristic. For example, some water quality parameters are temperature, pH, salinity, and dissolved oxygen concentration.

Pelagic. Living in the water column in open water rather than in waters adjacent to land or inland waters.

Persistent. Not readily degraded by natural physical, chemical, or biological processes. and therefore remaining in the environment for a long period of time.

pH. The degree of alkalinity or acidity of a solution.

Point Source. Any source of pollutants from a single point of conveyance (e.g. pipes, ditches, channels, tunnels, wells, cracks, containers).

Priority Pollutants. Substances listed by EPA under the Clean Water Act as toxic and having priority for regulatory controls. The list includes toxic metals, inorganic contaminants such as cyanide and arsenic, and a broad range of both natural and artificial organic compounds.

Puget Sound Dredged Disposal Analysis (PSDDA). A federal (Corps, EPA) and state (Ecology, DNR) interagency program to regulate the evaluation and unconfined open-water disposal of dredged material. The program has selected sites for disposal of dredged materials, specified sediment evaluation procedures, and established site monitoring and program management requirements. Now part of the Dredged Material Management Program (see **DMMP**).

Puget Sound Water Quality Authority. An agency created by the Washington State legislature in 1985 and tasked with developing a comprehensive plan to protect and enhance the water quality of Puget Sound. Now known as the Puget Sound Water Quality Action Team (PSWQAT).

Recolonization. Reestablishment of organisms in an area following disturbance by larval settlement and/or migration, leading to the development of a new benthic community.

Recruitment. The production, successful survival, and colonization of an area by newborn organisms (e.g., recruitment of fish larvae).

Regulatory Agencies. Federal, state, and local government agencies that have regulatory authority over and issue permits for certain actions.

Riparian. Living or located on the banks of streams or lakes.

Runoff. Surface water that flows from an area after rainfall.

Sediment. Unconsolidated soil-type material on the bottom and shoreline of an aquatic environment. For example, sand and mud.

Sheet pile wall. Closely spaced piles of wood, steel, or concrete driven vertically into the ground to obstruct the lateral movement of water.

Shoreline Development. As regulated by the Shoreline Management Act (RCW 90.58) the construction over water or within a shoreline zone (generally 200 ft landward of the water) of structures such as buildings, piers, bulkheads, and breakwaters, including environmental alterations such as dredging and filling, or any project that affects public navigational rights on the surface waters.

Silt Curtain. Flexible barrier of impervious material that hangs from the water surface and limits the spread of suspended sediment and contaminants in the water column.

Siting Guidelines. Environmental, social, and engineering guidelines for locating a proposed facility.

Slurry wall. A trench filled with semi-liquid fine-grained material (usually clay) to obstruct or inhibit the lateral flow of groundwater.

Stormwater. Surface water that is generated by rainfall.

Submerged Discharge. Discharge below the water surface.

Substrate. Sea floor material (e.g. fine to coarse sediment, gravel, cobble, rock).

Subtidal. The marine environment below low tide.

Surface Discharge. Discharge at or above the water surface.

Suspended Solids. Organic or inorganic particles that are mixed or suspended in the water.

Suspended Solids Removal. Methods such as particle settling, chemical flocculation, or filtration that are used to separate suspended solid particles from water.

Total Suspended Solids. All particles suspended in water, typically measured by weight.

Toxic Substances and Toxicants. Chemical substances, such as pesticides, plastics, detergents, chlorine, and industrial wastes that are poisonous, carcinogenic, or otherwise harmful to life if present in sufficient concentrations.

Treatment. Chemical, biological, or mechanical procedures applied to sediments, an industrial or municipal discharge, or to other sources of contamination to remove, reduce, or neutralize contaminants.

Trophic Level. Position in the food chain at which an organism feeds, with plants being the lowest trophic level and top predators (i.e., predators that are not prey) the highest.

Turbidity. A measure of the amount of material suspended in water as indicated by clarity or weight per volume.

Upland Disposal. Disposal of dredged material on land.

Volatile. Readily vaporized at a relatively low temperatures.

Water Column. The water in a lake, estuary, or ocean that extends from the bottom sediments to the water surface.

Weir. A dam or barrier in a stream or waterbody over which water flows; used to regulate water level, control effluent or runoff, or measure flow.

Wetlands. Habitats where the influence of surface or groundwater has resulted in development of plant or animal communities adapted to aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas.

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Tacoma Public Library
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Pierce County Public Library
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Tacoma, WA 98402-2215

Bremerton Library
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A.A. Lemieux Library
Seattle University
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Seattle, WA 98122-4320

Anacortes Public Library
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Army Corps of Engineers Library
PO Box 3755
Seattle, WA 98134-3755

Bainbridge Island Library
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Bainbridge Island, WA 98110

Bellevue Regional Library
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Bellevue, WA 98004

Bothell Regional Library
18215 98th Ave. NE
Bothell, WA 98011

Suzzallo/Allen Libraries
University of Washington Libraries
Box 352900
Seattle, WA 98195-2900

Edmonds Public Library
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Edmonds, WA 98020

WA State Library
PO Box 42460
Olympia, WA 98504

Collins Memorial Library
University of Puget Sound
1500 N. Warner
Tacoma, WA 98416-0004

Sno-Isle Regional Library
7312 - 35th Ave NE
Marysville, WA 98270-7417

Documents Unit
Seattle Public Library
1000 - 4th Ave
Seattle, WA 98104-1193

Seattle Pacific University Library
3307 3rd Ave. West
Seattle, WA 98119

Renton Public Library
100 Mill Ave So.
Renton, WA 98055-2126

Port Townsend Public Library
1220 Lawrence St.
Port Townsend, WA 98368-6527

Robert A. L. Mortveldt Library
Pacific Lutheran University
121st & Park Ave S.
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Olympia Timberland Library
713 8th St.
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Oak Harbor Public Library
7030 - 70th NE
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Kitsap Regional Library
1301 Sylvan Way
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APPENDIX A

INITIAL SITE SCREENING

TABLE OF CONTENTS

APPENDIX A - INITIAL SITE SCREENING

This appendix presents the results of an initial regional screening process for identifying potential upland, nearshore, and aquatic areas that may be suitable for the construction of confined disposal facilities for contaminated sediments dredged from Puget Sound. In the sections that follow, the study area is defined first, followed by a description of the initial siting process. The results of the screening process are presented in Maps A-1 through A-7. *Please note that this is only an initial screening of sites. Sites selected will undergo rigorous site-specific evaluation.*

STUDY AREA

Puget Sound Basin

The Puget Sound Confined Disposal Site Study area is defined as the area within which contaminated Puget Sound sediments can be removed, transported, and disposed of in a relatively cost-effective manner. In order to calculate maximum transport distances from contaminated sediment areas to each type of disposal alternative, a transportation range analysis was performed. The basic assumption underlying the transportation range analysis is that the difference between the total budget (disposal and transport cost per cubic yard times site capacity in cubic yards) and the estimated construction cost is set as the transportation budget. The total budget allowance for transportation and disposal of contaminated dredged material was set at $50 per cubic yard. This allowance is based on previous evaluations for similar projects in Puget Sound, and the recognition that per cubic yard transport and disposal costs to existing landfills likely approximate this value. A site capacity assumption was used to complete the transportation range analysis.

The volume of dredged material deemed unsuitable for open water placement under the PSDDA framework and the volume of sediments likely to be generated from dredging, waterfront construction, and cleanup projects in Puget Sound are currently estimated to range from 6 to 14 million cubic yards (see Section 1 of the PEIS). To account for a range in potential disposal volumes, two site capacity volumes of 500,000 and 2,000,000 cubic yards were considered to develop conceptual designs for each alternative and, consequently, costs associated with their construction (see Section 2).

Because the cost to transport and dispose of contaminated sediments is determined on a per ton basis, the transportation budget was converted to cost per ton using a conversion factor of 1.5, the assumed density of materials in tons per cubic yard. Contaminated sediments can be transported by barge, truck, or railroad car. Hart Crowser (1997) obtained verbal transportation cost estimates from regional rail, trucking, and tug and barge firms and plotted transport cost (per ton) versus distance. From the cost versus distance analysis provided in Hart Crowser (1997), maximum distances for each mode of transport were derived for this PEIS. The results of the transportation range analysis are summarized below.

	CAD		Nearshore CDF		Upland CDF[a]	
	500,000 cy	2,000,000 cy	500,000 cy	2,000,000 cy	500,000 cy	2,000,000 cy
Budget (x10^6)						
Construction	$12	$28	$21.7	$52.6	$26	$74.9
Transportation	$13	$72	$47.4	$47.4	NC	$25.1
Transportation/ ton	$17	$24	$15.8	$15.8	NC	$8.4
Ranges (miles)						
Barge	160	250	40	150	NA	NA
Truck	NA	NA	10	60	NC	30
Rail	NA	NA	20	50	NC	35

[a] Costs include rehandling.
NA - Not Applicable.
NC - Not able to Calculate. Costs associated with construction of this sized facility leaves no budget for transportation.

The Washington State Department of Ecology identified contaminated marine sediment sites in Puget Sound in the Sediment Management Standards Contaminated Sediment Site List (Ecology 1996). The location of these sites and the results of the transportation cost analysis determined the extent of the study area. The maximum economically feasible distance from contaminated sites in Puget Sound to an upland CDF is 35 miles. The 35-mile range encompasses the entire upland Puget Sound Basin from the Canadian border to 35 miles south of Olympia and eastward to the Cascade range foothills. The maximum distance for barge transport is 250 miles from a contaminated sediment area. The 250-mile range also encompasses the whole of Puget Sound and outward to the coast. The maximum distance for barge transport to nearshore CDFs is 150 miles, a distance falling within the study area defined by both CAD and upland transportation ranges.

Geographic Areas of Interest

Geographic areas of interest (GAIs) are regions within the Puget Sound Confined Disposal Site Study area where substantial volumes of contaminated sediments exist and therefore might benefit from the construction of a MUDS. Contaminated marine sediment sites in Puget Sound are depicted in Map A-1. Ecology's (1996) list of cleanup sites was used as a basis for depicting the geographic locations of contaminated sediments in this figure. (These same sites are listed in Table 1-1 of the main text along with associated volumes of contaminated sediment that may require confined disposal.) Based on the distribution of contaminated sediments in Puget Sound, five major embayments emerged for upland and nearshore site selection: Bellingham Bay, Port Gardner, Elliott Bay, Commencement Bay, and Sinclair Inlet.

Aerial photos were used to identify potential nearshore and upland sites (described below). Sites satisfying specific criteria were noted on the aerial photos and digitized. To limit the large number of photos to be analyzed, aerial photos taken up to 10 miles from contaminated sediments located in each of the five major embayments were reviewed for potential upland sites. If fewer than 10 upland sites were identified within the 10-mile radius, then aerial photos up to 20 miles from the contaminated sediments located in each major embayment were analyzed. For this initial screening, a 20-mile radius was used to identify potential upland sites. Areas for potential nearshore siting were observed within 10 miles of the five major embayments. GAIs for this initial upland site screening are shown in Map A-2 as circular regions around each of the five major embayments having a 20-mile radius.

Potential Aquatic, Upland, and Nearshore Sites

Potential aquatic, nearshore, and upland disposal sites were identified based on physical characteristics, current land uses, and proximity to major transportation routes. Potential sites were defined by determining areas of exclusion and inclusion, and represent Tier 1 of the MUDS siting process (see Appendix B). The following screening factors were used for site identification:

- Proximity to major transportation routes
- Lack of obvious land use conflicts (e.g., public parks and refuges and wetlands excluded)
- Capacity (i.e., minimum size) (for upland and aquatic sites)
- Maximum water depth (for aquatic sites)
- Topography (slope) restrictions (for upland and aquatic sites).

Ecology, Washington Department of Natural Resources (DNR), the United States Geologic Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and the Bureau of the Census were the primary sources for the geographic information system (GIS) data used in siting potential upland, nearshore, and aquatic sites. Additional data were developed from aerial photograph interpretation.

Screening Criteria

Screening criteria and the analytical approach taken for each of the three disposal alternatives is described below.

Upland Alternative

Siting potential upland sites involved both GIS analysis and the analysis of aerial photos (DNR orthoquads). Data, maps, and GIS coverages available from state and federal agencies provided information that excluded the following areas:

- Upland areas with slopes > 6%
- Designated parks, preserves, sanctuaries, and refuges (local, county, state, and federal)
- Designated municipal watersheds
- Tribal lands
- Wetlands (as defined by National Wetland Inventory)
- Areas greater than one mile from a road or railroad.

These exclusionary criteria were compiled in an "avoidance area" map needed to select and order orthophotos within each GAI. Orthophotos are geo-referenced aerial photos plotted at a scale of

1:12,000. Each orthophoto covers a quarter township, representing a 9-square-mile area. The aerial images purchased from DNR were prepared from high resolution black and white photography corrected to eliminate distortion caused by terrain relief. Accurate measurements (± 40 feet) could be taken directly from the photo.

The purpose of the orthophoto analysis was to identify upland sites with no structures or obvious uses. Because the photo analyst did not know the permitted use or legal status of a land parcel, an area was considered a potential upland site if no buildings, structures, or storage (e.g., logs) were evident. Ownership was not considered in this initial screening. Using this definition of a potential upland site prevents the identification of potential sites with structures or obvious uses, including many brownfields, during the initial screening. However, brownfields and other sites with structures or uses may still be identified and evaluated during the site-specific phase of MUDS as part of the stakeholder participation process. For example, potential sites may be available at existing port or municipal facilities, but based solely on the aerial photo analysis these sites would be excluded. A regional stakeholder could volunteer such a site during the site-specific siting process.

Areas identified in the initial screening included open fields, woodlands, and mixed vegetation. Some wooded areas may have sheltered buildings, but elimination of these areas will not occur until the site-specific MUDS phase. Using aerial photos, upland areas eliminated from consideration as potential upland sites included:

- Areas with existing structures/buildings/storage
- Areas not accessible by existing roads/rail lines
- Upland areas less than 50 acres in size.

Potential upland sites identified by applying exclusionary criteria in the GIS and by including potential areas without structures or uses are shown in Maps A-3 through A-7[1]. The number of potential Tier 1 upland sites surrounding each selected urban embayment are as follows:

- Bellingham Bay - 54
- Sinclair Inlet - 13
- Port Gardner - 37
- Elliott Bay - 15
- Commencement Bay - 72.

Kent-Kangley Road in King County served as the boundary between potential upland sites that surrounded Elliott Bay and those that surrounded Commencement Bay.

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[1] It is important to note that the upland mapped areas <u>may not exclude</u> critial areas (e.g., conservation areas, resource lands) that have been identified by counties and cities in accordance with the Growth Management Act. These areas will be excluded as part of site-specific disposal siting efforts (Appendix B).

Nearshore Alternative

The process used to identify potential nearshore sites up to 10 miles from known contaminated sediment sites in Puget Sound was the same as that used for the identification of potential upland sites. Shorelines were screened for the following exclusionary criteria:

- Areas with existing human uses (aerial photos)
- Designated parks, preserves, sanctuaries, and refuges (local, county, state, and federal)
- Designated municipal watersheds
- Tribal lands
- Wetlands (as defined by National Wetland Inventory).

Based on the conceptual nearshore design, a minimum length of approximately 2,100 feet of shoreline was used to eliminate small nearshore fragments. Shoreline areas that remained after these Tier 1 criteria were applied are depicted with a thick, dark line in Maps A-3 through A-7. Like the upland siting process, potential nearshore sites may best be identified during the site-specific MUDS studies as part of the stakeholder participation process. Potential sites available at existing port or municipal facilities, but excluded based on the photo analysis, could emerge during the site-specific siting process. In addition, potential nearshore and upland disposal sites identified as part of other sediment clean-up programs (Hylebos Waterway, Lockheed Shipyard, Southwest Harbor), port projects (East Waterway), and state-sponsored pilot studies (Bellingham Bay) could be included in the site-specific site screening process.

Aquatic Alternative

Water elevation data were compiled from several sources and compiled in ARC/INFO's GRID format. This coverage was processed and shaded to depict the following ranges in slope and water depth data:

- Aquatic areas with slope < 3% and from 3% to 6%
- Aquatic areas with water depths < 200 feet.

Potential Tier 1 aquatic sites in the vicinity of the five major urban embayments are shown in Maps A-3 through A-7. Isolated polygons meeting the slope restriction but consisting of less than 20 acres were eliminated. Similarly, contiguous polygons of less than 6-percent slope were eliminated if their combined area was less than 20 acres. Note that other potential aquatic sites exist in Puget Sound but are not shown at the scale of Maps A-3 through A-7. However, all potential aquatic sites will be carried forward to the site-specific phase of the siting process.

GIS AND PHOTO ANALYSIS METHODS

Database Dictionary and Design

A conceptual database dictionary and detailed database design were developed for the MUDs project in Microsoft Access. Source, scale, and accuracy of all data used in the development of preliminary sites were incorporated into this design. Target minimum source scale requirements for data were 1:100,000. The database design allows for simple addition and update of data as further sources of digital data become available in the site-specific site selection phase.

Exclusion Criteria

Contaminated Sediment Site Data

Ecology provided a contaminated sites data set in ArcView shape file format. Data were converted to an ARC/INFO coverage and plotted for review. Sites not included in this data set, but present in the Sediment Management Standards Contaminated Sediment Site List, were identified and added to the coverage if deemed necessary. Three sites, Mill E /Koppers (Everett), Mukilteo Air Force Tank Farm (Mukilteo), and the Harris Avenue Shipyard (Bellingham), were added to the figure based on discussions with Ecology (Gries 1997). The Corps (Cagney 1997) recommended including Eagle Harbor on the map because the removal action (completed in 1994) was considered interim. Finally, EPA's National Priority List was checked against the State's Contaminated Sediment Site List and one federal site was added. The U.S. Navy's Jackson Park site in Dyes Inlet was added to the map because, although the planned site remedial action is thin layer capping, construction is planned for the "distant future" according to EPA (Harney 1997).

Transportation Network

Transportation data were obtained from the U.S. Department of Commerce (Bureau of the Census), the Washington Department of Transportation, and DNR. Data from the U.S. Department of Commerce were selected for this study due to the detail and accuracy in line coding and the amount of roads included in the data set. Full documentation on the TIGER data set is included in digital format with the data. While data from the Washington Department of Transportation were determined to have a higher spatial accuracy, they did not include city and local routes. DNR data were found to be spatially incomplete.

Results of the general cost analysis indicated that the maximum distance for sediment transport by truck was 30 miles along an existing route to an upland site. Areas within a 30-mile radius of known contaminated sediment sites, and within one mile of an existing road, were identified using the ARC/INFO *buffer* and *clip* commands.

Orthophoto Interpretation

A map of exclusionary criteria was developed prior to the identification of potential nearshore and upland areas. Exclusionary criteria included wetlands, several types of land ownership, and slope.

Wetlands were obtained from the National Wetlands Inventory (NWI), available on-line from U.S. Fish and Wildlife and Ecology. These data show general, broad wetlands suitable for this initial screening process.

A major public lands (MPL) ownership data set was obtained from DNR. This data set contains ownership parcels for federal, state, county, city and tribal lands, derived from the 1:100,000 DNR Public Land Quads and Bureau of Land Management 1:100,000 Public Lands Quads. The MPL was created as a general analysis and planning data set, and is only as accurate as the source data. Areas of non-DNR ownership are only updated when data are made available to the DNR. The MPL data set was used to exclude parks, preserves, sanctuaries, refuges, municipal watersheds, recreation areas, and tribal lands from the potential upland and nearshore site list.

Potential upland sites were identified as non-developed areas greater than 50 acres in size, located adjacent to major roads or railways, did not have obvious land uses, and did not fall within the exclusionary criteria. Areas were identified on clear film overlays to orthophotos provided by the DNR, on a quarter-township basis. The identified polygons were scanned to develop a single coverage referenced to the Washington state plane (south zone) coordinate system.

Elevation

USGS digital elevation model (DEM) data are a digital representation of cartographic information in a linear array of pixels (raster form). DEMs consist of a sampled array of elevations for a number of ground positions at regularly spaced intervals. Data are available from the USGS at a variety of scales. Personnel at DNR assembled an elevation lattice from 7.5-minute quadrangles (30-meter spacing), supplementing data with smaller-scale data where the 7.5-minute data were not available.

A slope grid (percent) was generated from the elevation lattice data in ARC/INFO's Grid module. The resulting grid was reclassified into two categories, less than or equal to 6 percent, and greater than 6 percent. Areas with slopes greater than 6 percent were removed from consideration.

Bathymetry

Bathymetric data were compiled by the U.S. Army Corps of Engineers, Seattle District. NOAA National Ocean Service hydrographic survey data available for Puget Sound (approximately 1.3 million data points) was supplemented with USGS 1:24,000 line data and digitized NOAA navigation chart soundings. A slope grid (percent) was generated from the data, and classified into three categories: less than or equal to 3 percent, greater than 3 percent and less than or equal to 6 percent, and greater than 6 percent. The bathymetry grid was classified into two depth categories, greater than 200 feet, and less than or equal to 200 ft.

Elevation and Bathymetry

In order to place the bathymetry and upland elevation data into one grid, the upland elevation grid was resampled to a 100-ft grid cell (original grid cell was 104 ft). The shoreline coverage provided by DNR was used to eliminate overlapping areas. The two bathymetry grids were combined to create a grid with six distinct classes: 1) depth is greater than 200 ft and slope is less than or equal to 3%, 2) depth is greater than 200 ft and slope is greater than 3% and less than or equal to 6%, 3) depth is greater than 200 ft and slope is greater than 6%, 4) depth is less than or equal to 200 ft and slope is greater than 3% and less than or equal to 6%, 5) depth is less than or equal to 200 ft and slope is greater than 6%, and 6) depth is less than or equal to 200 ft and slope is less than or equal to 3%. This grid was merged with the upland slope grid to add two more classes: 7) upland slope is less than or equal to 6%, and 8) upland slope is greater than 6%.

Cartographic Products

Seven cartographic products (described above) were generated to illustrate the process of generating GAIs and potential upland, nearshore, and aquatic sites. All products included select 1:250,000 scale hydrologic features, major transportation routes, and political features including county boundaries and names, and international borders. Map products also included a location diagram, scale bar, north arrow, and legend. Products were generated at two scales: Maps A-1 and Map A-2 (1:1,000,000) and Maps A-3 through Map A-7 (1:200,000). To illustrate the position of contaminated sediments relative to the shoreline in Map A-1, insets were generated (scale of 1:200,000) covering each data cluster.

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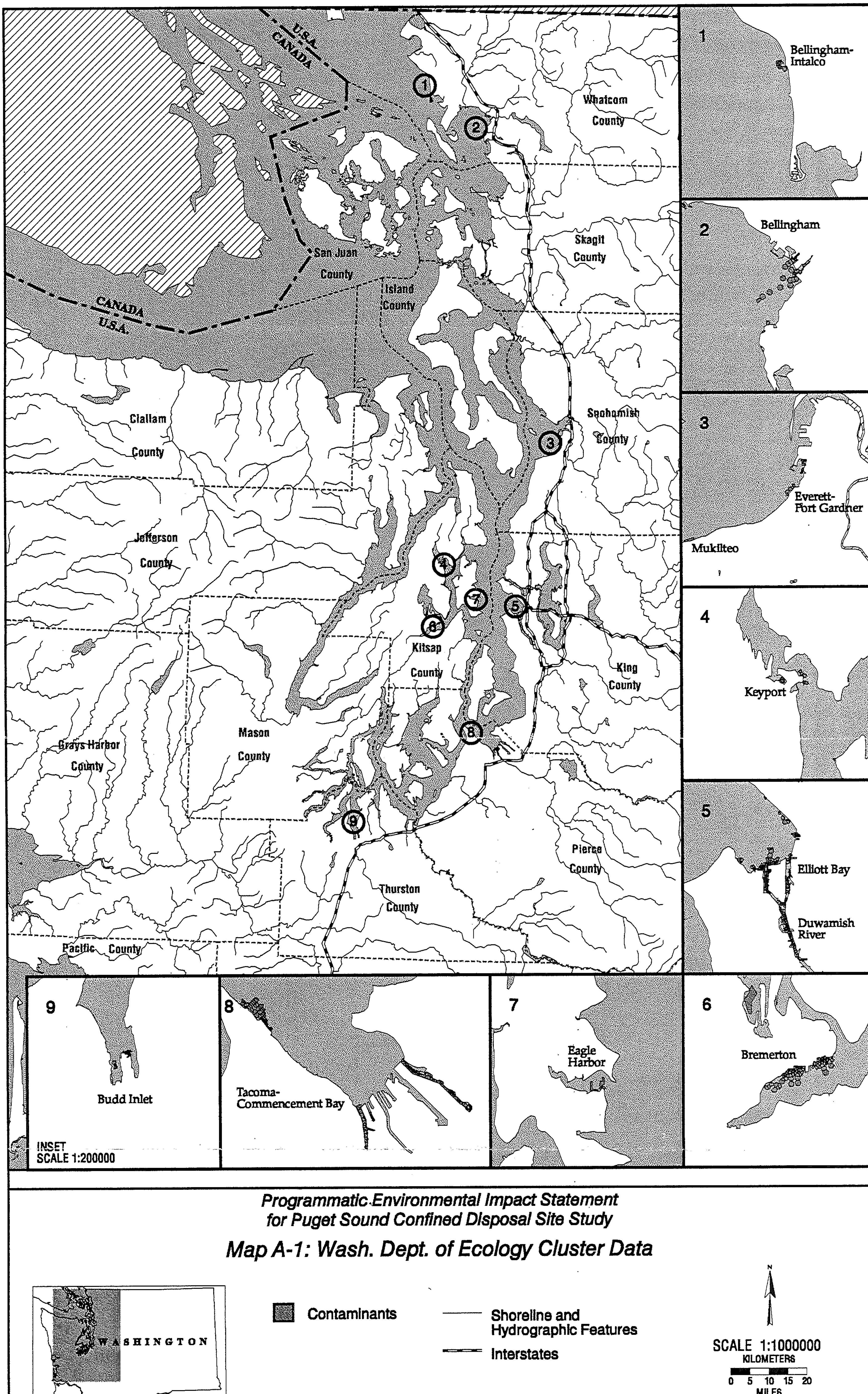
Washington State Department of Ecology (Ecology). 1996. Sediment Management Standards Contaminated Sediment Site List. Washington State Department of Ecology, Olympia, WA.

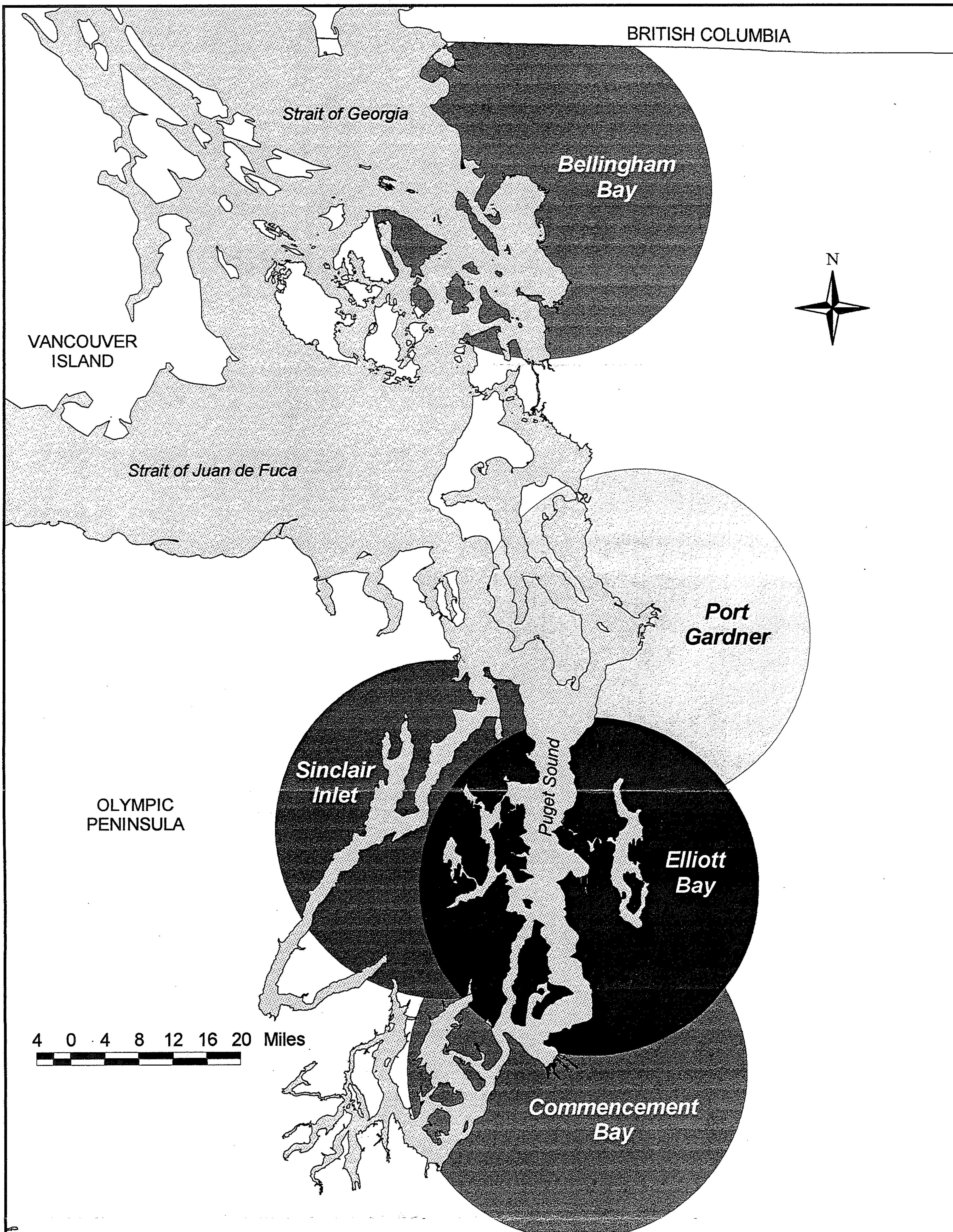


Programmatic Environmental Impact Statement for Puget Sound Confined Disposal Site Study

Map A-1: Wash. Dept. of Ecology Cluster Data

Striplin Environmental Associates

Map produced by Marshall & Associates, Inc.



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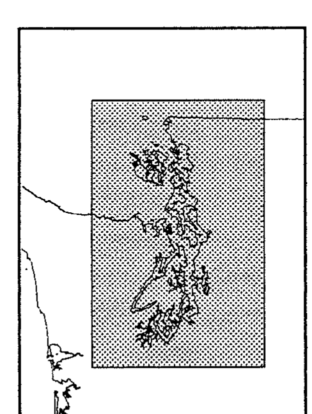
Programmatic Environmental Impact Statement

Map A-2: Geographic Areas of Interest for Preliminary Upland Siting Investigation

NOTE: The degree of shading is proportional to the maximum volume of contaminated sediment that may require dredging with confined disposal



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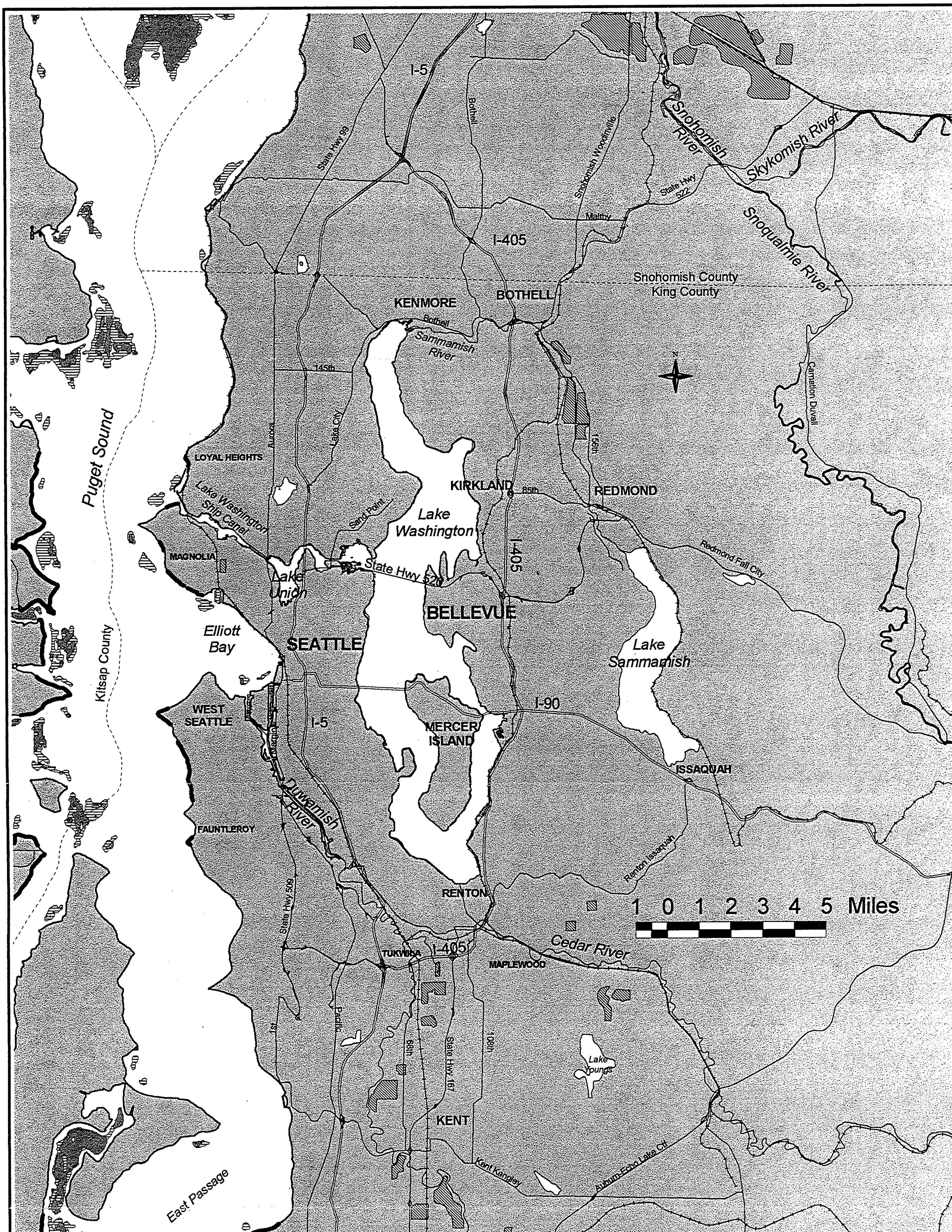

Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Map A-3: Preliminary Siting Investigation - Elliott Bay

- Water depth between 25 and 200 ft and bottom slope less than 3%
- Water depth between 25 and 200 ft and bottom slope 3-6%
- Upland area with no existing structures and slope less than 6%
- Undeveloped Shoreline
- Railroad
- Primary Road
- Interstate Highway

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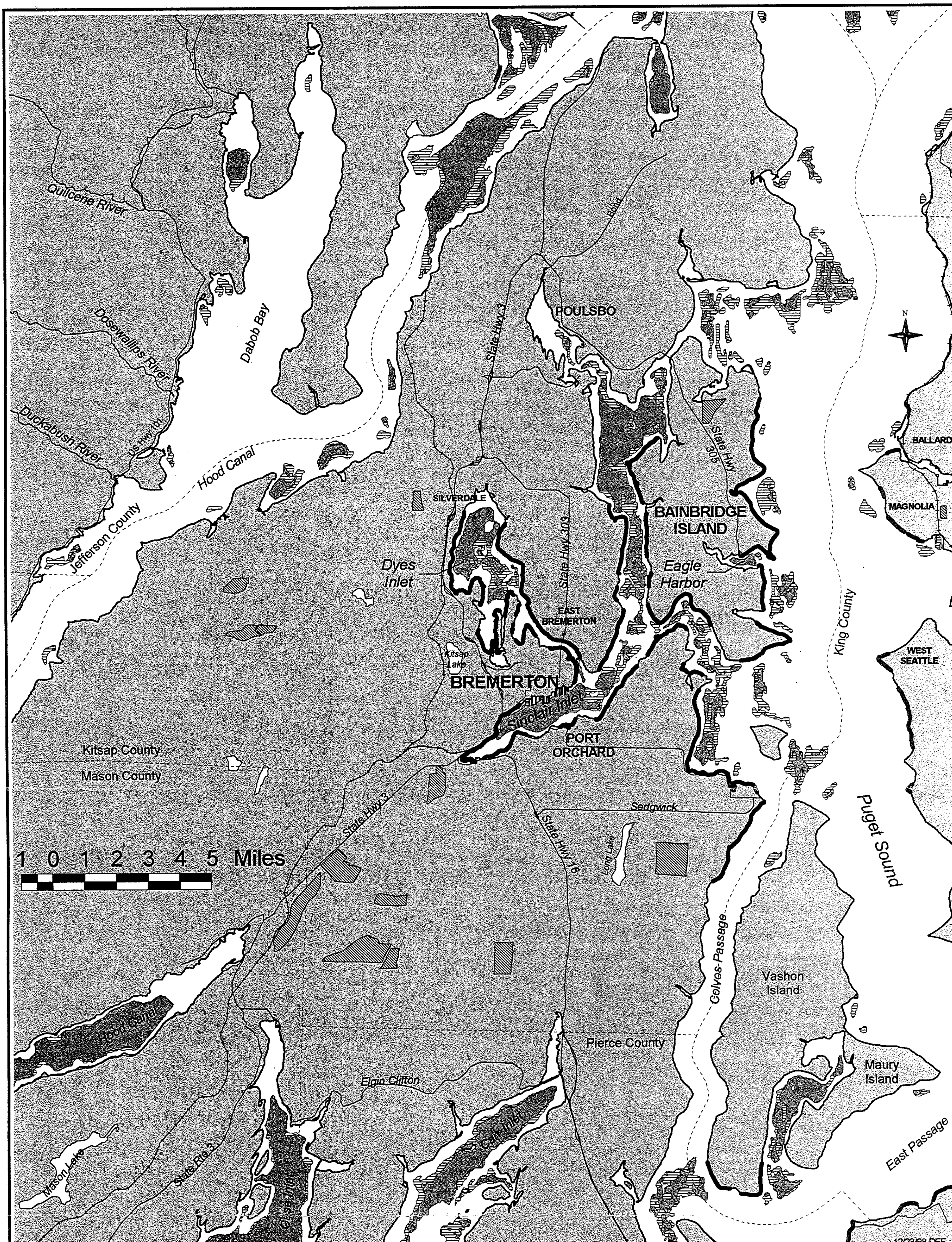

Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Map A-4: Preliminary Siting Investigation - Sinclair Inlet

- Water depth between 25 and 200 ft and bottom slope less than 3%
- Water depth between 25 and 200 ft and bottom slope 3-6%
- Upland area with no existing structures and slope less than 6%
- Undeveloped Shoreline
- Railroad
- Primary Road
- Interstate Highway

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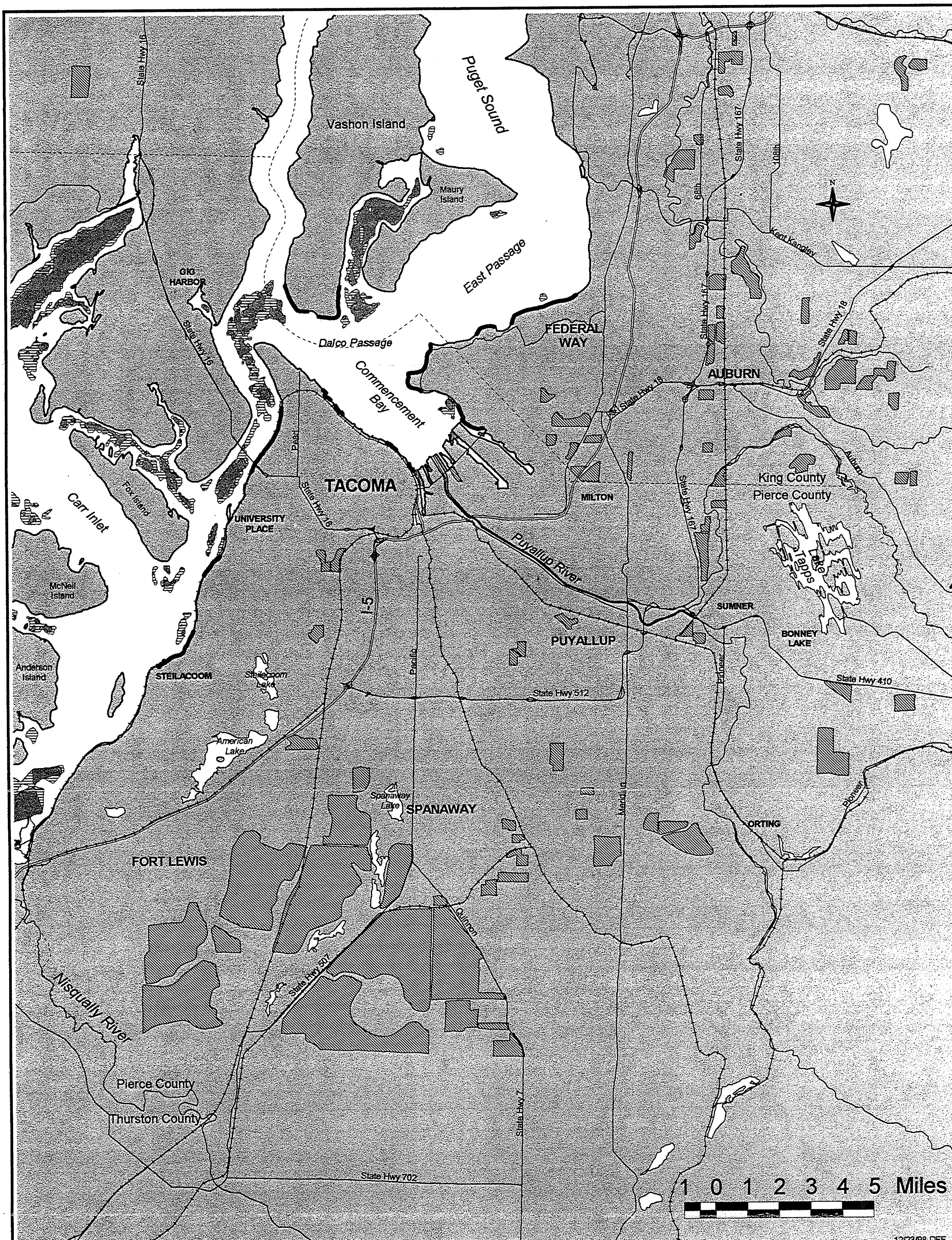

Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Map A-5: Preliminary Siting Investigation - Commencement Bay

- Water depth between 25 and 200 ft and bottom slope less than 3%
- Water depth between 25 and 200 ft and bottom slope 3-6%
- Upland area with no existing structures and slope less than 6%
- Undeveloped Shoreline
- Railroad
- Primary Road
- Interstate Highway

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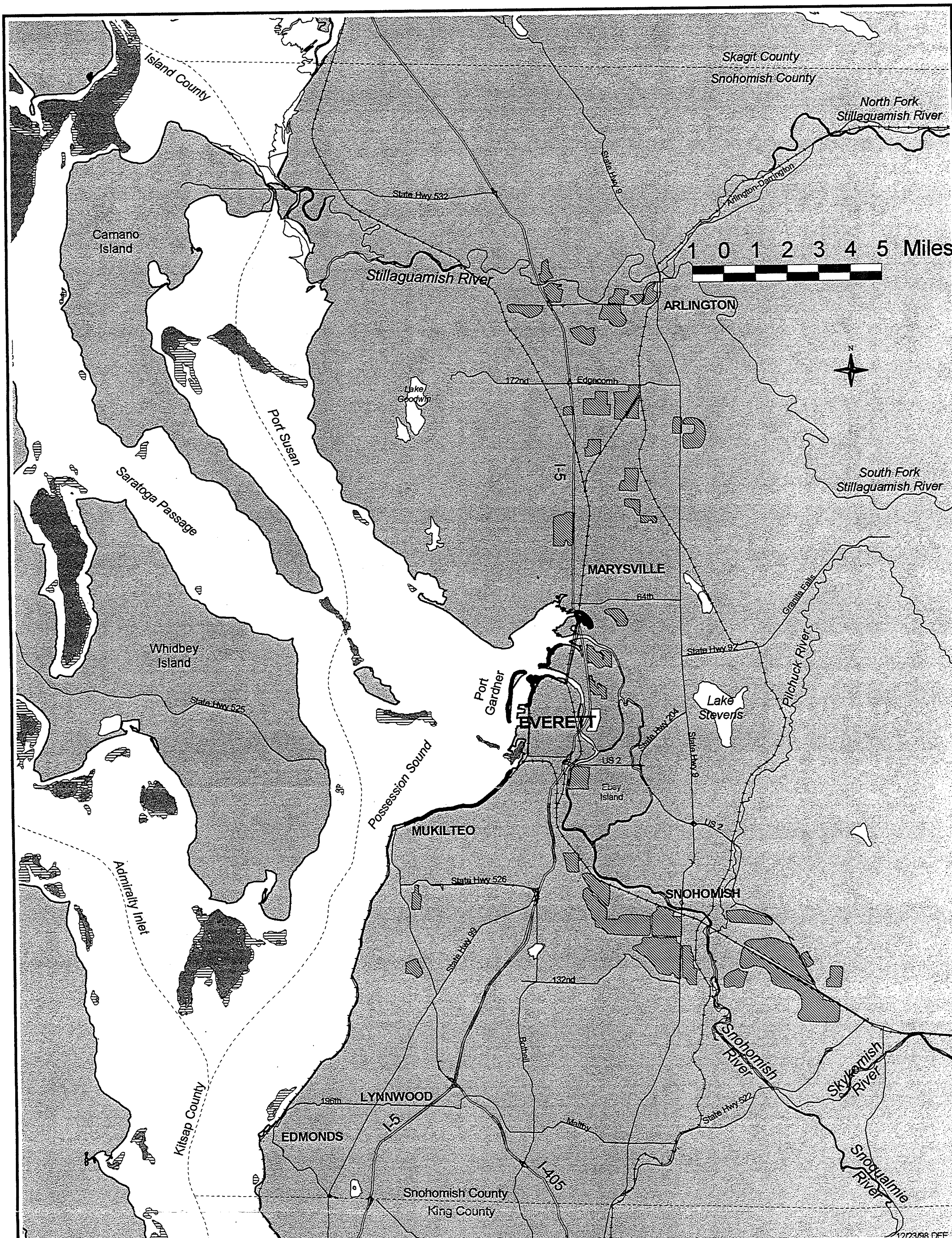
Striplin Environmental Associates



Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Map A-6: Preliminary Siting Investigation - Port Gardner

- Water depth between 25 and 200 ft and bottom slope less than 3%
- Water depth between 25 and 200 ft and bottom slope 3-6%
- Upland area with no existing structures and slope less than 6%
- Undeveloped Shoreline
- Railroad
- Primary Road
- Interstate Highway

U.S. Army Corps of Engineers

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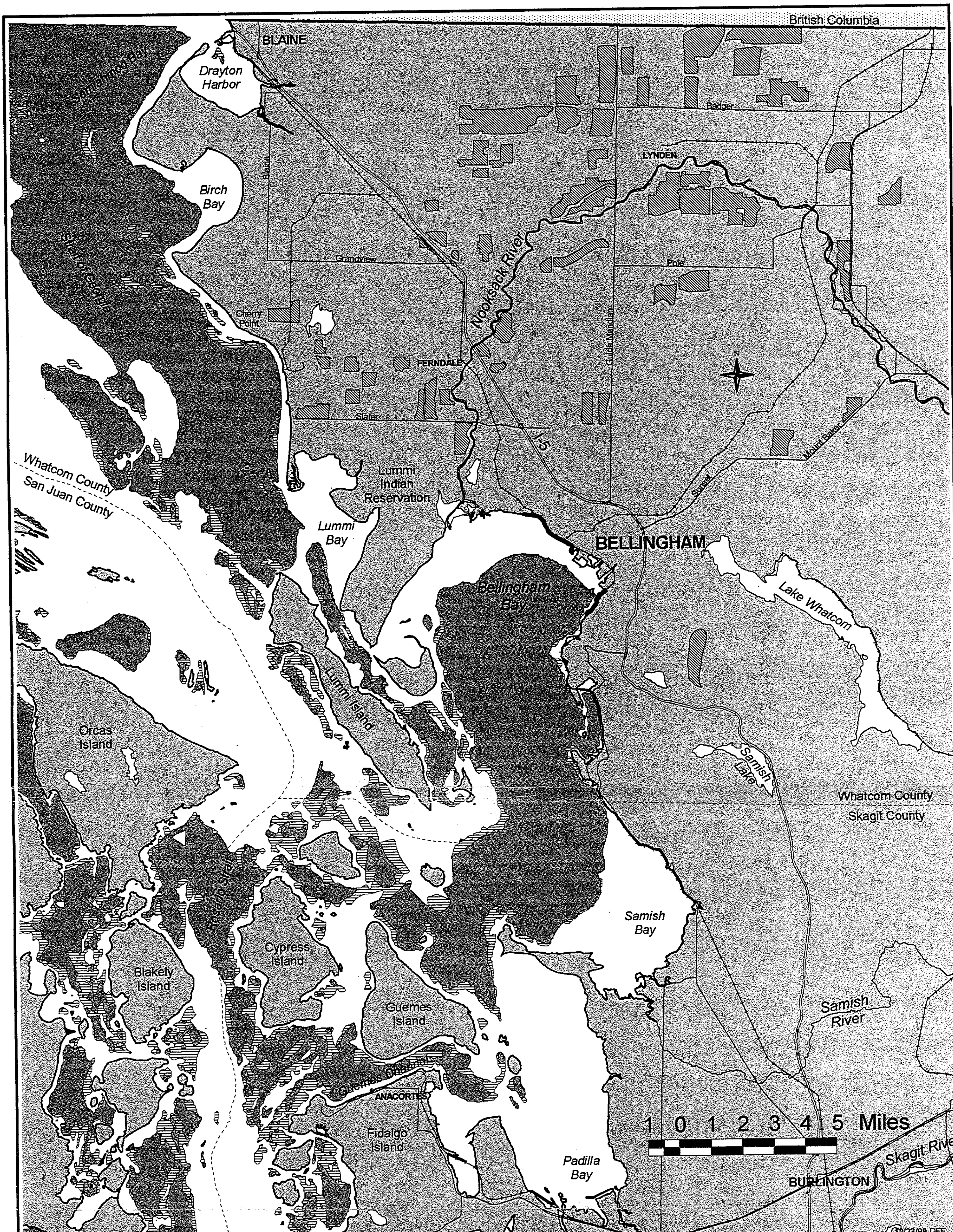
Striplin Environmental Associates



Puget Sound Confined Disposal Site Study
Programmatic Environmental Impact Statement

Map A-7: Preliminary Siting Investigation - Bellingham Bay

- Water depth between 25 and 200 ft and bottom slope less than 3%
- Water depth between 25 and 200 ft and bottom slope 3-6%
- Upland area with no existing structures and slope less than 6%
- Undeveloped Shoreline
- Railroad
- Primary Road
- Interstate Highway

U.S. Army Corps of Engineers

Marshall and Associates
Striplin Environmental Associates

APPENDIX B

SITING PROCESS AND CRITERIA

APPENDIX B - SITING PROCESS AND CRITERIA

RECOMMENDED MUDS SITING PROCESS

Based on review of siting models around the country and previous work on the Puget Sound Confined Disposal Site Study (PTI 1996), a recommended MUDS siting process is proposed in this section. This section begins with the identification of a set of principles intended to guide siting, then proceeds to describe a step-by-step recommended siting process that is based on a combination of siting models.

Guiding Principles For Siting

In developing this recommended siting process, several guiding principles have emerged. The most important of these principles are discussed below.

Establish A Hierarchical Tiered Siting Process

The process for identifying sites for disposal of contaminated sediments should move from the general to the specific in a tiered or phased fashion. This applies to a number of activities, including 1) forming a partnership for decision making, 2) narrowing from the region of interest to candidate sites, and 3) public involvement.

Initially, it may be appropriate to limit the number of partners in the development of a siting process to maximize the potential for reaching consensus on early decisions. However, the partnership should be expanded as necessary as regions, areas, and sites to be evaluated are identified. For example, once a region or area has been identified, local officials from the area and other major stakeholders should be invited to join the partnership.

The criteria for screening at each tier (regional, area, sites) should enable rapid decision making through the early phases of the evaluation with the more detailed evaluations focused on only a few, relatively small geographic areas or sites. Early in the process, those criteria that address relatively large areas should be used and should substantially reduce the land/water areas to be considered in subsequent steps. These criteria should be structured to use existing, readily available data early in the process, with onsite field studies being conducted only on a limited number of candidate sites.

Public involvement in the siting process should be tiered to accommodate the fact that the individuals concerned with the project will change as the project progresses. For example, while public involvement should be encouraged throughout the process, actual interest and the level of involvement will likely increase as the screening process progresses from regional to specific candidate sites. Opportunities for public involvement should be designed to accommodate these changes over the life of the project.

Incorporate Volunteer Participation

To enhance the potential for public acceptance of a disposal site, the siting process should include solicitation of volunteers. Such volunteers could be communities or other entities (e.g., Ports) that express interest in hosting or constructing a disposal facility. Once identified, volunteered sites would undergo the same technical evaluation as the sites identified through technical screening of selected regions and areas. Decision making on the preferred site should balance environmental considerations with social, economic, and policy needs.

Develop Criteria Specific to Disposal Environments

Different site suitability requirements will apply to each of the disposal environments (i.e., upland, nearshore, and confined aquatic disposal). A general set of siting criteria should be developed that apply to all three environments. For example, a screening criterion that would apply to all three disposal environments would be one that excludes from consideration all areas that are protected by federal or state law. In addition, three sets of siting criteria that are specific to each of the respective disposal environments must be developed. For example, depth to groundwater would be an important criterion in evaluating upland sites but would likely not need to be considered when evaluating confined aquatic disposal sites. Detailed siting criteria are provided in the "MUDS Site Selection" section of this Appendix.

Use Existing Data and Field Studies

The siting process should allow quick and efficient identification of a manageable number of regions of interest, candidate areas, potential sites, and candidate sites. The criteria applied at each step should maximize the use of existing information. Detailed and more expensive field studies to generate new data should be reserved primarily for candidate sites to verify data used in the screening process, develop site-specific data for site comparisons, prepare facility designs, and analyze environmental impacts.

Allow for the Discontinuation of Major Siting Paths at Selected Points

The Puget Sound Confined Disposal Site Study siting process should remain flexible in terms of the siting models used and the disposal environments considered. Initially, the siting process should include all three major siting approaches (partnership, technical screening, and volunteer) and sites in all three disposal environments should be sought. The process should allow any of the siting approaches to be discontinued or disposal environments removed from consideration if and when such changes are determined to be appropriate. For example, if the programmatic EIS finds that one disposal environment is significantly less desirable than the others, the portion of the siting process that seeks to identify sites in that disposal environment could simply not be exercised. In addition, if the screening process fails to identify suitable potential sites in one or more of the disposal environments, that portion of the siting process could be discontinued. Similarly, if no volunteer entities come forward, that portion of the siting process could be eliminated.

Allow for the Selection of Single or Multiple Sites (Combination of Alternatives)

The siting process should be structured to identify a list of potentially suitable candidate sites, leaving open the option of 1) selecting one preferred site, 2) identifying one site for the initial disposal location and reserving the others for future facilities, or 3) selecting more than one of the candidate sites (potentially including different alternatives) for initial facility development.

Include Early and Continuous Public Involvement

The siting process for a multiuser confined disposal facility should include a meaningful public involvement program. It should include a base of information on the Puget Sound Confined Disposal Site Study program and the siting process, and create convenient, meaningful opportunities for the public to participate in the process. The range of public ideas and values should be considered in making the decisions that will lead to selection of a disposal site. Public involvement in siting a multiuser disposal facility should begin early and be ongoing throughout the siting process.

Consider the Need for Independent Reviews

The partnership should consider whether it would be appropriate to provide for independent reviews of major portions and/or specific steps of the siting process to ensure the completeness, adequacy, and defensibility of the various activities and decisions. For example, a scientific advisory board could be convened to review the siting criteria and the field studies proposed for candidate sites. Similarly, the partnership could form a citizens' advisory committee made up of a cross section of members of the public (e.g., interest groups, civic organizations, local governments, business entities) to review the siting process, siting criteria, and the results of each major step of the siting process.

Each of these guiding principles has been incorporated into the proposed siting process. An overview of this process is presented in Figure B-1, which illustrates the steps that could be taken in implementing the siting process once the programmatic phase is complete. Each step in the process is described in the following sections.

Forming The Puget Sound Confined Disposal Site Study Siting Partnership

The foundation for a Puget Sound Confined Disposal Site Study siting partnership is already in existence and has been formalized through a cost-sharing agreement (Corps 1997). This partnership includes the entities represented in the Puget Sound Confined Disposal Site Study Interagency Management Committee, which is designing the multiuser confined disposal site program. This partnership worked together throughout the programmatic phase of the project leading to issuance of this programmatic EIS. Members of the partnership currently include:

- U.S. Army Corps of Engineers, Seattle District
- U.S. Environmental Protection Agency, Region 10
- Washington Department of Ecology

- Washington Department of Natural Resources
- Puget Sound Water Quality Action Team
- Washington Public Ports Association.

Following a decision to pursue a site-specific review in a geographic region of interest, the current partnership members will need to determine whether there are other stakeholders who play such a key role in the ultimate acceptability of the partnership's decisions that they should become members of the partnership. If so, the partnership will seek to add them. If volunteer communities come forward, one or more representatives of each volunteer community will be added to the partnership.

The partnership will make decisions at each step in the siting process and ultimately select the preferred site(s). Though extensive public involvement activities will occur throughout the process, it is important to retain decision-making authority and responsibility within the partnership. Thus, it will also be important to ensure that the members of the partnership maintain continuity and an active role throughout the process. This could be accomplished by requiring all partners to enter into the cost-sharing agreement. However, some potential partners who are critical to the decision-making process (e.g., volunteer communities) may be unwilling or unable to share costs. Therefore, some other measure of commitment to the partnership (e.g., memorandum of understanding, local government resolution, intergovernmental/interagency agreement) will be developed and implemented.

Solicitation Of Volunteer Entities

Single-User Facilities and Ongoing Baywide Efforts

The partnership may consider other sediment disposal activities or programs in Puget Sound to determine if these have adequate capacity and are amenable to inclusion as part of the Puget Sound Confined Disposal Site study, serving as multiuser site(s). The issues associated with this scenario (i.e., multiuser access to an independent confined disposal project) are presented as an alternative in the main body of this PEIS.

At this time (January 1999), there are a number of project-specific or baywide efforts underway to identify and evaluate disposal sites for contaminated sediments. These include efforts in Bellingham Bay and Commencement Bay as well as Port of Seattle work in Elliott Bay. In addition, a major project is underway to determine the disposition of contaminated sediments in Eagle Harbor. The Navy is also exploring alternatives for dealing with contaminated sediments from a CERCLA site at the Puget Sound Naval Shipyard in Bremerton and additional sediments that may be generated during navigational dredging to accommodate nuclear carriers at the Shipyard. There are numerous additional project-specific actions underway throughout Puget Sound that may also be considered.

Based upon a review of the status and potential capacity of these project-specific and baywide efforts, the partnership will identify those that have potentially viable sites. The partnership will contact the cognizant entity to explore interest in being considered for a Puget Sound Confined

Disposal Site Study site. This contact will include information on the Puget Sound Confined Disposal Site Study, the need for a multiuser facility, and the kinds of disposal facilities that are being considered. Given the relatively small number of entities to be contacted, it is anticipated that this will be initiated through personal contact rather than by letter. Where interest is expressed, a follow-up meeting or series of meetings will be conducted to share information on the Puget Sound Confined Disposal Site Study to determine the potential viability of the other project-specific or baywide disposal site(s). These meetings will provide an opportunity to discuss potential incentives to make the project-specific or baywide site available to multiple users, recognizing that the incentives may vary from one project to another.

Volunteer Communities

The partnership will also solicit expressions of interest from potential volunteer communities by releasing information on the need for a multiuser disposal facility, the general characteristics of contaminated sediments and how these compare to solid and hazardous wastes, the siting process, the kind of disposal facility that might be constructed, potential risks associated with the facility and measures that will be taken to protect public health and safety, and incentives and potential benefits to the sponsor community. Benefits may include creation of habitat to support Natural Resource Damage Assessment settlements, creation of new and developable shoreline, or redevelopment and revitalization options. The solicitation will also include an offer to meet with representatives of interested communities to discuss the project and share additional information to assist their decision on whether or not to respond.

To enhance the potential for identifying suitable sites within volunteer communities, the solicitation will also include minimum requirements (e.g., minimum site size, proximity to sediment locations or to transportation routes) that a site must meet. This will enable a potential volunteer community to assess the likelihood that it has suitable sites so it can begin to gather some of the data needed to identify those candidate sites.

Volunteer communities will be required to provide formal documentation from elected officials (e.g., county commission, city council) that they represent the interests of their community. Individual landowners offering a specific site, or third parties that suggest a particular location, will be asked to obtain the formal endorsement of elected officials of the community.

MUDS SITE SELECTION

MUDS site selection will consist of three major tiers (see Figure B-1). The elements of each Tier are described below.

Tier 1, the identification of Puget Sound Confined Disposal Site Geographic Areas of Interest (GAIs) was completed as part of this programmatic study. GAIs are locations where substantial volumes of contaminated sediments exist and therefore might benefit from a MUDS facility. As part of Tier 1, a preliminary screen of aquatic, nearshore, and upland portions of each GAI was conducted based on existing physical characteristics (e.g., bathymetry and slopes), and current

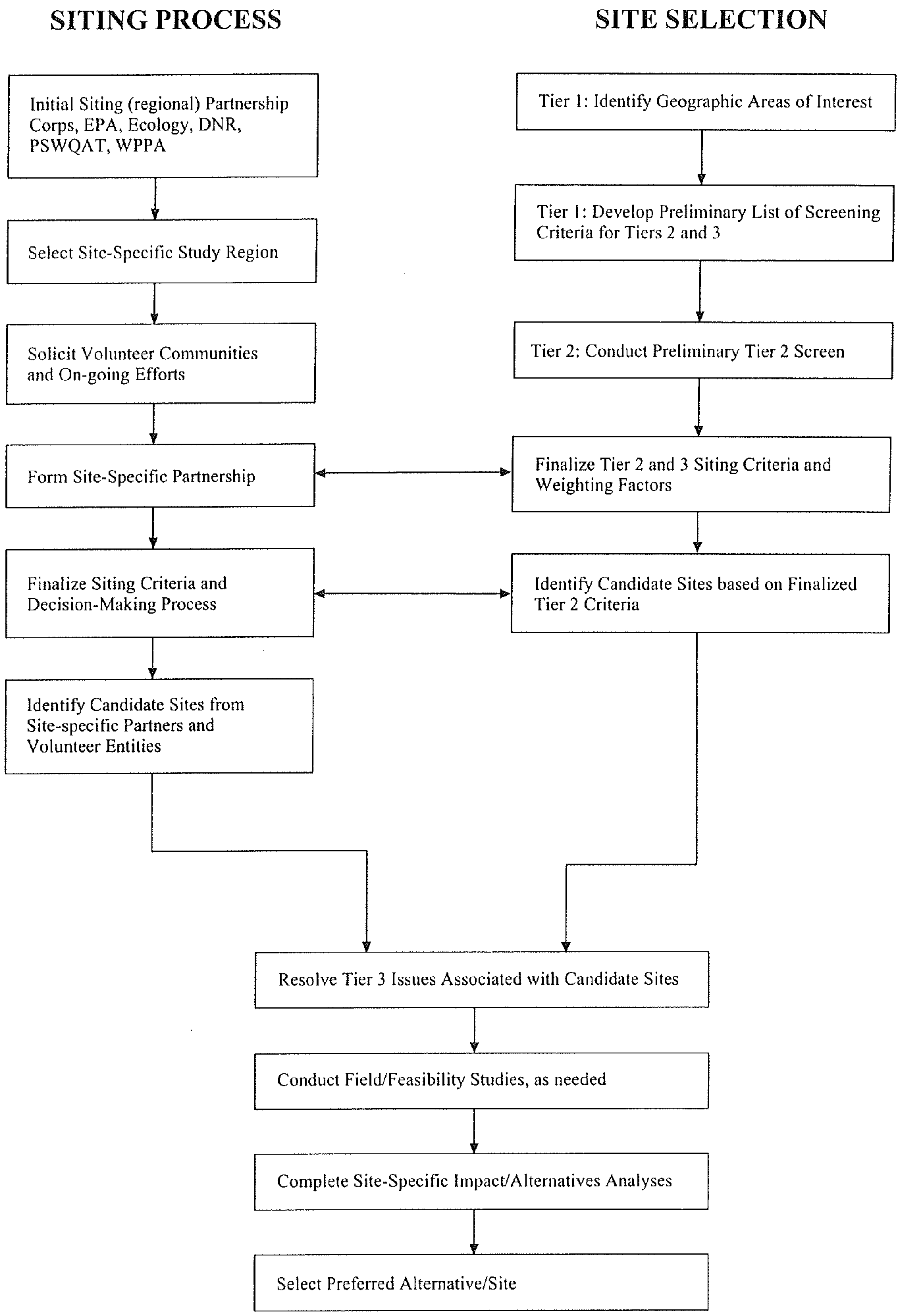


Figure B-1 Siting Process and Selection Tiers	MUDS Draft PEIS February 1999 MPEIS Figure B-01.xar

land uses (e.g., abandoned or undeveloped areas). The results of this Tier 1 screen (presented in Appendix A) defined locations where aquatic, nearshore, and upland disposal sites could feasibly be placed based on the broad siting criteria listed below:

- Proximity to contaminated sediment sources and transportation infrastructure
- Lack of obvious land use conflicts (e.g., excluded designated parks and wetlands)
- Capacity (minimum size)
- Maximum water depth (for aquatic sites)
- Topography (grade) restrictions (for upland and aquatic sites)
- Transport distance (based on a $50/cy transport and disposal total cost allowance).

Additional details on this initial GAI screening process are provided in Appendix A. It should be noted that this Tier 1 screen of GAIs does not 1) necessarily exclude all areas not meeting the listed criteria or 2) automatically include all areas captured for further consideration as a possible MUDS. Instead, the Tier 1 screen was conducted to illustrate the general availability of upland, nearshore, and aquatic areas in a given GAI that meet the broad environmental and land use criteria listed above.

Tier 2 of the Puget Sound Confined Disposal Site selection process will consist of the application of additional criteria to the GAI(s). Tier 2 is to be conducted by an interagency Puget Sound Confined Disposal Site GIS work group. Tier 2 screening criteria consist of environmental data that are available as existing GIS layers and do not require gathering of detailed site-specific information. The specific data layers to be applied in Tier 2 will be tailored to the three potential disposal environments (aquatic, nearshore, and upland). Tables B-1 through B-3 provide preliminary lists of Tier 2 siting criteria for each environmental setting.

As indicated in Tables B-1 through B-3, for non-exclusionary Tier 2 criteria, individual potential sites will be ranked according to their environmental suitability for each criterion, and a composite score will be generated for each site. There are four major siting categories that contribute to the total Tier 2 score (maximum of 100 points): 1) Containment and Stability; 2) Wildlife and Natural Resources; 3) Land, Water, and Cultural Uses; and 4) Legal, Regulatory, Policy Requirements. Each category is weighted equally at 25% of the total (25 points) regardless of the number of rated criteria within each category. The Tier 2 lists of screening criteria will be finalized and applied prior to the initiation of site-specific studies to provide a preliminary ranked list of sites in each environment for each GAI.

Tier 3 of the siting process will be a consensus building effort that will be accomplished by the site-specific Puget Sound Confined Disposal Site partnership members (the partnership will be formed at the initiation of any site-specific study). The criteria reserved for Tier 3 include site selection issues that are not directly quantifiable and/or that may require negotiation and consensus building (e.g. mitigation needs, beneficial use opportunities). Examples of Tier 3 criteria are included in Tables B-1 through B-3. Additional criteria or guidance needs will be identified through consensus of the regional siting board. Tier 3 of the siting process will afford the opportunity for a Puget Sound Confined Disposal Site partner or other entity to volunteer a

Table B-1. LBC or CAD Alternative - MUDS Siting Criteria, Tiers, and Site Ranking Approach.

	Programmatic	Site-Specific		
	Tier 1 GAIs	**Tier 2 Technical Ranking**	**Max. Score**	**Tier 3 Consensus Process**
Containment and Stability Factors				
High Seismic Hazard Areas (major fault zones)		Exclusionary		
Slope (> 6%)	Exclusionary			
Site Elevations		Natural depressions = 10; > 3% slope = 0	10	
Near-bottom currents > 50 cm/sec		Exclusionary		
Currents 50 cm/sec or less		< 5 cm/sec = 7; 50cm/sec = 0	7	
Depth (>300')	Exclusionary			
Depths < 300'		< 100' = 8; > 200' = 0	8	
Wildlife and Natural Resources				
Designated Parks, Preserves, Sanctuaries, or Refuges	Exclusionary			
Threatened and Endangered Species (TES) Critical Habitat		Exclusionary		
Proximity to TES Critical Habitat		> 1 mile = 7; < 0.25 mile = 0	7	
Priority Habitat and Species		Exclusionary		
Proximity to Priority Habitat and Species		> 1 mile = 6; < 0.25 mile = 0	6	
Proximity to Special Aquatic Sites		> 1 mile = 6; < 0.25 mile = 0	6	
Fisheries Nursery Areas, Migration Routes, Feeding Grounds		> 1 mile = 6; < 0.25 mile = 0	6	
Habitat Mitigation Need				√
Land, Water, and Cultural Uses				
Major Shipping Lanes and Anchorages		Exclusionary		
Significant Archaeological or Cultural Sites		Exclusionary		
Public Utilities/Utility lines		Exclusionary		
Shellfish Harvest Areas		Exclusionary		
Proximity to Shellfish Harvest Areas		> 1 mile = 9; < 0.25 mile = 0	9	
Proximity to Recreational Uses		> 1 mile = 5; < 0.25 mile = 0	5	
Proximity to Commercial/Recreational Fisheries		> 1 mile = 5; < 0.25 mile = 0	5	
Proximity to Tribal Fisheries		> 1 mile = 6; < 0.25 mile = 0	6	
Aesthetic Impacts (visual, noise)				√
Legal, Regulatory, and Policy Requirements				
Ability to Meet Existing Regulations and Standards				√
Compatibility with Existing Zoning Requirements		Compatible with all = 8; major inconsistencies = 0	8	
Compatibility with Existing Shoreline Management Requirements		Compatible with all = 8; major inconsistencies = 0	8	
Federal Navigation Channels and State Harbor Areas		Outside these areas = 9; inside FC or HA = 0	9	
Design Considerations				
Less than 500,000-cy capacity	Exclusionary			
Public Acceptance				
Community Support				√
Economic Factors				
Construction Costs				√
Life-cycle Monitoring, Management, and Mitigation Costs				√
Sediment Handling and Placement Costs				√
Proximity to Capping Material				√
Beneficial Use Opportunties				
Existing Site Cleanup				√
Habitat Restoration/Creation				√
		Total Maximum Score	**100**	

Table B-2. NEARSHORE CDF Alternative - MUDS Siting Criteria, Tiers, and Site Ranking Approach.

	Programmatic	Site-Specific		
	Tier 1 GAIs	**Tier 2 Technical Ranking**	**Max. Score**	**Tier 3 Consensus Process**
Containment and Stability Factors				
High Seismic Hazard Areas (major fault zones, liquefaction areas)		Exclusionary		
Foundation Unstable (unable to support containment berm)		Exclusionary		
Topography		Topog. advantageous = 10; impediment = 0	10	
Wave and Current Climate		Low energy = 8; High energy = 0	8	
Precipitation		< 35"/year = 7; >55"/year = 0	7	
Wildlife and Natural Resources				
Designated Parks, Preserves, Sanctuaries, or Refuges	Exclusionary			
Threatened and Endangered Species (TES) Critical Habitat		Exclusionary		
Proximity to TES Critical Habitat		> 1 mile = 7; < 0.25 mile = 0	7	
Priority Habitat and Species		Exclusionary		
Proximity to Priority Habitat and Species		> 1 mile = 6; < 0.25 mile = 0	6	
Proximity to Special Aquatic Sites		> 1 mile = 6; < 0.25 mile = 0	6	
Fisheries Nursery Areas, Migration Routes, Feeding Grounds		> 1 mile = 6; < 0.25 mile = 0	6	
Habitat Mitigation Need				√
Land, Water, and Cultural Uses				
Developed, existing human use areas	Exclusionary*			* Unless Identified by Partnership
Significant Archaeological or Cultural Sites		Exclusionary		
Public Utilities/Utility Line Corridors		Exclusionary		
Shellfish Harvest Areas		Exclusionary		
Proximity to Shellfish Harvest Areas		> 1 mile = 9; < 0.25 mile = 0	9	
Proximity to Residential/Recreational Uses		> 1 mile = 5; < 0.25 mile = 0	5	
Proximity to Commercial/Recreational Fisheries		> 1 mile = 5; < 0.25 mile = 0	5	
Proximity to Tribal Fisheries		> 1 mile = 6; < 0.25 mile = 0	6	
Transport Route Impacts				√
Aesthetic Impacts (visual, noise)				√
Design Considerations				
Less than 500,000-cy capacity	Exclusionary			
Regulatory Requirements				
Ability to Meet Existing Regulation and Standards				√
Compatibility with Existing Zoning Requirements		Compatible = 8; major inconsistencies = 0	8	
Compatibility with Existing Shoreline Management Program		Compatible = 8; major inconsistencies = 0	8	
Federal Navigation Channels and State Harbor Areas		Outside these areas = 9; inside FC or HA = 0	9	
Public Acceptance				
Private-Sector Owner(s) Unwilling to Sell Land or Allow MUDS				Exclusionary
Community Support				√
Economic Considerations				
Construction Costs				√
Life-cycle Monitoring, Management, and Mitigation Costs				√
Sediment Rehandling and Placement Costs				√
Beneficial Use Opportunities				
Property Development/Site Reuse				√
Existing Site Cleanup				√
Habitat Restoration/Creation				√
Public Access/Recreation				√
		Total Maximum Score - Tier 2	**100**	

Table B-3. UPLAND CDF Alternative - MUDS Siting Criteria, Tiers, and Site Ranking Approach.

	Programmatic	Site-Specific		
	Tier 1 GAIs	**Tier 2 Technical Ranking**	**Max. Score**	**Tier 3**
Containment and Stability Factors				
High Seismic Hazard Areas (major fault zones, liquefaction areas)		Exclusionary		
Topography (> 6% slope)		Exclusionary		
Topography (< 6% slope)		Topog. advantageous = 10; impediment = 0	10	
100-year Floodplains		Exclusionary		
Sole-source Aquifers, Groundwater < 10' deep, surf. drinking water within 0.25 miles		Exclusionary		
500-year Floodplains		not in 500-year Floodplain = 5; in 500 yr FP = 0	5	
Proximity to Surface Drinking Water Supply		> 5 miles = 5; < 1 mile = 0	5	
Soil Permeability and Thickness				√
Precipitation		< 35"/year = 5; >55"/year = 0	5	
Wildlife and Natural Resources				
Designated Parks, Preserves, Sanctuaries, or Refuges	Exclusionary			
Wetlands	Exclusionary			
Threatened and Endangered Species (TES) Critical Habitat		Exclusionary		
Priority Habitat and Species		Exclusionary		
Natural Hertitage Program Areas		Exclusionary		
Proximity to TES Critical Habitat		> 1 mile = 9; < 0.25 mile = 0	9	
Proximity to Priority Habitat and Species		> 1 mile = 8; < 0.25 mile = 0	8	
Proximity to Natural Heritage Program Areas		> 1 mile = 8; < 0.25 mile = 0	8	
Habitat Mitigation Need				√
Land, Water, and Cultural Uses				
Developed, Existing Human Use Areas	Exclusionary*			* Unless identified by Partnership
Significant Archaeological or Cultural Sites		Exclusionary		
Public Utilities/Utility Line Corridors		Exclusionary		
Not Accessed by Existing Roads/rail	Exclusionary			
Proximity to Residential/Recreational Uses		> 1 mile = 25; < 0.25 mile = 0	25	
Transport Route Impacts				√
Aesthetic Impacts (visual, noise)				√
Regulatory Requirements				
Ability to Meet Existing Regulation and Standards				√
Compatibility with Existing Zoning Requirements		Compatible = 15; major inconsistencies = 0	15	
Compatibility with Existing Shoreline Management Program		Compatible = 10; major inconsistencies = 0	10	
Design Considerations				
Less than 500,000-cy Capacity	Exclusionary			
Proximty to PTOW or Other Wastewater Treatment Plant				√
Public Acceptance				
Private-Sector Owner(s) Unwilling to Sell Land or Allow MUDS				Exclusionary
Community Support				√
Economic Considerations				
Construction Costs				√
Life-cycle Monitoring, Management, and Mitigation Costs				√
Sediment Rehandling and Placement Costs				√
Beneficial Use Opportunities				
Property Development/Site Reuse				√
Existing Site Cleanup				√
Habitat Restoration/Creation				√
Public Access/Recreation		**Total Maximum Score - Tier 2**	**100**	√

potential site that meets the basic technical requirements as defined in siting Tiers 1 and 2 (see "Solicitation of Volunteer Entities" in this appendix).

In addition, the site-specific Puget Sound Confined Disposal Site partnership may choose to revisit the Tier 2 criteria and ranking scheme to reflect the relative importance of each siting criterion to the local partnership members. A site-specific list of siting criteria, weighting factors or other measures of relative importance, and the decision methodology to be used by the partnership will be documented in a publicly available Puget Sound Confined Disposal Siting Plan for that GAI. A draft of the siting plan will be issued for public review and comment. At least one public meeting, open house, or workshop will be held to obtain public input on the siting plan to enhance the ultimate acceptability. Once public comments are addressed, the siting plan will be finalized and made available to the public. Any significant changes that need to be made during plan implementation will be formally adopted and publicized by the partnership. The site-specific siting plan will be included in the Puget Sound Confined Disposal Site Study NEPA/SEPA documentation.

REFERENCES

PTI. 1996. *Multiuser Confined Disposal Site Program - Recommended Siting Process.* Prepared for Washington Department of Ecology. PTI Environmental Services and Enviroissues, Inc. Bellevue, WA.

U.S. Army Corps of Engineers. 1997. Puget Sound Confined Disposal Project Study Plan, Appendix A: Feasibility Cost-Sharing Agreement. U.S. Army Corps of Engineers, Seattle District.

APPENDIX C

CONCEPTUAL PLANS AND COST ESTIMATES FOR UPLAND, AQUATIC AND NEARSHORE OPTIONS

Costs contained in this appendix are for engineering design and construction only and do not reflect total project costs. Other costs associated with confined disposal facility development (e.g., land acquisition, mitigation, monitoring) are discussed in Section 2 of the PEIS.

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Puget Sound Confined Disposal Site Study: Conceptual Plans and Cost Estimates For Upland, Aquatic, and Nearshore Options

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October 7, 1998

Table of Contents

Tables

Figures

1.0 Introduction

Conceptual plans and estimated costs for upland, aquatic and nearshore confined disposal facilities are presented in this document. The conceptual designs proposed by Palermo, et. al., Waterways Experiment Station (WES), 1998, "Multiuser Disposal Sites (MUDS) for Contaminated Sediments from Puget Sound - Subaqueous Capping and Confined Disposal Alternatives" were used as a basis for the conceptual plans and estimated costs developed in this study. In some cases additional assumptions and/or modifications to those presented in the WES document were made in this study. The concepts presented in the WES document and below are not site specific beyond their proposed location somewhere within the Puget Sound Area. Where possible, physical parameters generally applicable to the Puget Sound Area were used to develop the conceptual plans and estimated costs for this study. This document is organized into three main components corresponding to the upland, aquatic, and nearshore options in Sections 2.0, 3.0, and 4.0, respectively.

2.0 Upland Confined Disposal Concept

This section is presented in three parts corresponding to the Upland Rehandling Site Concept (2.1), the Upland Long-Term Disposal Concept (2.2), and the Operations Costs for Upland Confined Disposal Concept.

2.1 Upland Rehandling Site Concept

Project Summary

A waterfront offload dewatering facility is proposed. The facility would provide holding capacity to dewater dredged material prior to transfer by truck or rail to a long-term upland disposal site elsewhere. The concept consists of a barge dock; dockside clamshell unloading to a feed-hopper; and short conveyor delivery to an upland array of concrete block dewatering cells within a paved and drained work area. Sediment drainage water and rainfall runoff will be collected from the barges, dewatering cells and paved service area, and then treated and discharged. Alternative layouts are developed for handling assumed throughput rates for the following MUDS capacities: 1) a 500,000 cyd disposal need over 10 years, or 50,000 cyds/year; and 2) a 2,000,000 cyd disposal need over 10 years, or 200,000 cyds/year. Nominal cell size of 80 ft. X 200 ft. would each hold about 3500 cyds, while a smaller 75 ft. X 150 ft. cell would hold about 2500 cyds. The aggregate multi-cell capacity is sized to provide a target holding/dewatering time for dredged materials of 4 to 5 days prior to re-handling and transfer to the final upland disposal site. Schematic plan and cross-section of the conceptual layouts are shown on the attached Figures 1 and 2.

Site Description

It is assumed that an industrial waterfront site with navigation depths of at least -15 ft., MLLW, is available with convenient access to upland truck and/or rail transportation. Although some flexibility is possible for site layout, the overall site will be 300 ft. to 400 ft. wide along the waterway and 400 ft. to 600 ft. in length perpendicular to the waterway, depending partly on assumed throughput capacity and rate, i.e., 500,000/2,000,000 cyds.

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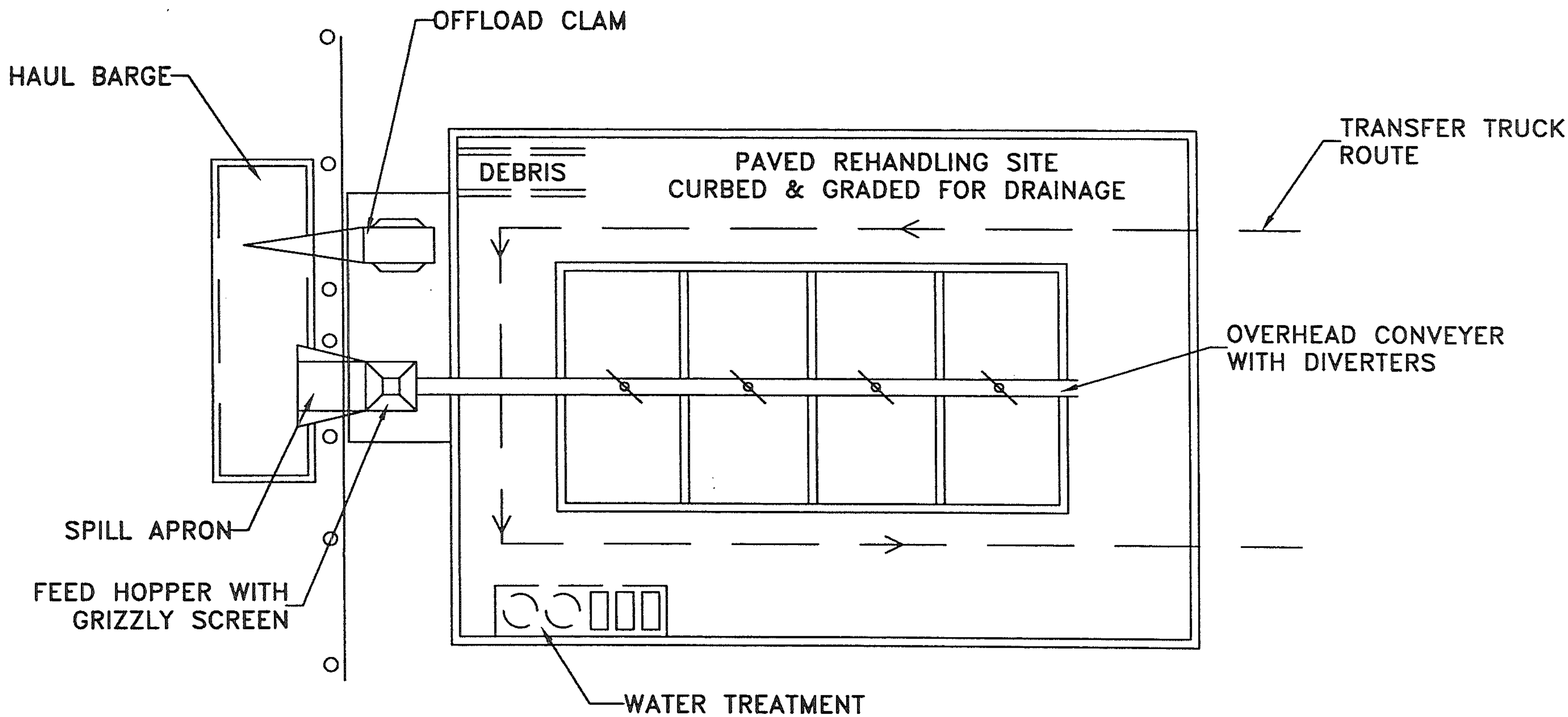

Figure 1. Schematic Plan View of the Upland Rehandling/Dewatering Site

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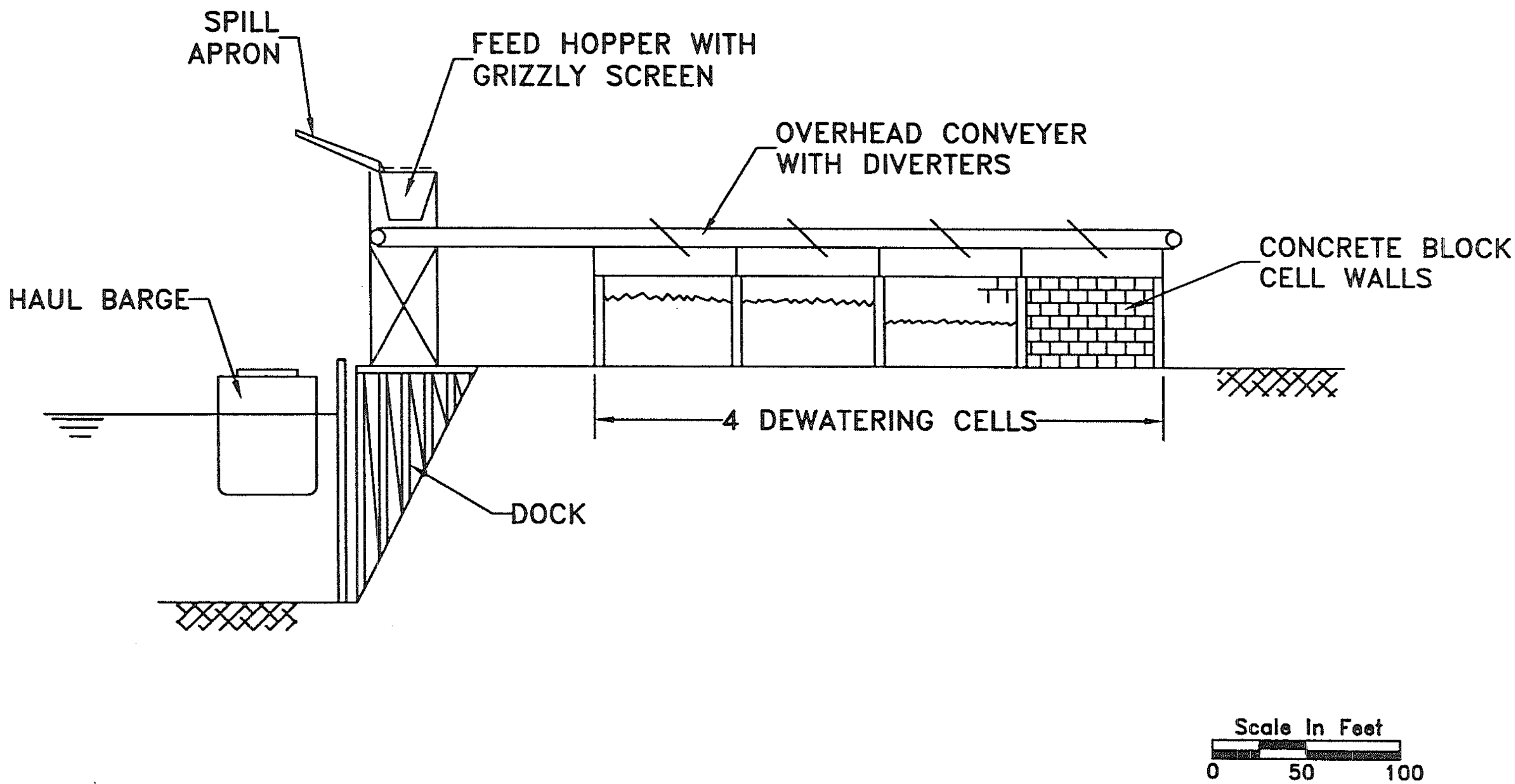

Figure 2. Schematic Cross Section of the Upland Rehandling/Dewatering Site

Most of the re-handling site would be paved and curbed to provide both a durable long-term work surface as well as positive drainage collection and containment.

This concept includes a new 70 ft. x 120 ft. waterfront dock for placement and operation of the off-load clamshell and conveyor feed hopper.

CDF Dewatering Area

This concept plan does not closely follow that provided by WES. The WES concept included two 15,000 cyd unlined dewatering cells enclosed by dikes built on 3H:1V slopes from on-site soils. The WES dike option would enable hydraulic offloading with sedimentation and decanting of return flow. Dredged material would dewater by gravity drainage over time and then be re-handled and transported from the filled cell to the final upland disposal site. It is possible that repeated placement and removal of dredged materials over the long-term could damage the cell bottoms and dikes.

However, the approach selected for this MUDS concept development is to rehandle and dewater clamshelled dredged material without adding slurry water for hydraulic pumping. This should improve and shorten the dewatering process, reduce the site area, and avoid management and treatment of large hydraulic flows. The resulting concept plan is for a small number of adjacent cells, each capable of holding one or two barge loads of dredged material. The overall combined capacity would be sufficient to provide for holding times resulting in acceptable dewatering at the assumed through-put (disposal) rate.

<u>Dewatering/Holding Time</u>

For this concept development, it is assumed that dredged material must be dewatered to meet the EPA Paint Filter test requirement before it can be transferred to landfill disposal, i.e., no-free-water seepage within 5 minutes testing. Dredged material in Puget Sound is expected to range from well-draining sands/gravels to slow-draining soupy muds. There is no reliable technical basis for efficiently sizing the re-handling facility holding capacity to assure dewatering to the 'no-free-water' requirement for the wide variety of dredged materials. Rather, it is assumed that up to 4 days holding time will adequately dewater most Puget Sound dredged materials to allow re-handling and transport to a final upland CDF. This rough assumption is based on consideration of the following experience factors:

- Local construction experience with fine-grained dredged material has shown that most dewatering occurs by simple consolidation within the first day or two of sitting on the barge or in an upland cell, and that this has met the no-free-water requirement for landfilling. (Port of Seattle Pier 90, US Navy Pier D).
- Dredged material that does not dewater to acceptable conditions within the first few days likely will still be unacceptable even after a longer period unless steps are taken to aid in dewatering. These steps could include addition and mechanical mixing of desiccants such as lime, sawdust, fly ash, drier dredged material, etc., to remove residual free water.
- Fine-grained dredged material tends to 'wick' (hold) water, even in a somewhat soupy condition, although it may still meet the no-free-water requirement (COE, Bellingham).

- Rainfall collects mainly on the surface of the deposited dredged material, but does not generally penetrate the dredged material mass. Although this makes for difficult (slick) working conditions during heavy rains, it does not much affect the overall water content of the dredged material.

There may be some few projects in Puget Sound where dredged material cannot be readily dewatered by the MUDS facility and therefore will require an independent dredging/disposal program-- as is presently required for all projects.

Holding Capacity

Given the target holding/dewatering time of 4 days (see above), the overall rehandling facility capacity is sized to accommodate the expected daily loading (through-put) rate. The average disposal rates are 50,000 cyds/year and 200,000 cyds/year for the 500,000 cyd and 2,000,000 cyd, 10-year MUDS disposal options. This would yield average daily through-put rates of about 250 cyds/day and 1000 cyds/day, respectively, over the 9-month annual dredging season. However, actual daily rates are dependent on dredging project activity, including dredging rates and barge sizes, and will vary from long periods of no disposal to times when more than one project is delivering to the offload site each day. For this concept development, it is assumed that the maximum through-put rate over a 4-day target holding/dewatering time is in the order of 1,500 cyds/day for the smaller (50,000 cyds/yr) option and up to 2,500 cyds/day for the larger (200,000 cyds/yr) facility. This results in assumed 4-day holding time capacities of at least 6,000 cyds and 10,000 cyds for the small and large options, respectively.

The number of holding cells is also dependent on the operating plan. For this concept it is assumed that a minimum of four dewatering cells is required. This will support active disposal tc one cell, gravity dewatering in the second cell, rehandling for transport in the third cell, and one additional cell for management of possible overload or problem materials, e.g., mixing desiccants. Assuming that the depth of dredged materials in a filled cell is 6 ft., the approximate cell layout parameters are as follows:

	10-Year Rehandling Capacity	
Parameter	500,000 cyds	2,000,000 cyds
Assumed Through-put Rates:		
10-year	500,000 cyds	2,000,000 cyds
Annual	50,000 cyds/yr	200,000 cyds/yr
Daily Average over 9-month dredging season	250 cyds/day	1,000 cyds/day
Maximum over 4-day dewatering period	1,500 cyds/day	2,500 cyds/day
Required Minimum 4-day holding capacity	6,000 cyds	10,000 cyds
Number of Cells (min.)	4 cells	4 cells
Depth of dredged Mat'l Deposit (max.)	6 ft.	6 ft.

Cell Size (nom.)	60 ft. X 150 ft.	75 ft. X 200 ft.
Cell capacity (@ 6 ft. deep)	2,000 cyds	3300 cyds

One of the four cells can be reserved for management of problem sediments as needed, with the remaining three active cells providing the required minimum 4-day holding capacity.

<u>Cell Layout</u>

For this concept, the dewatering cells will be located on a fully paved durable work surface located as near the waterfront dock as practicable. The entire site surface will be curbed and graded for collection and treatment of drainage water and rainfall runoff. The cell walls would be formed of portable rectangular concrete blocks (ecology blocks) to a minimum height of 8 ft. to 10 ft. The four cells would be situated adjacent to each other, using a single block wall between adjacent cells. A geotextile fabric would be used to line the block seams and beneath the blocks. Cell sizes and/or surface access to the cell interior can be obtained by moving the concrete blocks.

Offload Facilities

Clamshelled dredged material will arrive at the dewatering site dock by haul barge. A clamshell located on the dock would offload the dredged material directly into a hopper assembly which feeds a conveyor belt out to the dewatering cells. The hopper would be equipped with a water-side apron device to prevent spillage between the barge and the hopper, and a 'grizzly'-screen mechanism to remove debris too large for the hopper/conveyor. The conveyor belt would carry dredged material from the hopper out across the top of the cell array. The conveyor belt would be equipped with remote-actuated diverter assemblies to deflect delivered dredged material at appropriate locations as needed into each cell.

Some types of dredged material will feed onto the conveyor better than other types. Granular sandy/gravel materials and softer muds would feed better than heavy consolidated muds and clays which might block the hopper if overloaded. This could be helped by a vibrating hopper feed system and/or special operating procedures by the offload clamshell. Also, if needed the offload clamshell could reach the nearest dewatering cell for direct deposition and rehandling of problem materials.

Water Management

All water arising within the operations area will be collected and treated to meet WQ requirements for discharge back to the waterway (Puget Sound). Collected water would include the following sources:

- free water ponding in the arriving haul barge will be decanted by pumping prior to offloading the dredged materials;
- drainage water from each dewatering cell;
- rainwater runoff from the entire operations area including the cell surfaces;

- water from wheel washing of the out-bound transport vehicles.

All collected water would be routed by gravity drainage or pumping to a primary treatment system (pond) for gravity removal of settleable solids. This could be provided by large steel tankage, e.g., 16,000 gal. Baker tanks. Gravity settling would be followed by filtration for removal of residual suspended solids through a vertical sand filter assembly as described by WES. Each system would be built to provide dual capacity, allowing one system to be used while the other was cleaned. Solids removed by the treatment processes would be disposed to the dredged material dewatering cells. It is assumed that conventional gravity settling and filtration will comply with WQ requirements. Additional special treatment steps are possible if needed for WQ compliance, e.g., flocculation, carbon absorption, but are not included in this concept.

Design flow rates must accommodate both dredged material drainage and stormwater runoff. Estimated water volume arising from clamshelled dredged material could be in the order of 50 to 100 gals./cyd. total during barge transit and over the 4-day holding time. This would produce a nominal flow rate averaging about 180 gpm for the maximum assumed 2,500 cyd/day average through-put over 4 days. A hard rainfall of 1-inch in 24-hours would produce runoff in the range of 60 to 90 gpm depending on overall site size, while a 25-year storm of about 3.5 inches rainfall in 24- hours could produce about 200 to 300 gpm.

A low cost option to aid in dewatering is to include bottom drainage pathways recessed into the paved cell bottom. These bottom 'slots' would contain perforated drainage pipe placed in a sandy bedding. Collected water would be intercepted to the treatment system. Occasional maintenance would consist of re-bedding or replacing the pipes while the cell was empty.

Operations

Dredged material would be centrally placed in each dewatering cell by the conveyor belt delivery system. The site manager would select the amount and type of materials for each cell. The diverted dredged materials would tend to mound beneath the belt discharge point, leaving the gravity drainage path toward the outside ends of the cell. If needed, a rubber-tired loader could enter the cell or a clamshell could be used to assist in distributing the dredged material to both properly fill the cell and enhance surface drainage.

Dredged material would be left in the cell to allow pore water to be extruded to the surface by the weight of consolidation. Limited ditching could be accomplished to promote effective surface drainage. All free-water drainage arising within the cell would be removed, probably by selective pumping. Heavy rainfall will complicate the surface drainage and removal process.

When the dredged material mass has dewatered to the point of meeting the no-free-water requirement, the dredged material will be mechanically rehandled (loader, clamshell, hoe) to trucks or containers for transport offsite to the final upland disposal area. Loaded vehicles will be wheel-washed before leaving the paved operations area to limit track-out of contaminated dredged materials. The entire operations area will be managed to limit losses of dredged materials.

It is possible that some of the especially fine-grained dredged may not dewater sufficiently to meet the no-free-water requirement by simple consolidation and surface drainage. Desiccants could be added and mixed to meet the requirement.

Concept Level Estimated Costs

Concept level costs are estimated for construction of the rehandling and dewatering facilities for both the 500,000 cyd and 2,000,000 cyd 10-year CAD options. Basic layout and assumptions are described above. Primary cost factors are for construction of the dock; purchase and placement of the offload clamshell, hopper feed assembly and the conveyor belt delivery system; grading, paving and curbing of the entire operations area; construction of four dewatering cells (walls); and installation of the integrated water collection and treatment systems. Basic estimates are for direct costs of materials, manpower and equipment for mob-demob and operations. Typical rates for indirect costs (15%), contractor profit (10%) and contingencies (20%) are added.

The concept-level estimated cost summary for the upland rehandling and dewatering concept plan is shown on Table 1.

Table 1. Concept Level Estimated Costs for Construction of Upland Rehandling/Dewatering Site

Major Capital Elements	Unit	Unit Cost	500,000 Cyd Capacity Quantity	500,000 Cyd Capacity Estimated Cost	2,000,000 Cyd Capacity Quantity	2,000,000 Cyd Capacity Estimated Cost
MARINE PORTION						
-Mob-demob	L.S.	-	1	$50,000	1	$50,000
-Grade and Riprap Bankline	lin. ft.	$230.00	310	$71,300	400	$92,000
-Dock	sq. ft.	$100	8400	$840,000	8400	840,000
-Dolphins (steel 3-pile)	ea.	$15,000	6	90,000	6	90,000
Total Estimated Cost Marine Portion				**1,051,300**		**1,072,000**
UPLAND SITE WORK						
-Mob-demob	L.S..		1	$50,000	1	$50,000
-Site Grading	cyd	$3.00	15,000	$45,000	20,000	$60,000
-Pave (incl. curbs, surface drainage)	acre	$155,000	3.2	496,000	4.6	713,000
-Cell (bin) Walls (in place)	lin. ft.	$150	1350	202,500	1600	240,000
-Water Collection & Treatment Works	L.S.		1	200,000	1	300,000
Total Estimated Cost Upland Site Work:				**993,500**		**1,363,000**
OFFLOAD SYSTEM						
-Offload Crane/Clam	L.S.		1	400,000	1	500,000
-Hopper w/grizzly Screen & Spill Apron	L.S.		1	80,000	1	80,000
-Conveyor w/walkway (48 in.)	lin. ft.	$700	400	280,000	400	280,000
-Conveyor Belt Diverter/plow	ea.	$10,000	4	40,000	4	40,000
-Front-end Loader	L.S.		1	100,000	1	150,000
Total Estimated Cost Offload System:				**900,000**		**1,050,000**
TOTAL ESTIMATED DIRECT COSTS:				**$2,944,800**		**$3,485,000**
ADD (Assumed):						
	Indirect Costs (15%)			$441,720		$522,750
	Contractor Profit (10%)			$294,480		$348,500
	Contingencies (20%)			$588,960		$697,000
Total Estimated 10-Year Concept Cost:				**$4,269,960**		**$5,053,250**

2.2 Upland Long-Term Confined Disposal Concept

Project Summary

The long term upland confined disposal facility concept is consistent with that provided by WES. A large diked confinement area will be built to receive dewatered dredged material over a 10 year period. The major area will be divided into three or more diked sub-cells. For this concept development it is assumed that the disposal site must meet basic construction requirements for a Municipal landfill. A bottom liner and leachate collection system will be installed beneath each cell. All site water (drainage, leachate and surface runoff) will be collected and treated by gravity settling and filtration prior to discharge. Dewatered dredged material arriving by trucks from the waterfront rehandling/dewatering site will be deposited and advanced within each sub-cell by conveyor system. As the fill builds, low-ground-pressure equipment would be used to eventually grade and progressively cap the emerging consolidated deposit with a layer of low-permeability soil, a geotextile membrane and topsoil.

Two 10-year disposal options are considered: 1) for 2,000,000 cyds *in situ* dredged material volume; and 2) for 500,000 cyds *in situ* dredged material volume. Consistent with WES an assumed net bulking/consolidation factor of 0.75 is applied, which reduces conceptual capacity at the disposal site to 1,500,000 cyds and 375,000 cyds, respectively. Schematic plan views and cross-section are shown on the attached figures.

Site Description

The assumed site is near-level. This will minimize need and costs to raise the dike height to compensate for containment on sloping ground. On-site soils are assumed clean and structurally suitable for use in building the containment dikes. It would be less costly if on-site materials were low-permeability clays that would also serve as a source of acceptable bottom liner and surface cap for the leachate collection and drainage system. However, this is not assumed for this concept development.

It is noted that a level site presents problems for deposition of dewatered but likely still somewhat fluid dredged materials. End-dumped materials would quickly level and spread to cover the immediate truck access area without building a thick deposit (e.g., Port of Everett materials at Coal Creek landfill). It would be months and perhaps years before the deposited soft dredged material alone would support dump vehicles to further build the fill by direct dumping. An ideal direct-dumping condition would be to end-dump over a higher shoulder into a large deposition area descending well-away from the dumping spot. This was successfully accomplished at Kitsap County landfill for US Navy dredged material from Pier D at Bremerton. For level ground disposal as assumed for this concept, deposition of dredged material into the broad CDF area must be otherwise conveyed into the site beyond the truck dump location.

Site Layout

The disposal site layout follows the basic WES concept. The overall site is a rectangular plan with a 2:1 length:width ratio (approx.). The given overall dimensions of the disposal cell for the WES 2,000,000 cyd site option are 3700 ft. long by 1900 ft. wide including the dikes. A similar approximation for the 500,000 cyd option would be about 2000 ft. long by 1000 ft. wide. Rough calculations indicate that these overall dimensions are conservatively large by 10% to 15% for the consolidated fill values assumed above (1,500,000/375,000 cyds). Cross-dikes would be constructed to divide the major cell into (at least) three sub-cells. The assumed thickness of the dredged material disposal deposit is 8 ft. A leachate collection system would be installed beneath each cell (to meet requirements for municipal landfills). Schematic plan views are shown in Figures 3 and 4. The plan views provide for a 200± ft. buffer/operating area fringe around the disposal cell, with fencing, a site management office and shops.

The entire disposal site would be scalped and graded to provide the needed clean foundation for the dikes and leachate collection system. Phasing construction to complete and fill one cell at a time could allow some or all of the removed surface material to be replaced as topsoil to the cap upon cell closure. This would require stockpiling the scalped materials on-site or nearby.

Containment Dikes

Dike construction follows the WES concept plan. Perimeter and cross-dikes would be built to an interior cell height of 12 ft. above the top of the leachate collection system. Allowing for a 3± ft. thick leachate collection system (see below) the dike height above the base site grade would be about 15 ft. (12 ft. + 3 ft. = 15 ft.). This would allow for a ponding depth of 2 ft. for collected surface water above the (+8 ft.) dredged material deposit and a freeboard of 2 ft. Dikes would be built and compacted with on-site soils to 3H:1V side slopes. It is assumed that the design is capable of withstanding structural and seismic design requirements. The crown (top) width would be 20 ft. to provide for a durable graveled all-weather access road. A dike cross-section is shown in Figure 5.

Leachate Collection

A leachate collection system would be installed under each disposal cell in preparation for deposition of dredged materials. Following the WES concept, the assumed leachate collection system would consist of a 2 ft. compacted clay barrier layer at the bottom of the cell; an impermeable geotextile membrane overlaying the clay; and a 1.5 ft. layer of coarse sands/gravels over the geotextile. The leachate liners would extend up the dike slope to the planned top elevation of the dredged material mass (+8 ft.). Perforated plastic leachate collection pipe would be buried within the sand/gravel layer. A schematic cross-section of the assumed leachate collection system is also shown on WES Figure 5.3.2c (attached). Collected leachate would be intercepted by a manifold piping and pumping system and transferred to the water treatment plant.

The leachate collection system is a critical operating element of the long-term disposal cell. Once installed, it cannot be disturbed or damaged. Therefore, trucks and/or dozers/loaders cannot operate directly upon the completed surface without excessive risk of damage to the leachate collection system. This then precludes the most straightforward means of offload and distribution of dredged material within the cell. Roads could be properly designed and

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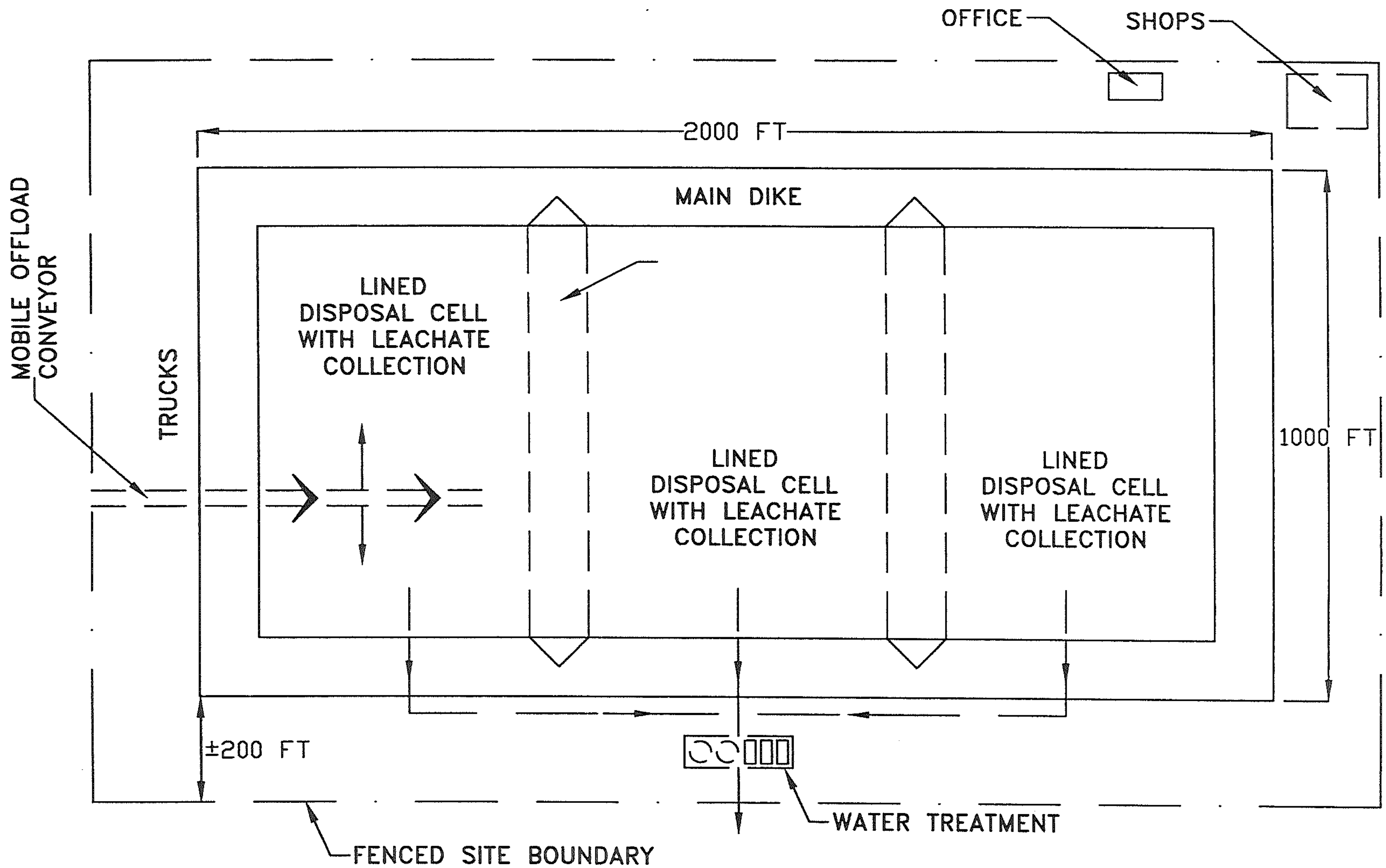

Figure 3. Schematic Plan View of Upland Disposal Site for 500,000 CYD Option

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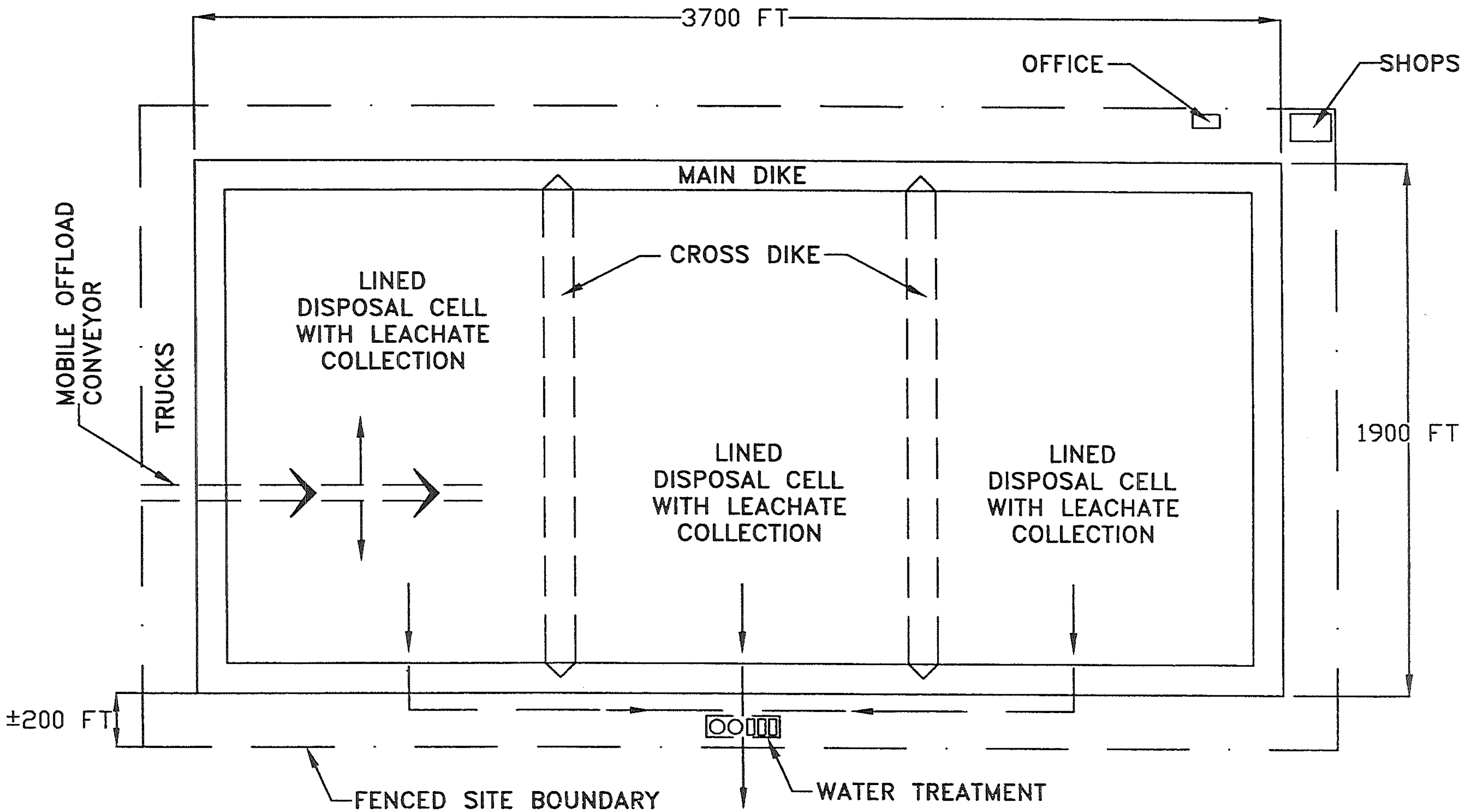

Figure 4. Schematic Plan View of Upland Disposal Site for 2,000,000 CYD Option

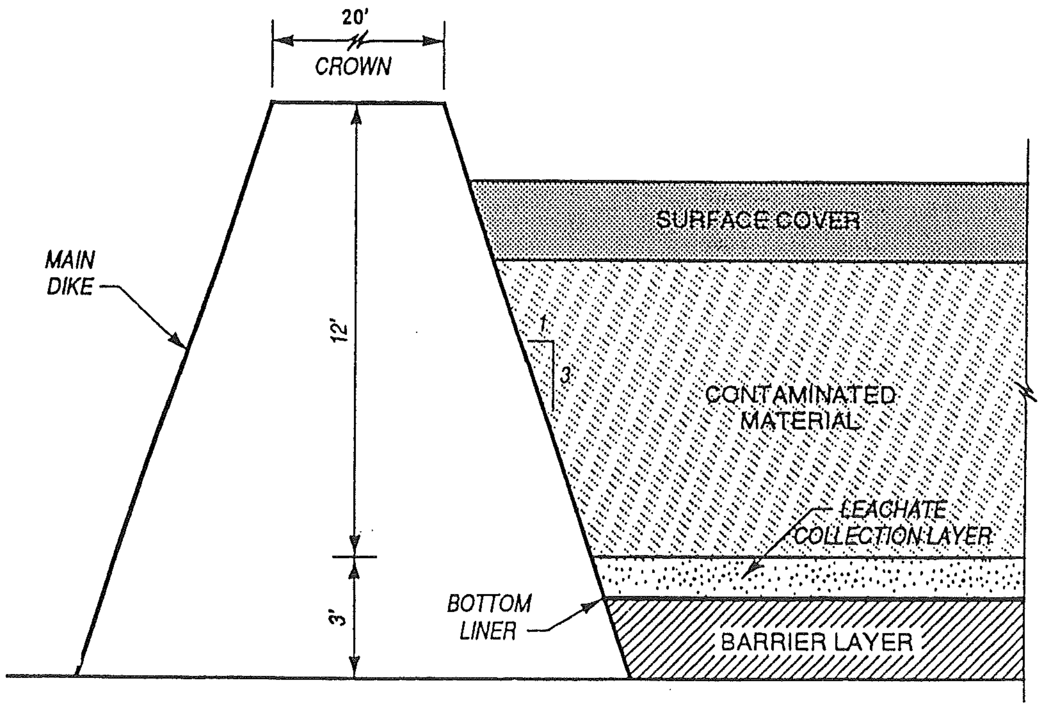

Figure 5. Cross Section of the lined cell for upland CDF conceptual design. (Figure 5.3.2c from Waterways Experiment Station, 1998).

built over the finished surface for truck and equipment access to the cell bottom. However, this would be costly and such limited access would not support the need for active distribution of the soft dredged material across the remaining cell expanse which is not protected by a road. Similarly, the entire floor of the cell could be surfaced with an additional 2 ft. to 3 ft. of roadbed-type gravels to support construction equipment operating within the cell, but this would be even more costly. For this concept development it is assumed that dredged material will be deposited and distributed within the cell by conveyor offload equipment in order to protect the completed leachate collection system from damage by operating vehicles.

Cap and Cover

Upon cell closure the dredged material deposit would be graded for surface drainage and capped with 1.5 ft. of imported compacted low permeability soils (clay) and an impermeable geotextile membrane. An additional 2 -ft. layer of topping soil would be added to encourage surface vegetation. The closure cap is intended to divert rainfall runoff overland without contacting the contaminated dredged material mass.

Summary of Site Layout Parameters

Based on the above assumed concept, estimated site layout parameters are summarized below:

	10-Year Disposal Option	
Parameter	500,000 CY	2,000,000 CY
Assumed Disposal Rates:		
10-year total (*in situ* volume)	500,000 CY	2,000,000 CY
Annual (*in situ* volume)	50,000 CY	200,000 CY
Daily Average (9 month dredging season)	250 CY/day	1,000 CY/day
Maximum daily (assumed)	1,500 CY/day	2,500 CY/day
Disposal Cell Capacity (assume 0.75 consolidation ratio)	375,000 CY	1,500,000 CY
Disposal Cell:		
Thickness of dredged material deposit	8 ft.	8 ft.
Height of containment dike above leachate collection system (incl. 2 ft. ponding and 2 ft. freeboard)	12 ft.	12 ft.
Overall height of dike above base level site-grade (approx.)	15 ft.	15 ft.
Dike crown width	20 ft.	20 ft.
Dike Side Slopes	3H:1V	3H:1V
Overall footprint of diked disposal cell	1000' X 2000'	1900' X 3700'
Perimeter dike length (nom.)	6000 ft.	11,200 ft.

Disposal Cell Cont.		
Perimeter dike volume (approx.)	217,000 CY	404,000 CY
Number of sub-cells (assumed)	3	3
Number of cross-dikes	2	2
Total length of cross-dikes (2, nom.)	2000 ft.	3800 ft.
Total cross-dike volume (2, approx.)	72,000 CY	137,000 CY
Leachate Collection Field (overall):		
Footprint (cell interior, approx.)	850' X 1850' (36 acres)	1750' X 3550' (142 acres)
Volume of 2-ft. clay liner	116,000 CY	458,000 CY
Volume of 1.5 ft. sand/gravel layer	87,000 CY	344,000 CY
Capping and Cover (overall):		
Volume of 1.5 ft. clay liner	89,000 CY	347,000 CY
Volume of 2 ft. soil cover	118,000 CY	463,000 CY

Water Treatment and Management

It is intended that all water arising within the cell during and after filling be collected and provided primary treatment for solids removal before discharge. Water sources include:

- Pore water extruded from the dredged material deposit. Although dewatered to meet Paint Filter test requirements before transfer to the upland disposal site, some additional pore water may still be extruded as the dredged material mass consolidates over the long term. Much of this will be captured at the bottom by the leachate collection system, while some may pond to the surface for decanting directly to the water treatment system. Most of the pore water extrusion would likely occur within the first several weeks or months of confinement, diminishing over time. The average water release within a sub-cell during the first few months is judged to be less than 20 gpm.

- Rainfall runoff. Typical heavy precipitation would be in the order of 1-in. of rainfall in 24 hours, while the 25-year storm at places in Puget Sound may approach 3.5-in. in 24 hours. The upland CDF is divided into 3 equal sized sub-cells for this concept. For the 2,000,000 cyd option, rainfall runoff in the 1/3 sub-cell for the 25 year storm could collect at an average of about 3300 gpm for the 2,000,000 cyd option and 850 gpm for the 500,000 cyd option. For the more typical 1-in. rainfall this discharge is reduced to about 950 gpm and 250 gpm, respectively.

It is important to note that while several inches of rainfall may collect within the cell during a prolonged storm, the runoff does not need to be treated and discharged at the rate of accumulation. Rather, rainfall runoff can be ponded below the dike freeboard elevation. This capacity would allow runoff water to be temporarily collected and stored within the cell, and then treated and discharged at a reduced rate over a longer period of time within capacity of the water treatment system.

The leachate and rainfall runoff will be collected and treated for solids removal prior to discharge in compliance with WQ requirements. As developed by WES, adequate treatment is assumed to consist of gravity sedimentation of settleable solids within the ponded waters of the dredged material cell, followed by filtration through a set of vertical sand/gravel filters constructed for this purpose. Dual sand filters are required to allow continuous treatment by one filter while the other is undergoing maintenance. For this concept it is assumed that the water treatment plant would include the 30 ft. diameter filter cells described by WES preceded by a set of large (Baker-type) steel tanks for additional gravity settling capacity. While not assumed here, the steel tanks could also provide flexibility for additional treatment with flocculent if needed.

Collection and treatment of the potentially large amount of rainfall runoff is assumed needed only while the emerging dredged material mass is exposed at the surface. After cell closure the impermeable cap would preclude contact of surface drainage with the dredged material, thereby allowing such runoff to be discharged overland without collection and treatment.

Fill Operations

As described above, the overall upland disposal site is assumed to be divided into (at least) three equal-sized sub-cells. Although not required, it is probable that the filling sequence over time would proceed to complete filling of one sub-cell before beginning at the next. Each sub-cell, with cross-dikes and a leachate collection system, would more or less be constructed and operated to completion as an independent disposal cell.

Dewatered dredged material will be transferred by sealed-bed trucks from the waterfront dewatering/handling facility to the long term upland disposal site. Although meeting the Paint Filter test, much of the dredged material is expected to arrive in a soft and somewhat fluid consistency. A natural slope of freshly deposited dredged material might be in the order of 5H:1V or flatter, with particularly soupy materials running further overground. In the broad flat expanse of the disposal cell, such materials are not expected to develop enough structural stability to allow equipment operation on the surface for several months or more, especially during the rainy season. Without additional heavy rock surfacing to allow equipment operation on the fragile leachate collection system (not assumed here), this essentially means that the dredged materials must be deposited into the CDF cell by advancing deposition across the cell from overhead.

For this concept development it is assumed that the trucked dredged material will be transferred into the CDF cell by conveyor. Trucks would dump directly to a conveyor feed hopper and a mobile conveyor system would deposit the dredged material in a planned distribution pattern within the cell. There are different conveyor configurations that could satisfy the requirement. For this concept it is assumed that the conveyor would be cantilevered over the dike into the cell interior. Deposition would begin as a fringe of dredged material deposited along the dike. The initial pass along the perimeter would extend into the cell by as much as 100 ft. beyond the dike crown. The conveyor would progress along the dike as the cell filled to the +8 ft. target elevation beneath the conveyor discharge. Eventually the conveyor would need to be extended further across the emerging fill and the distribution process repeated.

Extending the conveyor system out and across the built fill will require at least some structural stability of the underlying dredged material mass for safe access. It is assumed that this can develop by consolidation over the course of several months during the one-year dredging/disposal season. At some point in cell building, it should be possible to begin working the consolidated fill surface with low ground pressure equipment to extend and advance the conveyor system further into the disposal cell. If needed, marsh mats could be used to assist in providing a more stable working position for equipment. A layer of sand could also be spread over the dredged material mass. Sand would both provide an improved working surface as well as hasten consolidation by the added overlying weight. The cost for a sand layer is not included in this concept development.

It is likely that the upland disposal plan would include a program of at least annual cover to minimize long term exposure of dried dredged material prior to capping. As described above it is assumed that equipment access to the fill could occur within one year of deposition. As the advancing dredged material fill became accessible to equipment, the top would be graded and capped for closeout. This progressing cover approach would leave only the recent wet deposits in the yet-to be-completed portion of the cell exposed to the air, thereby minimizing opportunity for wind-blown migration of surface-dried contaminated sediment offsite.

Concept Level Estimated Costs

Concept level costs are estimated for construction of the long-term upland CDF for both the 500,000 CY and 2,000,000 CY 10-year disposal options as shown on Table 2. Basic layout and assumptions are described above. Primary cost factors include site preparation and grading; dike building; leachate collection system; water treatment works; and offload/distribution system. Basic estimates are for direct costs of materials, manpower and equipment for mob-demob and operations. Typical rates for indirect costs (15%), contractor profit (10%) and contingencies (20%) are added. Future cost over the phased project development are shown only as present cost.

Table 2. Concept Level Estimated Costs for Construction of Upland Disposal Site

Major Capital Elements	Unit	Unit Cost	500,000 Cyd Capacity		2,000,000 Cyd Capacity	
			Quantity	Estimated Cost	Quantity	Estimated Cost
PRE-CONSTRUCTION						
-Mob-demob	L.S.	-	1	$100,000	1	$200,000
UPLAND CDF SITE WORK						
-Site Stripping/grading/stockpiling	CY	$2.00	120,000	$240,000	350,000	$700,000
-Main perimeter dike (on-site soils)	CY	$3	217,000	$651,000	405,000	1,215,000
-Cross-dikes (two)	CY	$3	72,000	216,000	137,000	411,000
-Leachate Collection System:						
- 2 ft. clay bottom liner	(acre)	($45,000)				
- geotextile membrane w/flow net	(acre)	($17,000)				
- 1.5 ft. sand/gravel layer	(acre)	($25,000)				
- collection piping	(acre)	($12,000)				
Subtotal, Leachate Collection System	acre	$99,000	36	3,564,000	142	14,058,000
-Water Collection & Treatment Works	L.S.		1	250,000	1	350,000
-Gravel Dike Roads (all dikes)	CY	$20	4400	88,000	8,300	166,000
-Cap and Cover:						
- 1.5 ft. clay liner	(acre)	($33,000)				
- geotextile membrane	(acre)	($17,000)				
- 2 ft. soil cover (use on-site soils)	(acre)	($9,000)				
Subtotal, Cap and Cover	acre	$59,000	37	2,183,000	144	8,496,000
Total Estimated Cost Upland CDF Site Work:				**7,192,000**		**25,396,000**
OFFLOAD/SITE EQUIPMENT						
-Drive-over Feed Hopper	L.S.		1	80,000	1	80,000
-Conveyor, cantilevered over dike (36 in.)	lin. ft.	$600	190	114,000	190	114,000
-Conveyor, extended (36 in.)	lin. ft.	$500	450	225,000	950	475,000
-Front-end Loader	L.S.		1	100,000	1	150,000
-Low Ground Pressure Tractor	L.S.		1	200,000	1	200,000
Total Estimated Cost Offload/site Equipment:				**719,000**		**1,019,000**

Table 2. Cont.

<u>OTHER SITE DEVELOPMENT</u>						
-Gravel outer yard/roads	CY	$16	25,000	400,000	41,000	656,000
-Fence yard	lin. ft.	$10	7600	76,000	12,800	128,000
-Utilities/lights	L.S.		1	100,000	1	150,000
-Office/shop	L.S.		1	125,000	1	150,000
Total Estimated Cost Other Site Development:				**701,000**		**1,084,000**
TOTAL ESTIMATED DIRECT COSTS:				**$8,712,000**		**$27,699,000**
ADD (Assumed):						
	Indirect Costs (15%)			$1,306,800		$4,154,850
	Contractor Profit (10%)			$871,200		$2,769,900
	Contingencies (20%)			$1,742,400		$5,539,800
Total Estimated 10-Year Concept Cost:				**$12,632,400**		**$40,163,550**
	(unit cost)			($25.26/CY)		($20.08/CY)

2.3 Operations Costs For Upland Confined Disposal Concept

The upland disposal alternatives present complex operational logistics problems. The contaminated dredged materials require three inter-related steps: 1) offloading from the haul barge to the upland rehandling/dewatering facility; 2) rehandling and transport by truck to the final upland disposal site; and 3) rehandling and distribution of the hauled sediment into the distant long term upland disposal site. The steps are essentially mutually dependent upon the through-put rate of dredging and disposal as it occurs over the 9 month annual dredging period. For the assumed concept, dredged material must be rehandled, transported and disposed to the upland disposal cell within only a few days of its receipt at the marine offload/dewatering facility in order to maintain adequate open capacity for incoming dredged material. However, depending on dredging/disposal schedules at Puget Sound projects there may be weeks or even months when little or no dredged material is received. Still, the sites would require about the same level of personnel and operations coverage (and cost) during slack dredging times in order to be ready to receive and process dredged materials as needed, e.g., the personnel cannot be intermittently furloughed without pay. The problem will be in how to cost-effectively keep the sites open, managed and ready to receive and efficiently process dredged material with a skilled crew and special equipment.

Upland disposal operations will require more comprehensive consideration than will be assumed here. For example, the MUDS project may want to provide additional guidance on ownership and operation of MUDS facilities, and/or the overall concept of managing Puget Sound dredging schedules to condense the disposal operations to shorter more efficient time frames. At this point, the following assumptions are made:

- Both the marine offload rehandling/dewatering facility and the upland disposal site will be available to receive and process dredged material for the entire annual 9-month open dredging window. This essentially assumes that the annual average through-put rates of 250 CY/day and 1000 CY/day will apply more or less continuously during the dredging year for the 500,000 CY and 2,000,000 CY disposal options, respectively. However, there will be periods of high through-put as well as standby time.

- Both the rehandling/dewatering facility and the upland disposal site are considered permanent year-around sites that require at least some management, operation, maintenance and security even when dredged material is not being processed.

To implement this approach the following operating cost scenarios are assumed:

Offload Rehandling/Dewatering Facility

Dredged material will be offloaded from the haul-barge, placed by conveyor into the dewatering cells, and then rehandled to trucks for upland disposal after a few days dewatering time. Purchase of the site equipment (offload crane, loader, conveyor, water treatment system) is already included as part of the initial construction cost. A year-around manager/supervisor is required. Minimum need for site operations include an offload crane operator, loader operator and helper for the 9-month dredging/disposal period. Site operating costs would include both the personnel and the costs for operation of the MUDS-owned equipment, e.g., fuel, maintenance, repairs. Costs would also include operation and maintenance of the water collection and treatment facilities. In addition, for the 2,000,000 CY option an allowance is made for rental and operation of a backup loader during possible high-volume periods of maximum through-put (up to 2500 CY/day assumed maximum).

Transportation

Dredged material would be rehandled to conventional sealed-bed trucks with pup-trailers for highway transport to the long term upland disposal site. Cost is dependent on the distance and time traveled. It is assumed that arrangements can be made with a local contract hauler to insure ready availability of transport services when needed. For the concept cost estimate it is assumed that a 20 mile one-way haul is required. At an assumed cost of $0.60/CY-mile, the estimated concept unit cost for transport is $12/CY.

At this stage it is also important to note that the frequency of truck/pup combinations loaded and on the road could vary from only a few per week or even per month during slack dredging periods, to more than 150 per day during the assumed 2,500 CY/day maximum through-put for the 2,000,000 CY disposal option. Given that State highway requirements may restrict hauling of contaminated sediment to daylight hours only, e.g., USN Pier D upland disposal, this could require out-loading and hauling at a rate approaching 15 to 20 trucks/hour during dark winter months. This high rate of truck loading and turnaround is probably faster than a single loader can sustain through a work day.

Upland Disposal Site

Dredged material arriving by trucks will be dumped to a feed hopper and delivered by mobile conveyor system into the long term upland disposal cell. Purchase of the site equipment (feed hopper, conveyor system, dozer/loader and water collection and treatment system) is already included as part of the initial construction cost. A year-around site manager/supervisor is required. Minimum additional site operations personnel needs include a dump-person, conveyor operator, and equipment operator (dozer/loader) through the 9 month dredging/disposal season. Site operating costs would include both the personnel and the costs for operation of the MUDS-owned equipment, e.g., fuel, maintenance, repairs, as well as operation/maintenance of the water collection/treatment system. A shop/repair staff is not included, since much routine maintenance could be done by the operators or by out-contract.

Based on the above assumed operating scenario, a summary of concept-level annual operating costs for the offload/dewatering site, transport and upland disposal is outlined below:

Table 3. Operations Costs For Upland Confined Disposal Concept

Cost Element	Long Term Disposal Option: 500,000 CY (50,000 CY/yr)	Long Term Disposal Option: 2,000,000 CY (200,000 CY/yr)
Offload/Dewatering Site:		
-Labor	$ 255,000/yr	$ 326,000/yr
-Equipment (fuel, maintenance, repair)	$ 106,000/yr	$ 165,000/yr
-Rental equipment allowance (loader)	$ -	$ 40,000/yr
Subtotal, Offload/dewatering site:	**$ 361,000/yr**	**$ 531,000/yr**
(unit cost):	($7.22/CY)	($2.66/CY)
Upland Disposal Site		
-Labor	$ 285,000/yr	$ 285,000/yr
-Equipment (fuel, maintenance, repair)	$ 65,000/yr	$ 130,000/yr
Subtotal, Upland Disposal Site:	**$ 350,000/yr**	**$ 415,000/yr**
(unit cost):	($7.00/CY)	($2.08/CY)
Total Annual Direct Costs:	**$ 711,000/yr**	**$ 946,000/yr**
(unit cost):	($14.22/CY)	($4.73/CY)
Add: Indirect Costs (15%):	$ 106,650	$ 141,900
Contingencies (20%):	$ 142,200	$ 189,200
Total Estimated Annual Operations Cost:	**$ 959,850/yr**	**$1,277,100/yr**
(unit Cost):	($19.20/CY)	($6.39/CY)
plus,		
Transportation (20-mile contract haul)		
- @ $0.60/CY-mile (unit cost):	($12.00/CY)	($12.00/CY)
Subtotal, Annual Transportation Cost:	**$ 600,000/yr**	**$2,400,000/yr**

3.0 Nearshore Confined Disposal Concept

The Nearshore CDF follows the WES conceptual design. A perimeter dike is constructed to contain the 10-year unsuitable dredged material deposit. The dike is armored on both the exterior and interior surfaces to prevent erosion. Dredged material arriving by haul-barge is placed within the CDF by clamshell offloading over the dike. Distribution within the CDF is assumed to be by periodic rehandling using a portable hydraulic dredge. Capping is also assumed to be by hydraulic dredge. Water arising within the CDF cell is provided primary treatment (settling) within the confined cell to remove suspended solids, and then decanted and discharged to Puget Sound. Concept-level cost estimates are provided for both a 500,000 cyds and a 2,000,000 cyds capacity CDF.

Schematic drawings of the plan and cross-section for each of the nearshore CDF options (500,000/2,000,000 cyds) are shown on the attached Figures 6 through 9. All depths/elevations are referred to local Mean Lower Low Water (MLLW) at the project site.

Site Description

The CDF site is assumed to be a level nearshore bottom with average depth of -33 ft., MLLW. The adjacent bankline is assumed straight with an offshore slope of 2H:1V down to the -33 ft. bottom depth.

Perimeter Dike

The CDF is assumed to be a single long-term cell within a constructed perimeter dike. The perimeter dike is constructed to Elev. +17 ft. with 2H:1V side slopes and a 15 ft. crown (top) width. Dike material is imported select fill capable of temporarily standing on the 2H:1V side slope in the marine environment until armored during construction. The dike crown would be surfaced with rock to provide an access roadbed. No allowance is made here for the possible site-specific need to first excavate and dispose unacceptably soft sediment from the dike footprint to prepare a structurally sound foundation. Some areas of Puget Sound experience high tides to more than +14 ft. Storm waves runup during such tides could occasionally overtop the +17 ft. dike.

Dike Armoring

A 3 ft. thick layer of armor stone is placed on the entire exposed exterior surface of the dike to protect against erosion by waves and currents. A bottom toe trench is assumed to provide the armor foundation support. A designed 3 ft. thick outer armor layer is generally adequate to resist wave heights in the range of 4 ft. to 5 ft. with minimal damage. Larger waves could require a thicker layer of larger stone. The interior dike surface is assumed armored with a 1.5 ft. thick layer of quarry spall to protect against possible erosion and sloughing by waves and/or CDF operations within the CDF pond. Slope armoring would proceed concurrently with dike- building as the dike height progresses in order to provide required slope protection against erosion of the less stable select fill dike.

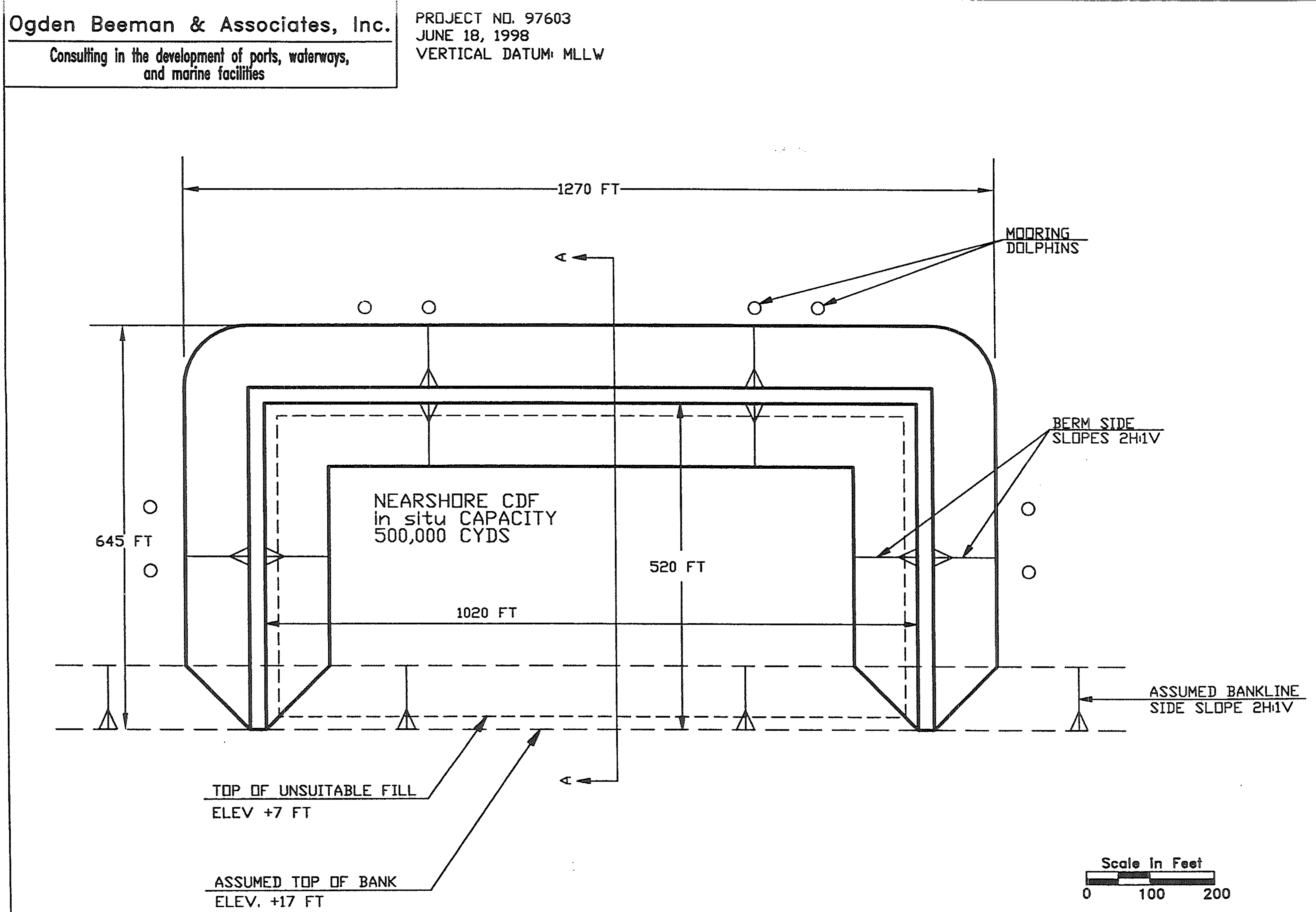

Figure 6. Schematic Plan View of 500,000 cyd Nearshore Confined Disposal Concept.

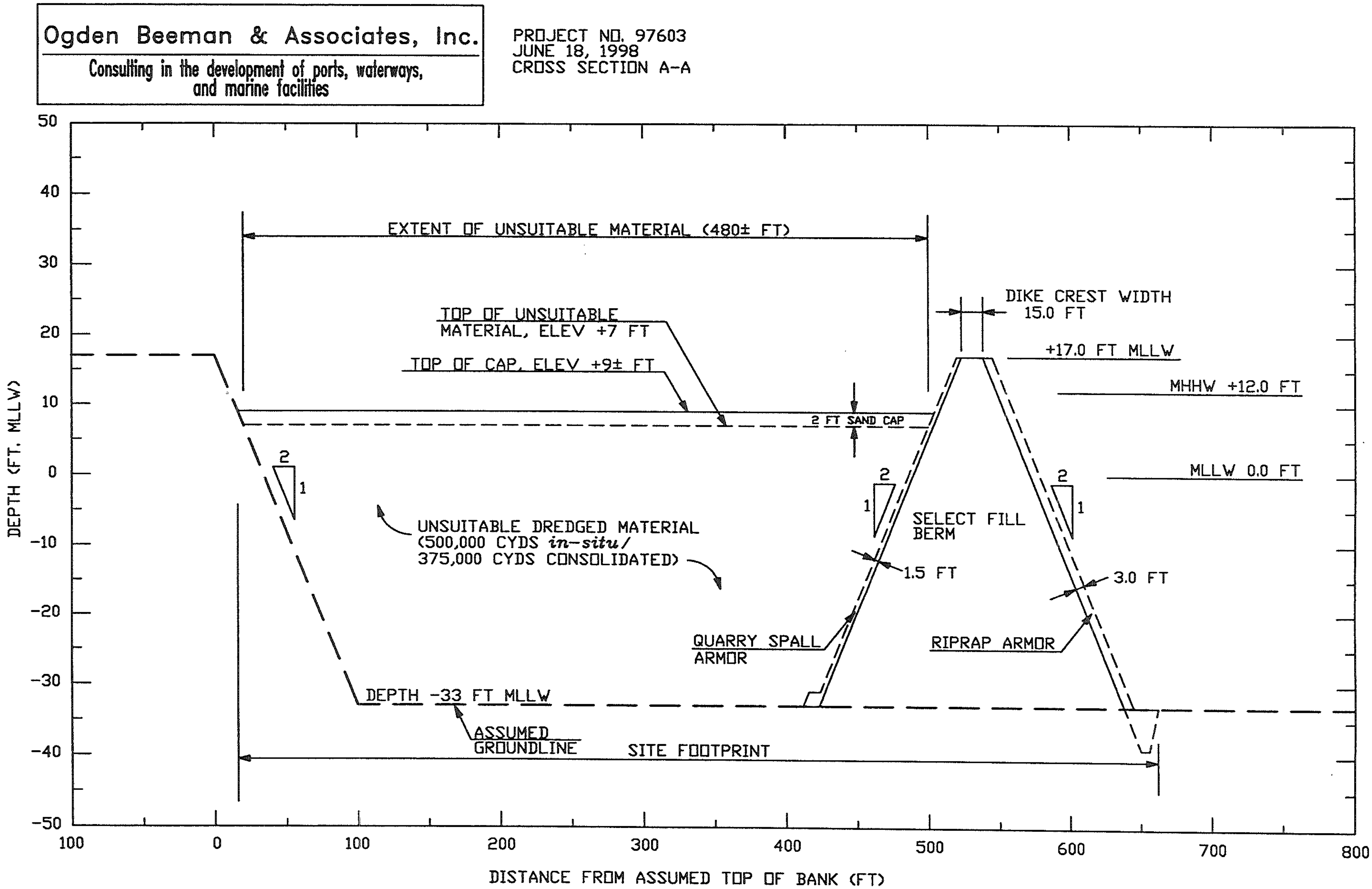

Figure 7. Schematic Cross Section of 500,000 cyd Nearshore Confined Disposal Concept

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Consulting in the development of ports, waterways, and marine facilities

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VERTICAL DATUM: MLLW

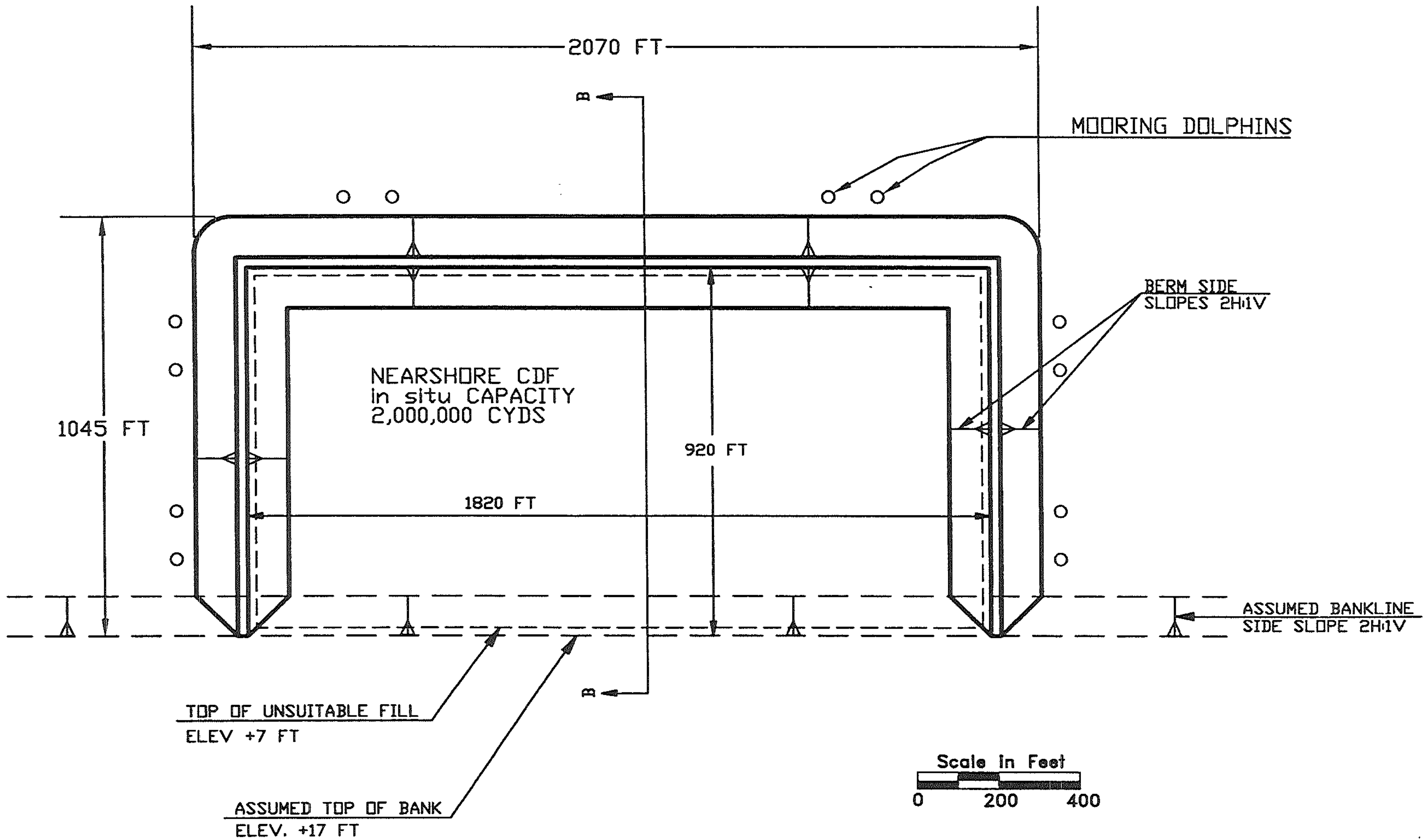

Figure 8. Schematic Plan View of 2,000,000 cyd Nearshore Confined Disposal Concept.

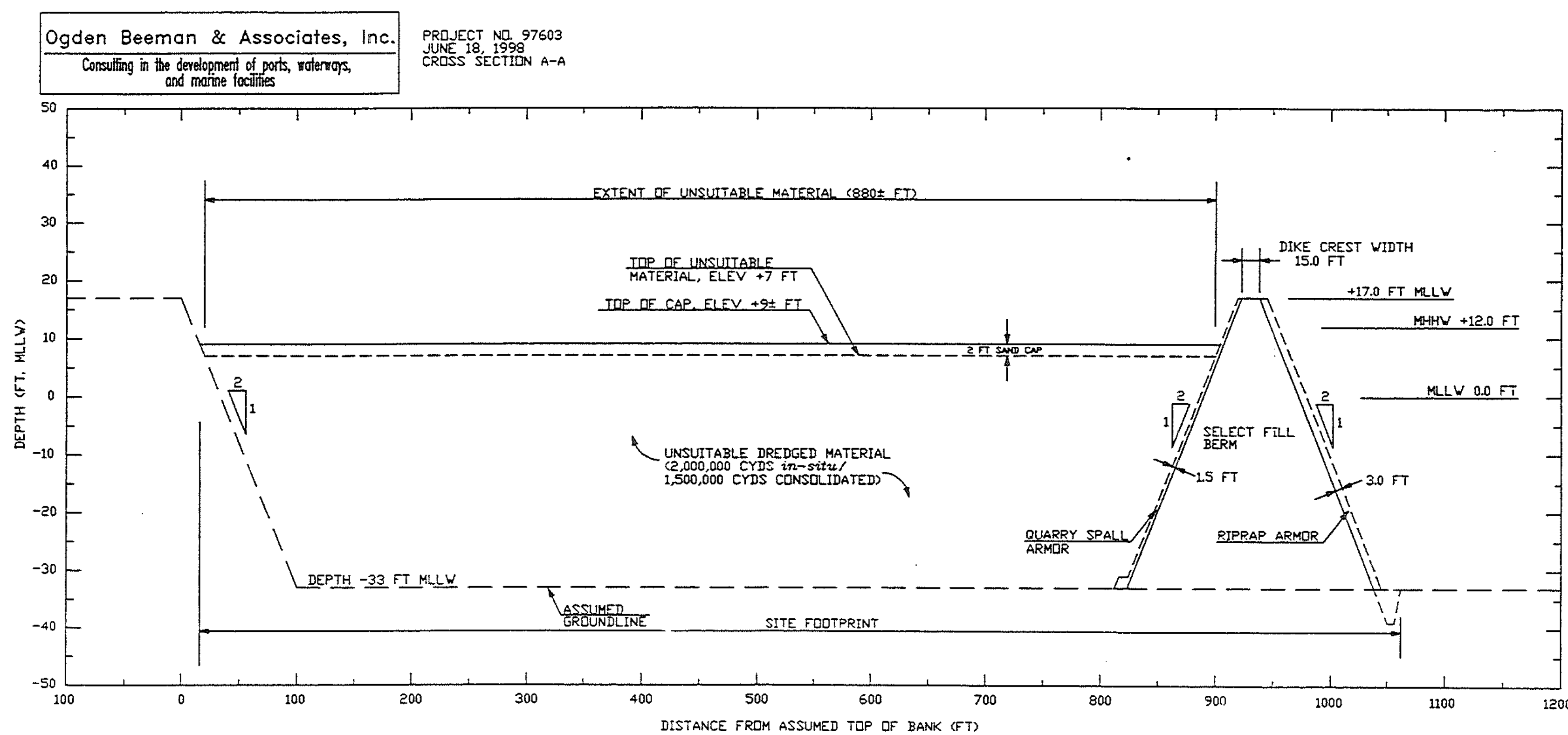

Figure 9. Schematic Cross Section of 2,000,000 cyd Nearshore Confined Disposal Concept.

Offloading

Clamshelled dredged material will arrive by haul barge. Options for offloading and distributing to the CDF include:

1. clamshelling directly over the dike and periodically re-distributing the materials evenly within the cell interior as needed by small hydraulic dredge;
2. slurrying the materials aboard the haul barge and hydraulic offload by pipeline into the CDF; and
3. clamshelling to a hopper system that feeds a hydraulic pumping and pipeline system into the CDF.

Permanent installations of hydraulic offload systems 2) and 3) are not selected here due to the following considerations: a) the varying nature of dredged materials, including unsorted debris, which can preclude effective hydraulic pumping; b) the probable more or less random (unscheduled) need for offloading operations resulting from the variety of dredging projects; c) the need for MUDS to fund and own a permanent installation that will only be used intermittently; and d) lack of locally available and proven equipment and operation for hydraulic offloading of the full range of dredged materials expected.

The offload approach selected for this concept development is option 1), above: clamshell offloading directly to the CDF with subsequent re-distribution as needed within the CDF using a small hydraulic dredge. Clamshell equipment is commonly available in Puget Sound. The offload clam could be spudded-in with the haul barge offshore adjacent to the CDF perimeter dike. Sets of pile dolphins are provided along the CDF perimeter to assist in temporary barge moorage and/or offloading. Dredged material would be clamshelled directly over the dike into the CDF along the interior perimeter slope. The deposited material would slough down-slope and build a fillet of dredged material spreading into the CDF along the interior dike perimeter. A means of preventing spillage onto and outside the dike during offloading would be provided by the dredging contractor at his expense, e.g., fabricated or geotextile apron arrangement and/or over-dike chute. The MUDS supervisor would direct dredged material placement along the dike perimeter to best utilize available CDF capacity. As the fill builds along the dike interior, a portable hydraulic dredge would periodically be used to re-distribute the dredged material deposit away from the dike and across the CDF expanse. This would maintain additional capacity along the dike available for continued clamshell offloading. To facilitate hydraulic dredging, site management must include directed separation of large debris by the offload clam with deposition in a limited selected area within the CDF.

The frequency of need for hydraulic re-distribution (dredging) will increase as the CDF site fills over time. For this concept development, hydraulic dredging is assumed required in years 3, 5, 7, 9 and 10 for the 500,000 cyd option and in years 3, 5, 7, 8, 9 and 10 for the 2,000,000 cyd option. It is further assumed that up to 65% of the unsuitable dredged material quantity will require re-distribution for the smaller 500,000 cyd cell and up to 85% will require re-distribution for the larger 2,000,000 cyd cell. Hydraulic re-distribution is assumed at MUDS expense, while clamshell offloading over the dike would be by equipment provided by and at the expense of the dredging contractor. Hydraulic re-distribution will utilize interior site water, thereby not contributing to the need for water volume management within the CDF.

It is noted that, depending on dredged material characteristics, the dredger could elect to use his own hydraulic pumpout from the haul barge directly into the CDF. This would require coordination with the MUDS manager for proper placement. However, it should use (recycle) CDF ponded water for slurrying rather than import new Puget Sound water which would require additional volume control and WQ management prior to discharge.

Water Management

Water arising within the CDF must be managed and discharged in compliance with WQ requirements. Puget Sound (sea) water will be trapped and ponded within the CDF to approximately Mean Tide Level (MTL) upon closure of the perimeter dike. Dredged material deposited into the CDF will displace an essentially equal volume of ponded water that must eventually be discharged. Rainwater will also collect within the CDF. And a small amount of entrained *in situ* pore water will be extruded from the deposited dredged material by long-term consolidation. It is assumed that a minimum interior pond depth of 2 ft. will be maintained over the dredged material until project completion, although the initial ponding depth will be in the order of 40 ft (33 ft. site depth plus 7 ft. MTL). Even the minimum ponding depth (2 ft.) is assumed to provide adequate sedimentation capacity to effectively remove suspended solids from the cell water column.

An adjustable decant weir would be used to skim the clarified surface water for discharge while maintaining a desired interior water level as shown in Figure 10. Discharge would be into Puget Sound through a submerged outfall/diffuser. Gravity discharge would occur only when the adjusted interior water level was higher than the outer tide height. The discharge pipe would be equipped with backflow preventer (tide-gate valve) to prevent outer high tides from backing into the CDF cell.

Capping

A 2 ft. layer of imported clean fine sand will be placed as a final cap over the completed CDF. It is assumed that the cap material will be dredged elsewhere by clamshell , transported by haul barge to the CDF site and offloaded by clamshell to a limited reserved area within the perimeter of the CDF cell. A portable hydraulic dredge would be used to distribute the arriving capping material evenly over the entire CDF dredged material deposit.

Nearshore Concept Layout

Basic site parameters are taken from the WES conceptual nearshore design. A summary of layout elements used in this review are summarized below for both the 500,000 cyd and 2,000,000 cyds options, as follows:

Concept Element	500,000 Cyds	2,000,000 Cyds
Site Capacity:		
-*in situ* dredged material volume	500,000 cyds	2,000,000 cyds

CDF Layout:		
-Type	Single cell	Single cell
-Bottom elevation of CDF cell	-33 ft., MLLW	-33 ft., MLLW
-Top elevation of unsuitable dredged material deposit (MTL)	+7 ft., MLLW	+7 ft., MLLW
-Average depth (thickness) of unsuitable deposit	40 ft.	40 ft.
-Footprint (nom., out-to-out)	645 ft. X 1270 ft. (19 acres)	1045 ft. X 2070 ft. (50 acres)
Dike Parameters:		
-Top elevation	+17 ft., MLLW	+17 ft. MLLW
-Crown width	15 ft.	15 ft.
-Side slopes	2H:1V	2H:1V
-Diking material (imported)	select graded fill	select graded fill
-Exterior slope armor	3 ft. thick riprap	3 ft. thick riprap
-Interior slope armor	1.5 ft. thick quarry spalls	1.5 ft. thick quarry spalls
Final Cap:		
-Materials	fine sand	fine sand
-Thickness	2 ft.	2 ft.

Schematic drawings of the plan and cross-section for each of the CDF options (500,000/2,000,000 cyds) are shown in Figures 6 through 9.

Conceptual Estimated Costs

Concept level cost estimates were developed for construction and operation of both the 500,000 cyd and 2,000,000 cyd nearshore CDF options. Basic layouts and assumptions are consistent with the WES concept plans. Where needed, WES concept plans were refined and/or supplemented to provide a more adequate basis for cost estimating. Primary cost factors of materials and equipment are based on best judgment of current availability, rates and conventional construction practice in Puget Sound. Basic estimates are for direct costs of materials and for equipment mob-demob and operations to construct and operate the CDF. Typical rates for indirect costs (15%), contractor profit (10%) and contingencies (20%) are added (additive rates taken from Bellingham project). Estimated costs for future work over the ten year project life, e.g., periodic re-distribution of unsuitable dredged materials and final capping by hydraulic dredge are shown only as present cost values.

The concept-level estimated cost summary is shown in Table 4.

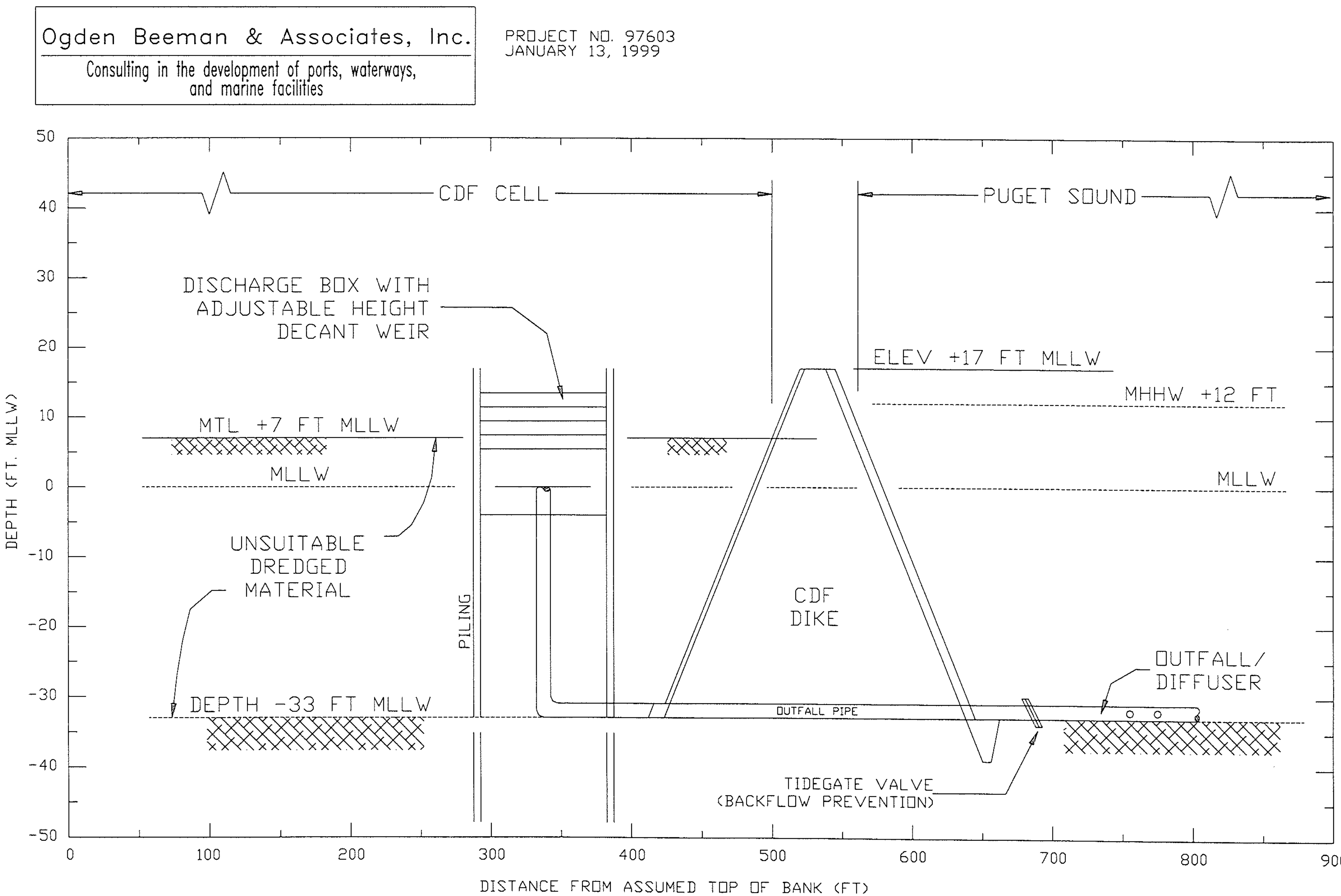

Figure 10. Schematic Nearshore CDF Drainage System.

Table 4. Concept Level Estimated Costs For Nearshore CDF

Major Capital Elements	Unit	Unit Cost	500,000 cyd Capacity		2,000,000 Cyd Capacity	
			Quantity	Estimated Cost	Quantity	Estimated
Pre-construction						
Pre/post construction surveys	ea.	$25,000	2	$50,000	2	$50,000
CDF Cell Construction						
Mob-demob	L.S	-	1	$200,000	1	$200,000
Dike material, in place	cyd	$10.00	418,000	$4,180,000	759,000	$7,590,000
Exterior armor (Riprap)	cyd	$16.00	35,800	$572,800	65,000	$1,040,000
Interior armor (Quarry spalls)	cyd	$15.00	11,750	$176,250	22,900	$343,500
Dike road rock (topping)	cyd	$32.00	650	$20,800	1,300	$41,600
Water control structure	L.S.	-	1	$39,000	1	$39,000
Mooring dolphins	ea.	$16,000	8	$128,000	12	$192,000
SUBTOTALS:	**cyd**			**$5,816,850**		**$9,446,100**
Offload & Re-distribute Dredged Materials						
Offload into CDF (contractor's expense)				-		-
Re-distribute by hydraulic dredge/pipeline						
General Mob-demob	L.S.	-	1	$100,000	1	$100,000
Interim mob-demob	L.S.	$36,000	4	$144,000	5	$180,000
Re-distribute	cyd	$2.70	325,000	$877,500	1,700,000	$4,590,000
SUBTOTALS:				**$1,121,500**		**$4,870,000**
Final Sand Cap						
Mob-demob clamshells (dig & offload)	L.S.	$20,000	1	$20,000	1	$20,000
Dredge, transport & offload sand	cyd	$4.40	37,000	$162,800	120,000	$528,000
WDNR mitigation (borrow) fee	cyd	$3.00	37,000	$111,000	120,000	$360,000
Re-handle to cap (hydraulic)	cyd	$2.70	37,000	$99,900	120,000	$324,000
SUBTOTALS:				**$393,700**		**$1,232,000**
TOTAL ESTIMATED DIRECT COSTS:				**$7,382,050**		**$15,598,100**

Table 4. Cont.

	ADD:	Indirect Cost (15%)	$1,107,308	$2,339,715
		Contractor Profit (10%)	$738,205	$1,559,810
		Contingencies (20%)	$1,476,410	$3,119,620
Total Estimated 10- Year Concept Cost:			**$10,703,393**	**$22,617,245**
		(unit cost)	(21.41/cyd)	(11.31/cyd)

4.0 Confined Aquatic Disposal Concept

Introduction

The Confined Aquatic Disposal (CAD) option follows the WES conceptual design for sequenced CAD. Ten equal-sized annual cells are developed sequentially to provide the 10-year design disposal capacity. A new CAD cell is excavated for each dredging year and then filled with unsuitable dredged material and given a final cap of clean sediment. Unsuitable dredged material is delivered by haul barge and bottom-dumped within the excavated cell. Precision positioning of the dump barge by DGPS and careful dumping procedures are required to assure placement and containment within the receiving cell. Assumed capping includes two interim 1-ft. thick caps during the annual dredged material deposition process and a final 3-ft. cap at the end of the dredging year. Capping material for each annual CAD cell is obtained by excavating the next year's CAD cell. For this concept development, capping materials are assumed granular and placed by controlled bottom-dumping from a split-hull barge maneuvered over the site. CAD options are developed for both a 500,000 cyd and a 2,000,000 cyd 10-year disposal capacity, with corresponding annual CAD capacities to contain 50,000 cyds and 200,000 cyds *in situ* dredged volume. Consistent with WES, a bulking allowance of 20% is applied for the dredging/disposal operations; this results in corresponding annual CAD cell sizes of 60,000 cyds and 240,000 cyds, respectively. No subsequent long-term consolidation factor is applied for the short-duration annual CAD sizing.

The plan view and cross-section for the annual CAD cells, and the related aggregate 10-year plan views, are shown schematically in Figures 11 through 16 for both the 500,000 cyd and 2,000,000 cyd total capacity options.

Site Description

For this concept, the assumed CAD site is located in a near-level bottom area capable of containing the full 10-year array of adjacent sequenced annual CAD cells. Ambient water depth is assumed at -65 ft., MLLW. This depth is below potential erosion effect of most local wind (storm) waves. Maximum tidal currents are assumed less than 0.5 ft./sec. at the bottom. The low current velocity minimizes the potential for both bottom erosion of the cap as well as migration of the suspended solids plume during dumping. Local surface sediments are likely soft and may not be entirely suitable as capping materials. However, it is assumed that deeper sediment within each CAD cell excavation will provide an adequate amount of fine-grained sandy material for capping the previous cell.

Basic CAD Cell Layout

Cell layout is based on WES's 2:1 length:width ratio. The long dimension is oriented as much as possible parallel to the ambient tidal currents. This alignment will minimize potential migration beyond the CAD site of settleable suspended solids in the water column during dumping, as well as assist in accurate navigation positioning of the barge during dumping. For this concept, the maximum depth of CAD excavation is assumed as -100 ft., MLLW. This results in a 35 ft. deep excavation of the CAD cell relative to the -65 ft. assumed ambient bottom depth. Top of the unsuitable dredged material in the cell is assumed at 5 ft. below the

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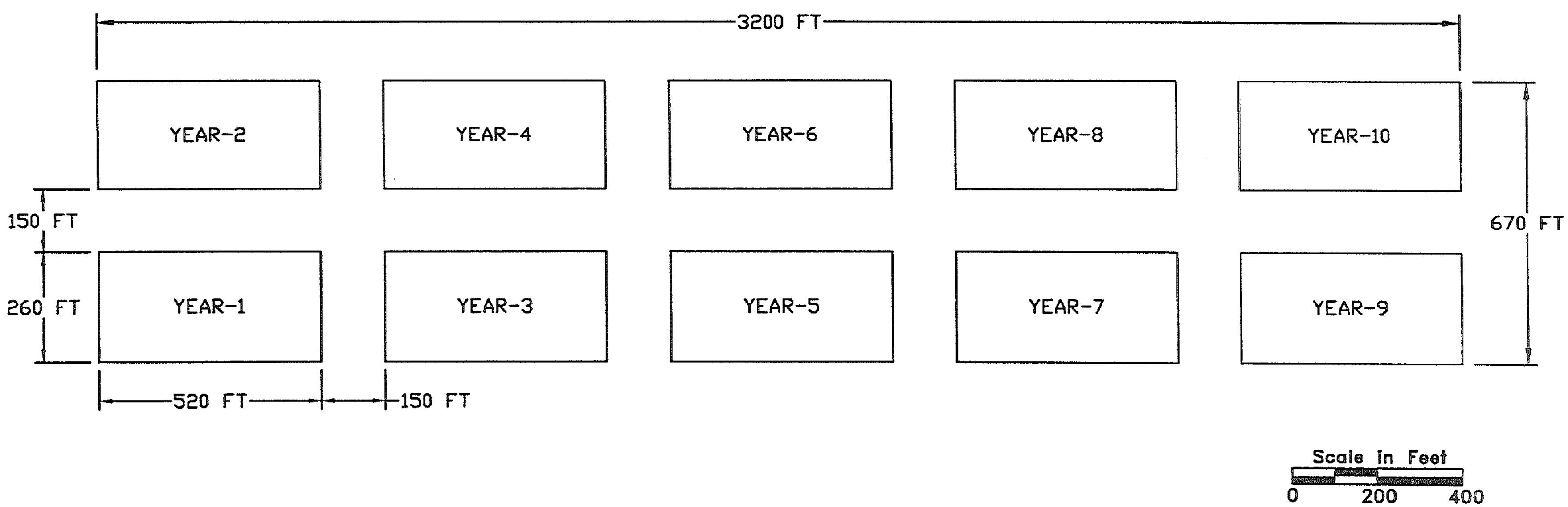

Figure 11. Schematic Footprint for 10-Year 500,000 CYD Sequenced CAD: 10 Annual Cells

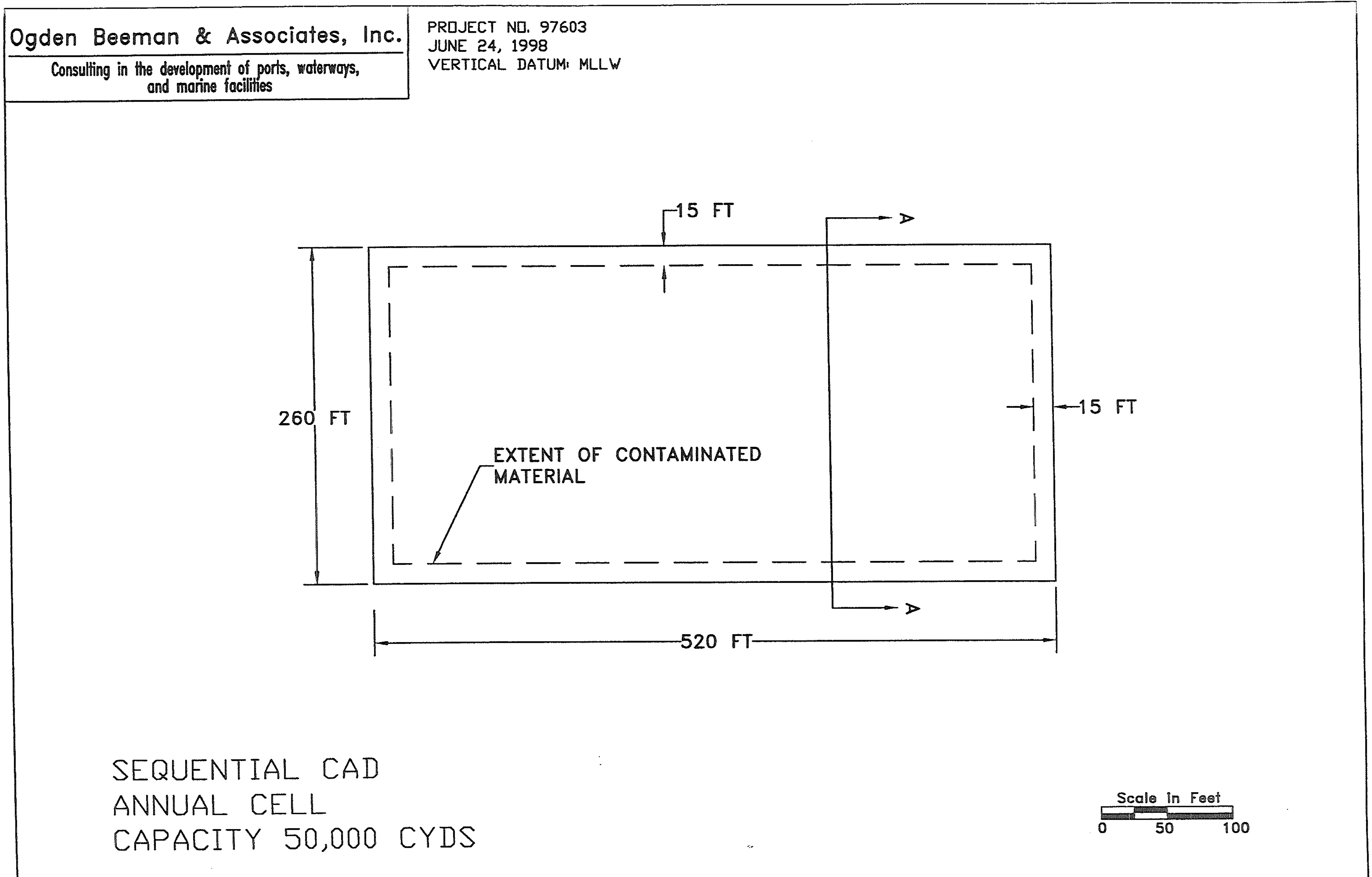

Figure 12. Schematic Plan View of a CAD Cell for the Sequenced 500,000 cyd Contained Aquatic Disposal Concept.

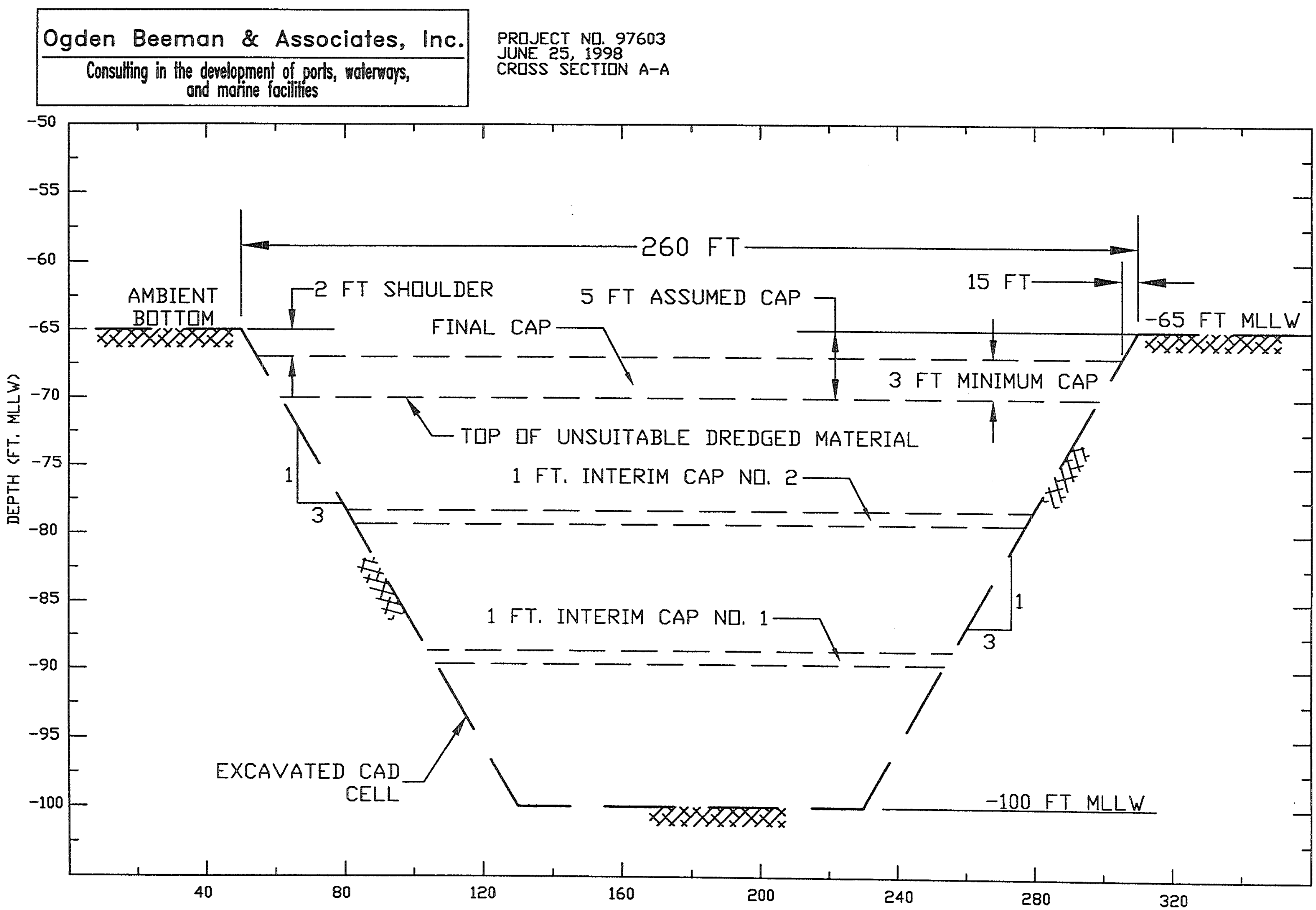

Figure 13. Schematic Cross Section of a CAD Cell for the Sequenced 500,000 cyd Contained Aquatic Disposal Concept

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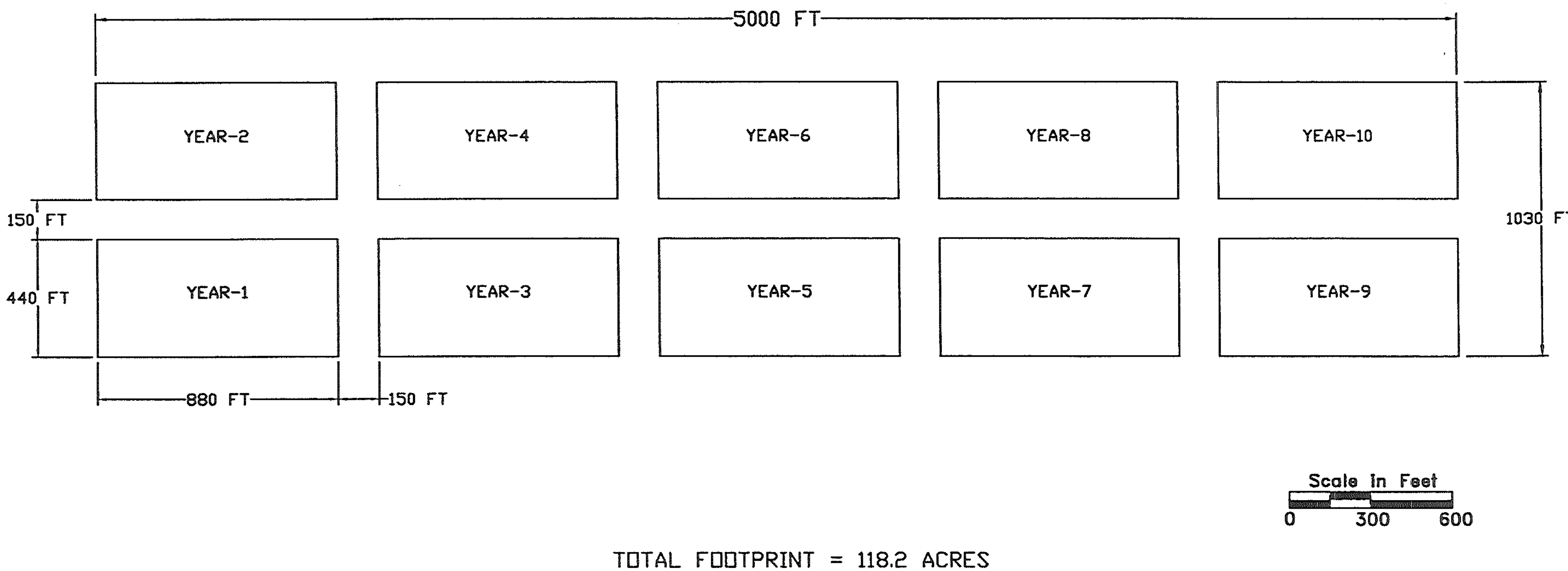

Figure 14. Schematic Footprint for 10-Year 2,000,000 CYD Sequenced CAD: 10 Annual Cells

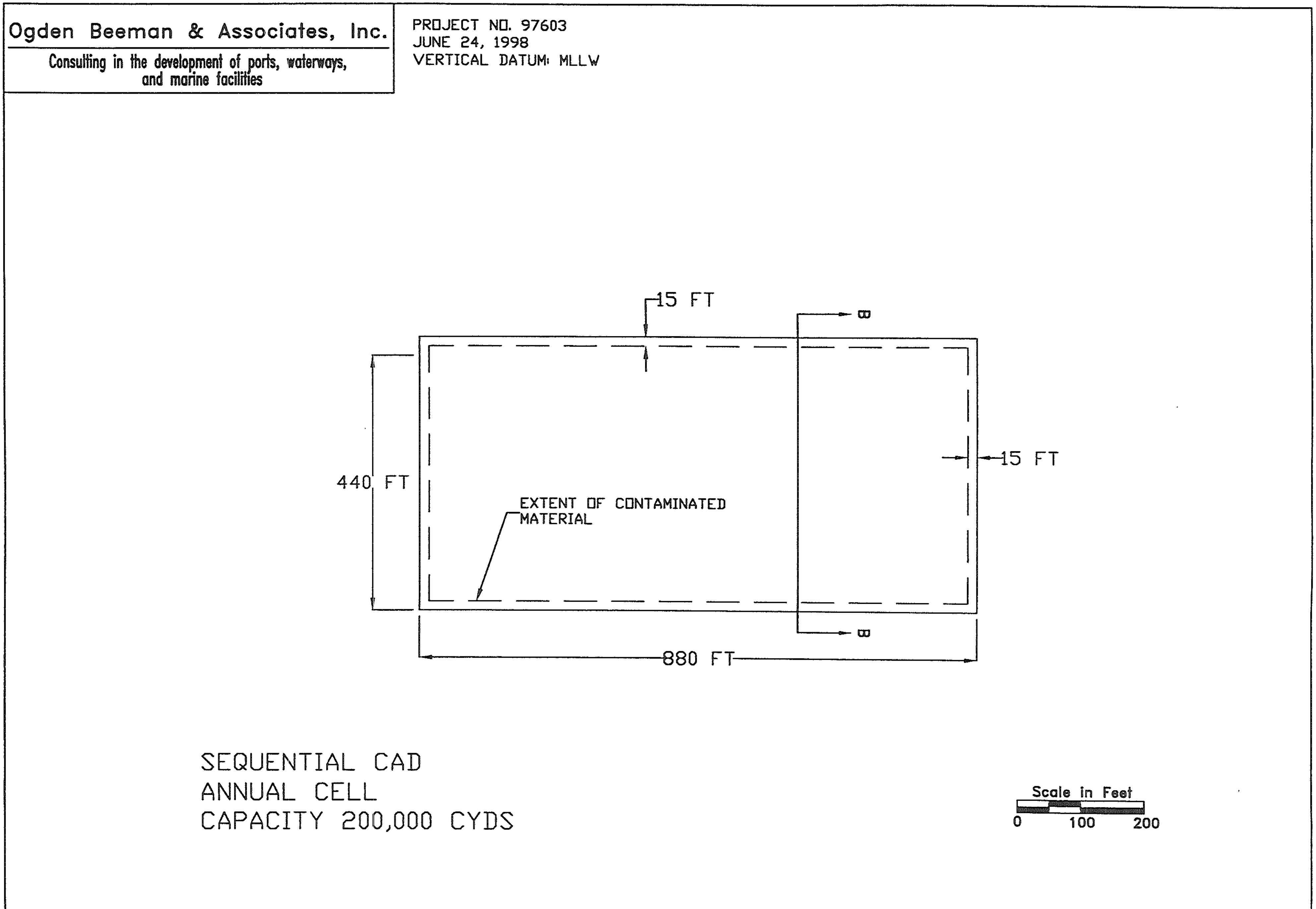

Figure 15. Schematic Plan View of a CAD Cell for the Sequenced 2,000,000 cyd Contained Aquatic Disposal Concept.

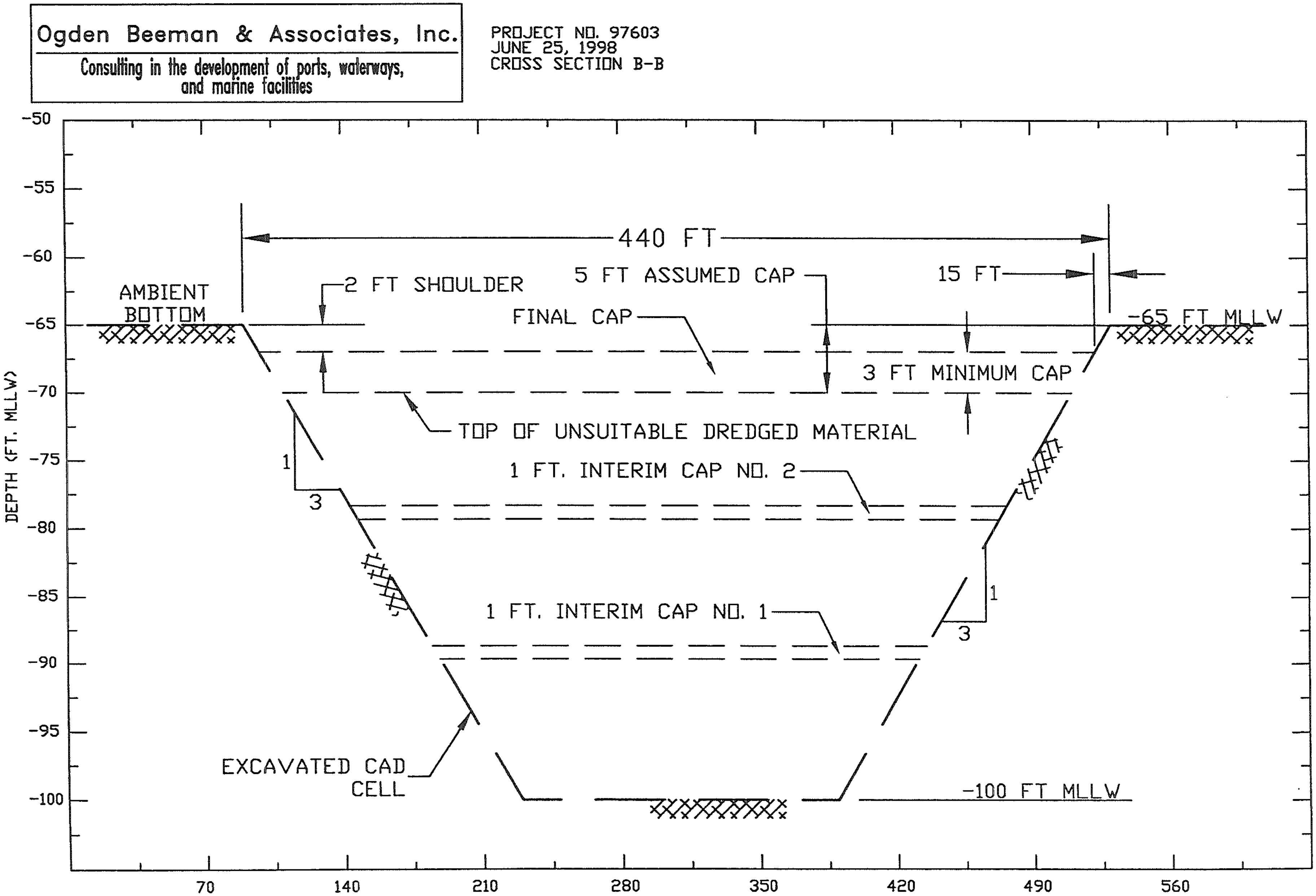

Figure 16. Schematic Cross Section of a CAD Cell for the Sequenced 2,000,000 cyd Contained Aquatic Disposal Concept.

ambient bottom, or at -70 ft. resulting in a 30 ft. thick CAD deposit (100 ft. -70 ft.). This 5-ft. remaining cell upper shoulder provides both a measure of lateral confinement during dumping of the unsuitable dredged material as well as space for required final capping below ambient bottom.

Each annual CAD cell will provide 10% of the target overall 10-year CAD capacity for *in situ* volume of dredged materials. The excavated volume for each annual cell will accommodate the design *in situ* dredged material volume for that year, plus a 20% bulking allowance, plus two assumed 1-ft. thick interim caps and a minimum 3 ft. final cap. A nominal 2 ft. residual depression would still remain between the top of the cap and the ambient bottom. This depression can either be filled as additional cap or allowed to naturally silt-in with native sediment over the long term. It is assumed for this concept that the entire 5 ft. residual depression will be used for final capping.

The estimated resulting annual CAD cell dimensions and related quantities are summarized below:

	Overall 10-Year CAD Capacity	
Project Element	500,000 Cyds	2,000,000 Cyds
Basic Site Capacity Req'd:		
-10-year *in situ* dredged material	500,000 cyds	2,000,000 cyds
-annual *in situ* dredged material	50,000 cyds	200,000 cyds
-annual capacity w/20% bulking	60,000 cyds	240,000 cyds
-subsequent long-term consolidation	none assumed	none assumed
Capping Requirements:		
-Interim caps (2)	1 ft. thick	1 ft. thick
-Final cap (minimum req'd)	3 ft. thick	3 ft. thick
Basic Annual CAD Cell Parameters:		
-Ambient bottom depth	-65 ft.	-65 ft.
-Excavated depth below ambient bottom	35 ft.	35 ft.
-Bottom depth of excavated CAD	-100 ft., MLLW	-100 ft., MLLW
-Top of unsuitable dredged material	-70 ft., MLLW	-70 ft., MLLW
-Thickness of unsuitable deposit	30 ft.	30 ft.
-Remaining surface depression available for final cap	5 ft.	5 ft.
Estimated surface dimensions of annual CAD cell (approx.):		
-Length X Width (2:1)	520 ft. X 260 ft.	880 ft. X 440 ft.
-Surface Area	3.1 acres	8.9 acres
Estimated quantities:		
-Bulked dredged mat'l capacity	60,000 cyds	240,000 cyds
-Interim caps (2)	6,000 cyd	24,000 cyds
-Final cap up to ambient bottom depth		

Estimated quantities Cont.		
(assume 5 ft. thick)	24,000 cyds	68,000 cyds
-Total capping materials	30,000 cyds	92,000 cyds
-Total CAD cell excavation (dredged mat'l plus total capping)	90,000 cyds	332,000 cyds

As noted above there is a 5 ft. remaining depression between the top of unsuitable dredged material at -70 ft. and the ambient bottom at -65 ft. It would appear that a minor cost savings is available by restricting the final cap thickness to the minimum 3 ft. requirement. However, it is generally considered that achieving a *minimum* cap thickness throughout will require about 25% more volume due to inherent inaccuracy of underwater placement methods. Therefore a minimum 3 ft. cap would require an overall placement volume equivalent to about 4 ft. (3.75 ft.) thickness. This would leave only about a 1 ft. residual depression. However, for practical purposes for this concept it is conservatively assumed that the entire 5 ft. depression would be used for the final cap since the capping material arises at no extra cost during excavation of the next year CAD cell--except for the 10th year (no further cell excavations). Reducing capping to 4 ft. average thickness for the 10th year would require about 19,000 cyds and 54,000 cyds of imported capping material for the 500,000 cyd and 2,000,000 cyd options, respectively.

CAD Excavation

Each annual CAD cell will be excavated by clamshell dredge. Site sediment is assumed suitable for open water disposal. All dredged material from the first-year annual CAD cell will be placed on bottom-dump barges and disposed to the nearest approved PSDDA site. Thereafter, excavation of the 2nd through 10th annual cells will be given priority for use as capping materials for the previous year cell. Sediment characteristics will determine its use as capping materials, with preference given to fine-grained granular silty sands for capping.

Use of cell excavation materials for capping will require sequencing of the next year CAD cell excavation with timing of capping requirements for the current year cell. Excavated sediment to be used for capping will be placed on split-hull dump barges for bottom-dump discharge to the cap. Depending on site characteristics, not all excavated sediment may be usable as capping materials. After satisfying capping needs, excavation of the next year CAD cell will be completed by continuing dredging without additional mob-demob. Excavated cell materials not used for capping would be disposed by bottom dumping to the PSDDA site.

Dredged Material Deposition

It is assumed that placement of unsuitable dredged materials to the excavated annual CAD site will be by bottom-dump barges with delivery, dumping and cost by the dredging contractor. Careful positioning of each dump will be accomplished using DGPS to assure deposition within the designated area of the excavated cell. The MUDS project may need to further delineate the CAD site by using marker buoys or other means to aid in visible confirmation of dump positioning. Each dump will require documentation of the dumping activity and the source, volume and nature of the dredged materials.

Other methods of deposition can be implemented either at contractor choice or if needed to comply with site-specific requirements for containment of the disposal operations. These could include off-loading and placement on the bottom by clamshell dredge, or placement within the cell by clamshell-fed tremie extending down through the water column. These methods are not assumed for this concept.

Location and placement of dredged materials by the contractor will be in close coordination with the MUDS manager to facilitate deposition in accordance with MUDS requirements. Significant considerations could include:

- location and amount of dump placement to maintain level filling within the excavated cell without over-filling;
- scheduling dumping to take advantage of slack or slow tidal currents for limiting potential migration of suspended settleable solids in the dump plume beyond the CAD boundaries;
- other special measures to improve dumping accuracy and/or limit loss of contaminated sediment beyond the CAD boundaries, e.g., anchoring the barge before dumping, placement by offload clamshell/tremie;
- pre- and/or post-dumping precision hydrographic (depth) surveys to document disposal impact on emerging remaining cell capacity;
- interim capping;
- WQ monitoring and/or bottom sediment sampling to verify containment of contaminated sediment within the CAD site boundaries.

Capping

A minimum final cap of 3 ft. is required. For this concept it is also assumed that dredged material quality and scheduling will result in need to place two interim 1-ft. (min.) thick caps during the annual disposal process. Using conventional methods capping materials cannot be placed with enough accuracy to obtain the required minimum thickness without allowing for over-placement in some areas. To assure the minimum cap thickness throughout, WES guidance is to assume that the average cap thickness and related quantity should be 25% more than the minimum required.

Capping materials will be obtained by excavating the next year sequenced CAD cell. This will allow capping and new cell excavation to proceed with one mob-demob cost. It is assumed that enough fine-grained granular silty sand can be obtained from each new excavation to satisfy capping needs for the current CAD cell.

Assuming a granular material, capping will be conducted using the split-hull barge method recently demonstrated at the Eagle Harbor project. The barge is maneuvered in a pre-determined pattern over the CAD area while slowly opening the split-hull to allow a controlled flow rate of capping sediment to 'rain down' through the water column. Cap build-up can be monitored by pre/post-placement hydrographic surveys and bottom sampling. It is noted that not all Puget Sound bottom materials are capable of controlled placement by split-hull barge. If cap material from the next year cell excavation is not acceptable for controlled deposition by split-hull barge, then it could be placed by clamshell release at depth into the water column over the CAD area, by washing the material from the barge using high-pressure water, or by slurrying the cap materials in the barge and placing by hydraulic pumping system. It is assumed that the split-hull barge method is applicable for this concept development.

Ten-Year Sequence

Ten CAD cells will be constructed and completed over the 10 year project life. Each annual cell requires preparatory excavation, deposition of unsuitable dredged materials within the cell, and capping. Capping materials will be obtained from excavation of the next year CAD cell, except for the 10th year cell (no further CAD cells). For the 10th year cell, capping materials will be similarly excavated and borrowed from a nearby approved non-CAD site. Based on the general March 15 to June 15 fishery closure period, three months will elapse between completing excavation of the next year cell and initiation of disposal of unsuitable materials in that cell when the dredging window re-opens. It is assumed for this concept that the excavated CAD cell remains viable (non-shoaled) during this three month period between excavation and disposal.

The resulting CAD sequence is outlined below:

<u>First Year</u>

- Excavate the CAD cell with disposal of all volume to PSDDA.
- Deposit unsuitable dredged materials.
- Place interim and final caps using materials excavated from the next year CAD cell.
- After final capping, complete excavation of next year CAD cell with disposal of excess materials to PSDDA.

<u>Second Through Ninth Year</u>

- Deposit unsuitable dredged materials.
- Place interim and final caps using materials excavated from the next year CAD cell.
- After final capping, complete excavation of next year CAD cell with disposal of excess materials to PSDDA.

<u>Tenth Year</u>

- Deposit unsuitable dredged materials
- Place interim and final caps using materials excavated from nearby non-CAD borrow area.

Concept Level Estimated Costs

Concept level costs are estimated for construction (excavation and capping) of the sequenced CAD program for both the 500,000 cyd and 2,000,000 cyd 10-year CAD options. Basic layout and assumptions are consistent with WES concept plans. Primary cost factors are for excavation of the CAD cells and disposal of the excavated materials either as capping for the previous annual cell or to PSDDA. Basic estimates are for direct costs of materials, manpower and equipment for mob-demob and operations. Typical rates for indirect costs (15%), contractor profit (10%) and contingencies (20%) are added. Estimated costs for sequenced future work over the 10-year project life are shown only as current cost values. A Washington Dept. of Natural Resources mitigation (borrow) fee is shown for borrowing capping materials from a non-CAD site during the 10th year, but not for use of capping materials or disposal to PSDDA of materials derived from CAD cell construction.

The concept-level estimated cost summary for the 10-year sequenced CAD options is shown on Table 5.

Table 5. Concept Level Estimated Costs for Confined Aquatic Disposal (CAD)

Major Capital Elements	Unit	Unit Cost	500,000 Cyd Capacity Quantity	500,000 Cyd Capacity Estimated Cost	2,000,000 Cyd Capacity Quantity	2,000,000 Cyd Capacity Estimated Cost
Pre-construction						
Pre/post-dredge surveys	ea.	$25,000	2	$50,000	2	$50,000
1st Year CAD Cell						
Excavation						
-Mob-demob	L.S.	-	1	$25,000	1	$25,000
-Excavate CAD Cell with disposal to PSDDA	cyd	$3.70	90,000	$333,000	332,000	$1,228,400
Capping						
-Mob-demob (2 interim, 1 final)	ea.	$11,000	3	$33,000	3	$33,000
-Excavate and place (2 interim, 1 final)	cyd	$3.70	30,000	$111,000	92,000	$340,400
Total Estimated Concept Cost for 1st -Year CAD:				**$502,000**		**$1,626,800**
2nd- through 9th- Year CAD Cell						
Excavation						
- Mob-demob (included for capping previous cell)	L.S.	-		0		0
- Excavate CAD cell volume remaining after capping previous cell, with disposal to PSDDA	cyd	$3.70	60,000	$222,000	240,000	$888,000
Capping						
-Mob-demob (2 interim, 1 final) ea.	ea.	$11,000	3	$33,000	3	$33,000
-Excavate & place (2 interim, 1 final) cyd	cyd	$3.70	30,000	$111,000	92,000	$340,400
Total Estimated Concept Cost each, 2nd thru' 9th-Year CAD:				**$366,000**		**$1,261,400**

Table 5 cont.

10th- Year CAD Cell						
Excavation (none, completed during 9th cell)						
Capping						
-Mob-demob (2 interim, 1 final) ea.	ea.	$11,000	3	$33,000	3	$33,000
- Excavate & place (2 interim, 1 final) cyd	cyd	$3.70	30,000	$111,000	92,000	$340,400
-WDNR mitigation fee (non-CAD borrow)	cyd	$3.00	30,000	$90,000	92,000	$276,000
Total Estimated Concept Cost for 10th Year CAD Cell:				**$234,000**		**$649,400**
Total Estimated Concept Cost for 10-Year CAD:						
Pre-construction				$50,000		$50,000
1st-year CAD				$502,000		$1,626,800
2nd through 9th-year CAD (eight CAD cells)				$2,928,000		$10,091,200
10th-Year CAD				$234,000		$649,400
Total Estimated Direct Costs:				**$3,714,000**		**$12,417,400**
ADD (Assumed):	Indirect Costs (15%)			$557,100		$1,862,610
	Contractor Profit (10%)			$371,400		$1,241,740
	Contingencies (20%)			$742,800		$2,483,480
Total Estimated 10-Year Concept Cost:				**$5,385,300**		**$18,005,230**
	(Unit cost)			$10.77		$9.00

5.0 References

Palermo M. R, J. E. Clausner, M. Channel, and D. E. Averett, 1998. "Multiuser Disposal Sites (MUDS) for Contaminated Sediments from Puget Sound - Subaqueous Capping and Confined Disposal Alternatives," Draft MUDS Rept. No. 4, U.S. Army Corps of Engineers, Waterways Experiment Station, Vickburg, MS.

APPENDIX D

INSTITUTIONAL STUDIES

Prepared for:
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APPENDIX D

INSTITUTIONAL STUDIES

The MUDS interagency team, comprising the U.S. Army Corps of Engineers, the Environmental Protection Agency, the Washington Departments of Ecology and Natural Resources, the Puget Sound Water Quality Authority, and the Washington Public Ports Association, has been studying how to site, operate, and manage a potential MUDS facility. As part of this ongoing effort, numerous studies have been performed over the last 10 years for different facets of developing and operating a MUDS facility. This appendix summarizes the following two institutional studies that are part of this effort:

- Marten & Brown, LLP. 1996. *Suggested Elements of a Contingency Management Agreement*. Prepared for Washington Department of Natural Resources.
- Fernandes Associates and PTI Environmental Services. 1989. *Multiuser Confined Disposal Sites Program Study: Institutional Options Analysis Issue Paper*. Prepared for Washington Department of Ecology.

The purpose of the Contingency Management Agreement report and the Institutional Options Analysis Issue Paper was to conceptually evaluate what elements would be critical to understand and address in fully implementing a multiuser disposal facility. The goal was to present potential combinations of entities who could be involved in a MUDS facility, the types of problems that may surface, and all potential contingencies that might occur so that the final decision to implement a facility could be well informed. The intent of adding a short summary of these reports as an appendix to the EIS is to convey to the reader that the MUDS interagency team is evaluating all aspects of implementing a facility, including the low-probability, worst-case scenarios.

The decision to implement any of the ideas contained in these reports on how to organize roles, manage the facility, or share liability for such a facility would be made separate from a decision to proceed with an alternative contained in the EIS. Any decision to establish a new institutional arrangement for overseeing a MUDS facility would have to comply fully with the State and National Environmental Policy Acts and any required permitting processes and public/agency review. It is not the intent of this EIS to evaluate these potential institutional arrangements.

TABLE OF CONTENTS

LIST OF TABLES

1.0 CONTINGENCY MANAGEMENT AGREEMENT

Before a MUDS facility could begin operation, several issues would need to be resolved, such as: what role(s) various federal and state agencies and private sector entities would perform in planning, operating, managing, and closing a MUDS facility; who would establish standards for the facility; how would costs and the liability of a facility be allocated between various parties; what contingencies would need to be managed; and what tools would be available for managing those risks. All of these various elements would be included in a Contingency Management Agreement.

1.1 POTENTIAL MUDS ROLES

This section describes the potential planning, operating, managing, and closing roles different entities could fulfill at a MUDS facility, and describes what the role would entail, what responsibilities would be included, and what types of protection would be provided to entities in those roles.

1.1.1 Planning

1.1.1.1 Standard Setting and Management Planning

The planning role could be divided between a standards setting and management planning role, and a site selection role. The standards setting and management role could provide general oversight of the operation and would include the task of defining the standards needed to regulate a MUDS facility from start to finish. As part of the planning role, the agency or agencies could establish and help implement standards in addition to the existing laws. Typical functions in this role might include drafting a management plan, setting disposal standards, setting testing and monitoring requirements, setting siting guidelines, establishing closure and post-closure requirements, and oversee inspections and permit development.

Responsibilities for the planning role might include reviewing environmental policies and procedures, contingency planning, developing agreements with outside emergency response services, performing user education to reduce the risk of unwanted material being placed in a MUDS facility, undertaking market research to determine need for disposal sites, contracting with users to bring in fixed amounts of dredge material, and providing the lead role for permit conditions, consent decrees, and administrative orders.

The planning role may also be responsible for establishing insurance for any contingencies, ensuring funding for operation and closure of a MUDS facility, and entering into indemnification agreements with operators and uses of the facility.

1.1.1.2 Site Selection

Agencies in the site selection role would determine the need for a MUDS facility at a specific site, help determine the disposal capacity available, coordinate public input during the siting process, help develop site alternatives, conduct or help coordinate environmental and cost analysis, and develop final site recommendations.

The primary responsibility of the site selection role would be to develop a site in a location that provides a high margin of safety and therefore minimize the liability associated with the facility. In addition to picking the best location, the site selection role would assist with permit conditions, Consent Decrees, and Administrative Orders.

The site selection role might also use insurance, assurances of full funding for operation and closure of a MUDS facility, and indemnification agreements with operators and uses of the facility to reduce their liability.

1.1.2 Operation and Management

The operation and management role could be split into five sub-roles: 1) owning the site, 2) permitting, designing, and constructing the site, 3) operating the site, 4) using the MUDS facility, and 5) being a transporter of material to the MUDS site.

1.1.2.1 Owner

The site where the MUDS facility is located would be owned by an agency or private entity. Their responsibilities would include routine review and enforcement of environmental policies and procedures and any permit conditions to reduce potential liability. The owner can use insurance, indemnities with users and operators of the site, and various agreements to reduce the liability of owning the site. The role and responsibilities of the owner could be merged with the operator.

1.1.2.2 Permit/Design/Construct

In the permit/design/construct role, the agency would be responsible for designing and constructing the MUDS facility. They would be responsible for selecting, reviewing, and supervising engineers and contractors during construction, and may also be responsible for ensuring proper permits are obtained. The primary responsibility for this agency would be to make sure the MUDS facility is designed and constructed with a high margin of safety. The agency overseeing the design and construction of the site can use insurance, indemnities with users and operators of the site, and various agreements to reduce the liability of designing and constructing the site.

1.1.2.3 Operator

The agency or entity operating the facility would be responsible for the daily operation of the site, including renewing permits, tracking costs versus revenue, and developing and implementing monitoring and contingency plans. In addition, this agency would be responsible for closing the site and arranging for finance closure requirements, regular inspections and audit programs, adequate staffing and training, internal and external reporting, review of environmental policies and procedures, environmental monitoring, and screening and educating users and transporters to ensure that the dredge material meets identified specifications. Having dedicated funding and a clear legislative mission would help to prevent any lapse in priority by the operator, and having one person in charge may also ensure that there is no lapse in the operator's attention.

The entity operating the site can use insurance, indemnities with users of the site, and various agreements to reduce the liability of operating the site. The language in an operating agreement can include provisions for good behavior such as reducing the frequency of audits if the operator has an exemplary compliance record, and disincentives for poor behavior such as making the parent corporation liable for lapses in attention. Provisions allowing right to access and sample the user's cleanup site would also protect the operator from liability.

1.1.2.4 User

The user would be the entity who disposes of dredged material in a MUDS facility. Responsibilities include screening of dredged material to help prevent unwanted material from entering the MUDS facility, educating themselves about the appropriate material for disposal in a MUDS facility, and considering entering into indemnity agreements with the operator of the facility. If there is a regulatory change creating additional closing costs, these costs may be shifted to the users of the facility.

1.1.2.5 Transporter

The transporter would be the entity who transports dredged material to a MUDS facility. Responsibilities include screening of dredged material to help prevent unwanted material from entering the MUDS facility, educating themselves about the appropriate material for disposal in a MUDS facility, and considering entering into indemnity agreements with the operator of the facility.

1.1.3 Post Closure

1.1.3.1 Post-Closure Care

The entity in this role would be responsible for any long-term care of a MUDS facility. Responsibilities would include any monitoring and financial assurance requirements, compliance with lease provisions, Consent Decrees, and Administrative Orders; and adhering to any contractual provisions making the entity in this role responsible for its actions and the actions of its tenants. This entity could use insurance, indemnities from previous occupants for previous conditions, lease provisions, permit conditions, and other liability shifting agreements to protect itself from liability.

1.1.3.2 Tenant

The tenant would be the entity allowed to develop the site after it is closed. Responsibilities include indemnifying the owners of the site and complying with any lease provisions, permit conditions, Consent Decrees, and Administrative Orders. A tenant would use insurance, indemnities from previous conditions, easement language, and other liability shifting agreements to protect themselves.

1.2 MUDS MANAGEMENT SCENARIOS

The next step would be to identify the agency or private entities that might fill each of the roles identified above. The MUDS interagency team considered the following entities: federal government, state government, local government, ports, private entities, a coordinating council, and a new government authority. Ports and private entities were not considered realistic options for the standard setting role. It's important to note that implementing a new management scenario would require a separate SEPA/NEPA review and public/agency review and comment process.

1.2.1 Standard Setting and Management Planning

The interagency team came to the consensus that a coordinating council made up of representatives from different agencies was the most likely option for this role. The second most likely option was a new authority. Beyond these two groups, the interagency team felt the likelihood of other entities establishing standards for the MUDS was less.

1.2.2 Site Selection

Again, the interagency agreed that a coordinating council would be the best choice for selecting sites for MUDS facilities. A new authority or a private entity was the second best option.

1.2.3 Permit/Design/Construction

For the permit/design/construction role, a new authority or a private entity was considered the most likely. The federal government was also ranked first and a coordinating council ranked second.

1.2.4 Owner

The interagency team ranked a new authority, private entity, or state government as the most likely entity to fill the role of owner. Local governments and ports were ranked second.

1.2.5 Operation

A new authority or a private entity were ranked as most likely to operate a MUDS facility. The group placed federal government, local government, and ports in the second tier.

1.2.6 Post-Closure Care

The interagency team felt that post-closure care was most likely to be undertaken by the owner of the MUDS facility. Therefore, the rankings were the same as those for the owner: new authority, private entity, or state government.

1.3 POTENTIAL CONTINGENCIES AND RANKING

In understanding what potential liabilities must be considered to site and operate a MUDS facility, it was important to identify all the things that could possibly go wrong at a MUDS facility. This section briefly describes and provides examples of potential problems that could surface at a MUDS facility. (For a complete listing of potential contingencies, see Marten & Brown 1996.) In addition, the interagency team agreed to rank the contingencies by the probability that the contingency might occur and the potential magnitude of the resulting harm. This exercise was intended to be comprehensive in identifying all events that could possibly occur, regardless of how "likely" the events were to occur. For this reason, many low-probability, worst-case scenarios are discussed. Potential problems include the following:

- Act of God, such as natural disasters like floods, earthquakes, windstorms, slope failure, or severe weather
- Act of war, including terrorism.
- Human action/inaction by a MUDS participant, including:
  - Breach of consent decree or private agreement
  - Agency funding for project reduced or eliminated
  - Entity goes bankrupt
  - Cost overruns
  - Schedule delays
  - Construction deficiency
  - Failure to obtain or comply with permit
  - Regulatory standards not followed
  - Failure to report release or spill
  - Failure to maintain closure or post-closure care
  - Sediment transporter accidents en route to site.
- Human action/inaction by a third party, including:
  - Off-site dumping
  - Midnight dumping
  - Vandalism

- Trespassers.

- Change in conditions, such as:
  - Lack of demand for a site
  - Standards or regulations change
  - Public policy change
  - Erosion
  - Bioturbation
  - Salt leached to fresh water
  - New scientific information obtained
  - New technological resource discovered.

- Disputes between parties
  - Disputes with contractors and subcontractors,
  - Employee disputes,
  - Rate or fee disputes with users,
  - Breach of consent decree or private agreement.

1.3.1 Ranking of Contingencies

The intent of the ranking was to include everything that could possibly go wrong, and then assess how likely an event would be and the level of resulting harm. The results of the ranking allows the interagency team to focus on the contingencies that are more likely to occur or that would cause the greatest harm. Using their best professional judgment and some empirical data on disposal site failure, the interagency team ranked contingencies into broad high-medium-low categories. The interagency team found it useful to create definitions for the high, medium, and low categories to enable them to focus on which contingencies needed further discussion. Even though some contingencies ranked low, all contingencies regardless of ranking would be managed in some form in the Contingency Management Agreement through the use of the contingency avoidance tools discussed in the next section.

Table 1 shows the results of this exercise. The contingencies are organized into the same categories as Section 1.3.1, and the ranking is for three different disposal environments: aquatic, nearshore, and upland. For a high ranking, the interagency team determined that it had an 80 percent chance of occurring. A medium ranking represented a 50% chance of occurring, and a low ranking indicated a less than 20% chance of occurring. Because of the importance of protecting the environment for future generations, the interagency team assumed the probability would be judged over a long planning horizon, such one hundred years or more.

For ranking the potential harm from a contingency event occurring, a high ranking had the potential to create a monetary liability of greater than $10,000,000. A medium ranking created a liability between $1,000,000 and $10,000,000. A project would also be ranked medium if it created a substantial risk to human health or the environment. A low ranking had a monetary liability of less than $1,000,000 and did not create a substantial risk to human health or the environment.

1.3.2 Contingency Avoidance Tools

The interagency team identified several management tools that could be used to limit potential liabilities associated with a MUDS facility. These tools are categorized into the following five categories:.

- **Specifications:**
  - MUDS Design
    - Engineering design
    - Construction specifications
    - Siting/location.
  - MUDS Operation
    - Contingency planning
    - Agreements with outside response services
    - Regular inspections
    - Audit program
    - Regular monitoring
    - Adequate staffing
    - Routine training
    - Employee incentives to perform operations in compliance with standards
    - Internal and external reporting procedures.
- **Legal agreements between MUDS participants or with third-party entities:**
  - Permit conditions
  - Lease language
  - Easement language
  - Construction contract
  - Design contract
  - Operating agreement language
  - Indemnities
  - Representations and warranties
  - Other liability shifting agreements (i.e. when liability shifts from transporter to operator)
  - Arbitration and mediation clauses

- Interagency agreements
- Consent Decree/Administrative Order on Consent
- Port management agreements.

- **Funding Mechanisms:**
  - Escrow accounts
  - Letters of credit
  - Bonds
  - Corporate guarantees.

- **Legislative Changes:**
  - New authorities, made up of representatives from different agencies
  - Legal immunities or defenses.

- **Insurance**

Table D-1. Ranking of potential contingencies and resultant harm by environment type.

Contingency	Aquatic Liability	Aquatic Harm		Nearshore Liability	Nearshore Harm		Upland Liability	Upland Harm
Act of God	Low	Medium		Low	High		Low	High
Act of War	Low	High		Low	High		Low	High
Human Action/Inaction MUDS Participant								
Standard Setting/Mgmt Plans	Low	Medium		Low	Low		Low	Medium
Site Selection	Low	Medium		Low	Medium		Low	High
Design/Permit/Construct	Low	Medium		Low	High		Low	Medium
Operate	Medium	Low		Medium	Medium		Medium	Low
Own	Low	Low		Low	Low		Low	Low
User	Medium	Medium		Medium	Medium		Medium	Low
Transporter	Medium	Medium		Medium	Medium		Low	Low
Post-Closure Care	Medium	Low		Medium	Low		High	Low
Tenant	N/A	N/A		Medium	Medium		High	Medium
Human Action/Inaction Third Party	Low	Medium		Medium	Medium		Medium	Medium
Change in Conditions								
Market	Medium	Medium		Medium	Medium		Medium	Medium
Environmental	Low	Medium		Low	Medium		Low	Medium
Science/Technology	Medium	Medium		Medium	Medium		Low	Medium
Regulatory	High	Medium		High	Medium		High	Medium
Disputes Between Parties	Medium	Low		Medium	Low		Medium	Low

2.0 INSTITUTIONAL OPTIONS

The objective of the Institutional Options Issue Paper prepared in 1989, and summarized in this section, was to develop and analyze a representative set of general institutional options for managing multiuser disposal facilities that will serve as a basis for consensus building or public review. The approach used in defining institutional options for analysis was to conduct an overview of the existing system for disposing of dredged material and identify the major stakeholders and the major problems. The functions to be implemented in a multiuser site program were then developed and various combinations of responsibilities for the major stakeholders in implementing these functions were created. Each combination of responsibilities for the major stakeholders represents an institutional option.

Implementing any of the institutional options described in this report would require separate review and public/agency comment under the State and National Environmental Policy Acts. This environmental impact statement does not evaluate the options presented in this report.

2.1 STAKEHOLDERS

The stakeholders identified in this paper include:

- Federal agencies – Corps of Engineers, Environmental Protection Agency, National Marine Fisheries Service, National Oceanic and Atmospheric Agency, U.S. Fish and Wildlife Service, and the Navy
- State agencies – Departments of Ecology, Natural Resources, Fish and Wildlife; Puget Sound Water Quality Authority (now called the Puget Sound Action Team); and the Shorelines Hearing Board
- Local government – City and county health, planning, and public works departments
- Ports – local Ports and the Washington Public Ports Association
- Tribal governments
- Other aquatic users – marinas, boat repair, and industrial/commercial transportation
- Private enterprise
- General public
- Environmental organizations

In addition to the stakeholders identified above, two potential new entities were added to the list: a Coordinating Council and a New Authority. A Coordinating Council would coordinate, delegate, and oversee the functions under its direction. This council may take the lead role in coordinating tasks, do so jointly with other entities, or delegate the responsibility. It would have a planning and coordinating role, but would implement actions as well.

A New Authority would be an entity that undertakes all planning and implementing functions including, developing a coordinated management plan, siting, regulation, permitting, construction, ownership, operation and funding of facilities.

2.2 ROLES

The roles that stakeholders could have were simplified into three broad categories: lead responsibility, joint responsibility, and mixed responsibility.

2.2.1 Lead Responsibility

This is the prime responsibility and authority for implementing a task. The lead agency may delegate the execution of functions to other entities or complete those tasks themselves.

2.2.2 Joint Responsibility

This term refers to two or more agencies sharing responsibility for a specific function, with one agency designated as lead agency. It differs from the lead responsibility above in that the relationship between agencies is a formally recognized organizational unit formed for the specific function.

2.2.3 Mixed Responsibility

This role refers to the ports, local governments, and private enterprise with ownership, monitoring, construction, closure plan, and rate setting responsibilities for different facilities.

In actual practice, the roles would be more complex when implementing actions. For example, permitting a facility would require many state, federal, and local permits in which many individual entities would take a lead role in permitting. In addition, many stakeholders may have to concur with a permit before its issuance, and most stakeholders can take legal action to prevent the issuance of a permit.

2.3 FUNCTIONS

The functions related to management and operation of contaminated sediment disposal facilities are divided into five categories: planning/regulation, siting, operation, closure/post-closure, and advisory. The functions included in each of these categories are listed in the following sections.

2.3.1 Planning/Regulation

The planning and regulation functions related to management of contaminated sediment disposal facilities include:

Coordinated management plan. The development of a comprehensive program of strategies for handling contaminated dredged material from the time it is dredged and disposed of, to the closure and post-closure of disposal facilities.

Standards. Standards include defining what dredged materials require confined disposal, setting testing and monitoring requirements, setting siting guidelines, and establishing site closure and post-closure requirements.

Oversight regulation. Overseeing compliance with regulatory requirements of users, owners, and operators.

Liability management. The process of designing disposal management so as to mitigate problems and minimize liability, identify specific liability responsibility and determine how liability should be financed, including apportioning shares among those involved.

2.3.2 Siting

The siting functions related to management of contaminated sediment disposal facilities include:

Site selection. Determining the need for sites and the required capacities, developing alternative site options, conducting environmental and cost analyses, developing final site recommendations, and obtaining community acceptance for the location of specific facilities.

Construction. The design and construction of specific disposal facilities.

Permitting. Responsibility for the final permit for the site.

2.3.3 Operation

The facility operation functions related to management of contaminated sediment disposal facilities include:

Ownership/operation. Refers to the daily operation of a facility; permit renewals, and responsibility for costs and revenues. Ownership and operation can be separate, and can be undertaken by either public or private entities.

Monitoring. Monitoring day-to-day operational activities to ensure compliance with permit requirements.

Rate setting. Establishing rates for the users of facilities. Ongoing task to be completed on a regular basis to ensure that all costs for operation, as well as maintenance, closure and post-closure are taken into consideration.

2.3.4 Closure/Post Closure

The closure/post closure functions related to management of contaminated sediment disposal facilities include:

Closure Plan. A plan for closing a facility including issues such as closure construction, monitoring and contingency plans in case of failure, and plans for financing closure and post-closure requirements.

Liability. Assumption of liability undertaken through cash payments, insurance coverage, etc. Would follow from liability management plan identifying stakeholders and their proportionate share amount.

2.3.5 Advisory

The advisory function refers to a broad range of review and advice on all functions to those agencies in lead or joint roles. It could refer to advisory committee participation or more active involvement in plan development.

2.4 PROBLEMS

The major institutional problems associated with the existing system of managing and disposing of dredged material in 1989 included:

- Lack of capacity and increasing difficulty in siting facilities for contaminated dredged material
- Lack of a coordinated management plan for dealing with contaminated dredged material
- Lack of assurance regarding the consistency and standards for disposing of dredged material in an environmentally sound manner (*Sediment Management Standards are now in place*)
- Lack of assurance that the current method of disposal results in the most cost-effective means of disposal
- Inadequate involvement by some stakeholders in disposal planning and decision-making.

2.4.1 Siting

The most significant of the problems would be siting a new facility. Communities would resist siting a facility near them despite the need for waste disposal facilities and available land. Primary concerns are the potential environmental and human health impacts and the lack of belief that adequate safeguards are available. Communities are concerned that cost-cutting measures would outweigh promises made to communities about environmental controls. Another concern is that current knowledge about environmental impacts may not accurately reflect long-term damage, and that analytical techniques may not be sophisticated enough to detect all potential hazards.

Siting a facility used to entail a process of determining land that was available and then screening potential sites based on technical criteria. Major site determinations now include a major community negotiation process. Some entities have land that they can make available for waste disposal and that could potentially put them in a more favorable position than those that do not. Some institutions have access to funding sources that others do not. Liability management is also a concern in siting facilities because of the uncertainty of the amount and share of that liability.

2.4.2 Lack of Coordinated Plan

Dredged material disposal is typically handled on a project-by-project basis. The lack of coordination between dredgers, transporters, permitting agencies, disposal site owners/operators, and those entities who need dredging leads to inefficiencies in operations. There is no entity authorized to coordinate the management and disposal of contaminated sediment, resulting in overlaps or gaps in service.

2.4.3 Environmental Considerations

Concern was raised in the 1989 Institutional Options Issue Paper about the lack of consistent, environmentally sound handling of contaminated sediment due to the lack of confined disposal standards.

2.4.4 Cost Considerations

The existing dispersed system of managing and disposing of dredged materials is less cost-effective than it might be with a centralized multiuser system with established standards and a comprehensive management program.

2.4.5 Involvement

Contaminated dredge material management and disposal has included major stakeholders in the process, but not all users and interested groups. There is no assurance that the interests of all stakeholders are taken into consideration.

2.5 INTERVIEW FINDINGS

Information on institutional arrangements was gathered by literature search or direct interview from related waste disposal examples around the country. Contacts for the interviews included representatives from mineral waste, solid waste, hazardous waste, and dredged material waste. The entities researched or interviewed included the Delaware Solid Waste Authority, Maryland Port Authority, Great Lakes Detroit District of the Corps of Engineers, Connecticut Resource Recovery Authority, Connecticut Hazardous Waste Management Service and Siting Council, Rhode Island Waste Management Board, and New York State's Siting Entities/Activities.

The focus of the interviews was to gain information on the institutional arrangements for disposing of waste. The types of information collected included:

- Type of waste handled
- Major activities

- Institutional arrangements in place
- Users of facilities
- Siting process uses/recommended
- Liability management
- Problems encountered
- Funding.

The types of institutional arrangements identified include:

- Specially created authority with full planning and implementation authority
- State lead with regional district support institutions
- Federal lead with local state sponsorship
- State lead for planning and regulation, with a non-profit, quasi-public authority as implementing agency
- State lead for waste management service with a siting council for siting facilities
- Quasi-governmental, state-level board
- Local government prime responsibility with state regulation.

The study found that the type of institutional arrangement in place appeared to have less effect on the success in siting facilities than the planning and siting process that was used. Collaborative, negotiated planning and siting processes appeared to have the best chance for success. Another significant finding was that the authority bestowed on the entity in charge was a major contributor to its being able to successfully site facilities. The implications of these findings are that the authority and the siting process are two key ingredients as part of an institutional option.

2.6 PROCESS FOR SELECTING INSTITUTIONAL OPTIONS FOR EVALUATION

Given the large numbers of functions to be performed and the stakeholders that could be involved in an institutional arrangement for implementing a MUDS facility, there are several combinations of stakeholders and functions that could be derived. The report had a goal of arriving at six to ten options that represented a reasonable range. Some decisions were made to keep the number of options within the stated range:

- Delay consideration of institutional arrangement variation by disposal environment (aquatic, nearshore, and upland) and geographic coverage until a later stage in the process
- Create a set of institutional options for analysis based on best judgement of the most likely and appropriate stakeholders to perform the needed functions
- Keep the options and the analysis at a general level in order to focus on the key "big picture" issues until a later stage in the process.

2.7 SELECTED INSTITUTIONAL OPTIONS

The seven potential institutional options discussed included the following:

1. Status quo
2. State/local government/port
3. State/local government/private
4. Federal/state/port/local government
5. Coordinating council
6. New authority
7. Federal

Options 2 through 7 have some characteristics in common. All those involved in dredging, transport, and disposal are responsible for liability as determined by the liability management plan. All other stakeholders not specifically identified for the tasks under each option are involved in an advisory role. Options 2, 3, and 4 do not require new legislative authority. Options 5, 6, and 7 will require new legislative authority.

Two additional options are discussed, but not analyzed for the management of all waste: a coordinating council, and a new authority.

2.7.1 Status Quo

Responsibilities vary depending upon the disposal environment. The state is responsible for contaminated sediment and dredging planning, but there is not currently a requirement for a coordinated management plan. The state is responsible for the Sediment Management Standards. Oversight regulation is a mixture of federal, state, and local government responsibilities involving several different laws and regulations.

Liability management has not been resolved. Liability responsibilities have not been clearly defined, but all stakeholders involved in dredging, transporting, and disposing of contaminated sediments have some liability.

Site selection and construction are generally the responsibility of the project proponent, and site permitting is the responsibility of local, state, and/or federal governments. Ownership, operation, and monitoring is generally the responsibility of the project proponent. The local sponsor has the responsibility in the case of Corps dredging, and local governments or private entities have the responsibility for municipal landfills.

Rate setting is only used at municipal landfills and that is the responsibility of local government. (Private landfills now accept contaminated sediment, and private entities are responsible for negotiating the rates.) Closure is the responsibility of the project proponent, but closure plans are not consistently required.

2.7.2 State/Local/Ports

The state would have lead responsibility for developing the coordinated management plan, standards, oversight regulations, and liability management. Local government would have the lead responsibility for site selection and permitting. Ports would have the lead responsibility for site construction; operation of the facilities, including ownership/operation, monitoring and rate setting; and the closure plan.

2.7.3 State/Local/Private

The state would have lead responsibility for standards, oversight regulations, and liability management. Local government would have the lead responsibility for developing the coordinated management plan, site selection, and permitting. A private entity would lead construction, ownership/operation, monitoring, rate setting, and the closure plan for each facility.

2.7.4 Federal/State/Port/Local

A federal/state/port/local entity similar to PSDDA would share joint responsibility for the coordinated management plan, standards, oversight regulation, liability management, and site selection. The ports would have lead responsibility for constructing sites, ownership/operation, monitoring and rate setting at particular sites; and the closure plan. Local governments would lead permitting responsibilities.

2.7.5 Coordinating Council

A coordinating council would be appointed by the state with representatives from each of the major categories of stakeholders. It would have lead responsibility for the coordinated management plan, standards, oversight regulation, liability management, site selection, rate setting, and the closure plan. The state and local governments would have lead responsibility for identifying and obtaining a network of multiuser sites. The state would also be responsible for permitting, and the local government would also be responsible for construction, ownership/operation, and monitoring of the sites.

2.7.6 New Authority

A new authority would be created with extensive powers to undertake almost all phases of contaminated sediment management from planning to ownership and operation of the sites. A professional staff could provide the necessary technical support. This new authority would have the lead responsibility for standards, oversight regulations, liability management, the coordinated management plan, site selection, permitting, construction, ownership/operation, monitoring, rate setting, and the closure plan for each facility.

2.7.7 Federal

A federal agency would have lead responsibility for developing a coordinated management plan, establishing standards, oversight regulation, and liability management. The state would have lead responsibility for site selection and permitting. Ports, local governments, and the private sector would be responsible for site ownership, operation and monitoring, site construction, rate setting, and closure plans.

2.7.8 Coordinating Council – All Waste

Unlike the option discussed in Section 2.7.5, this option would handle all waste types (e.g. solid waste, hazardous waste). A coordinating council would be formed with representatives from the stakeholders from the stakeholders list for contaminated sediment, as well as from other types of waste. This coordinating council would have lead responsibility for the coordinated management plan, standards, oversight regulation, liability management, and the closure plan. The state and local governments would have lead responsibility for implementing the siting portions of the plan. The state would have responsibility for site selection and permitting for all contaminated waste. Local governments would have responsibility for construction, ownership/operation, monitoring, and rate setting.

2.7.9 New Authority – All Waste

Unlike the option discussed in Section 2.7.6, this option would handle all types of contaminated waste. A new authority would be created with extensive powers to undertake almost all phases of contaminated waste disposal from planning to ownership and operation of the sites. A professional staff could provide the necessary technical support. This new authority would have the lead responsibility for standards, oversight regulations, liability management, the coordinated management plan, site selection, permitting, construction, ownership/operation, monitoring, rate setting, and the closure plan for each facility.

2.8 EVALUATION OF INSTITUTIONAL OPTIONS

2.8.1 Approach

The options were evaluated based on their ability to resolve the problems identified with the existing system:

- Improve the capacity and possibilities for siting facilities for disposal of contaminated sediments
- Develop a coordinated management plan for dealing with contaminated sediments
- Provide an environmentally sound means of disposing of contaminated sediments
- Dispose of material in the most cost-effective manner consistent with environmental and public health considerations
- Involve more stakeholders in an active advisory capacity.

2.8.2 Criteria for Evaluating Options

The criteria for evaluating institutional options are listed in the following sections.

2.8.2.1 Siting

The institutional option evaluation criteria related to siting include the following:

Authority. The authority of an entity to site facilities was considered by some to be one of the most significant criteria in the ability to site a facility. An institution may also enhance its siting capability through authority to develop and establish siting criteria and standards.

Process. The community involvement process was widely recognized as being the foremost factor in successfully siting waste facilities.

Availability of Land. The ability to site a facility may also be affected by the availability of land as determined by ownership or the ability to make land available to an institution. A state or federal agency with land may be in a more advantageous position than one that has to first acquire the property.

Liability Management. The long- and short-term hazards involved in managing and disposing of contaminated sediment is not fully known. Potential liability has become a major factor in undertaking siting responsibilities.

2.8.2.2 Coordinated Management Plan

The institutional option evaluation criteria related to management plans include the following:

Authority. A new institutional arrangement should be in a position to develop and implement the plan. The entity must have the authority and appropriate relationships with implementing agencies in order to carry out the intent of the plan. Another factor in determining the effectiveness of the development and implementation of the coordinated management plan is the relationship with agencies.

Coordination. The institution charged with the responsibility of developing a coordinated management plan should be able to adequately coordinate the activities of the agencies involved. Stakeholders and the community want to be assured that the institutional arrangement provides the maximum understanding of and interest in the entire geographic region.

Staffing. Any institutional arrangement should be structured to provide the ability to hire and retain qualified staff.

2.8.2.3 Environmental Considerations

The institutional option evaluation criterion related to environmental considerations is consistency. This criterion refers to being able to consistently implement environmental standards across the service area in order to achieve environmental and public health protection.

This means consistent establishment and enforcement of standards in all disposal environments (aquatic, nearshore, and upland).

2.8.2.4 Cost Considerations

The institutional option evaluation criteria related to cost include the following:

Cost effectiveness. The cost-effectiveness of institutional arrangements will vary and will be a major factor in determining their viability. A decentralized arrangement could result in the duplication of services and subsequent increases in cost. A new institutional arrangement would likely cost more to start up than an already existing arrangement.

Funding. An important consideration is the ability of an institutional arrangement to secure funding for its own planning, operation, and capital facilities. Bonding authority may be required for capital investments. The authority to charge user fees could be important, and access to grant funding may also help.

2.8.2.5 Representation

The institutional option evaluation criteria related to actual or perceived representation include the following:

Involvement. The involvement of stakeholders and the public in major decisions will also be a factor in determining the potential of an institutional arrangement to meet the objectives. The arrangement should have, and the public should perceive, that the arrangement represents the entire region.

Equity. Stakeholders want to be assured that costs and services are equitably distributed and that their needs are being adequately addressed.

2.8.2.6 Implementation

The institutional option evaluation criteria related to ease of implementation include the following:

Compatibility. The ease with which different institutional arrangements may be implemented depends on the compatibility with the existing administrative framework and programs.

Legal Authority. Some institutional arrangements will require legal changes in order to take on new responsibilities, while others may not.

Political/Public Acceptability. Creating a new arrangement may have several advantages, but creating something new rather than working within the existing framework may be looked on unfavorably.

2.8.3 Analysis of Institutional Options

The analysis of the different institutional options was conducted by evaluating the advantages and disadvantages of each option with respect to meeting the criteria described above. The evaluation includes a significant amount of judgment. Consensus among the stakeholders will be important in implementing any institutional option.

The options were evaluated based on the following general assumptions:

- The status quo was evaluated on the basis of the current situation rather than the potential.
- A coordinated management plan could be developed in all options so evaluation is based on the likelihood of successful development and implementation.
- A mechanism for ensuring a consistent and predictable flow of waste to each established disposal site is necessary in order to ensure a steady stream of revenue to pay for capital investments.
- The evaluation is conducted for options 2 through 7, but does not include the all-waste options.

There are certain advantages and disadvantages common to options 2 through 7. They all have the advantages that 1) development of siting guidelines and a liability management plan would improve the siting process, 2) a coordinated management plan would be developed and would have a reasonable chance for successful implementation, and 3) funding of the program is more likely because of the coordinated effort among the various agencies.

2.8.3.1 Status Quo

The advantages of this option is that it is in place and has the potential for improvement without the disruption posed by a new arrangement.

The disadvantages include: siting waste facilities is difficult, a coordinated management plan does not exist, a liability management plan does not exist, sites are not consistently permitted, there is inconsistent oversight of disposal and little centralized support, current planned functions are not adequately funded, and major stakeholders are involved, but intermediate and minor stakeholders are not involved.

2.8.3.2 State/Local/Ports

Advantages of this option include that siting may be improved for aquatic and nearshore sites due to the role of the ports in site ownership, environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the three major stakeholders, and the option is fairly compatible with the existing system and easily implemented.

The disadvantages include the lack of a major role for the federal government, especially the Corps and EPA; the three major stakeholders have other responsibilities that could divert their attention; and a potential stakeholder, the private sector, does not have a role.

2.8.3.3 State/Local/Private

The advantages are 1) the private sector may own land that could be used for a disposal facility; 2) environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the three major stakeholders; 3) the private sector may be more cost-effective in developing and operating sites; and 4) the option is fairly compatible with the existing system and easily implemented.

Disadvantages include 1) the exclusion of the ports may have a negative impact on the availability of sites, especially in nearshore areas; 2) a lack of a strong role for the Corps and EPA may have a negative impact on funding, cost-effectiveness, and development of a coordinated management plan; 3) the ports and federal government do not have significant roles; and 4) the entities involved have other responsibilities and may not maintain a focus on the issue.

2.8.3.4 Federal/State/Port/Local

The advantages of this option include: 1) siting may be improved because of the coordinated role assigned the four entities in site selection; 2) environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the four major stakeholders; 3) funding is likely because of the more coordinated approach and the involvement of the federal government; 4) services might be centralized; 5) all major stakeholders have key roles which will improved coordination and funding; 6) the option is fairly compatible with the existing system and could be easily implemented; and 7) this PSDDA type arrangement has been successfully used in establishing open-water confined disposal sites.

The disadvantages of this option are that it may lack the focus and authority of an entity established specifically for dredged material management.

2.8.3.5 Coordinating Council

Advantages of this option include: 1) siting may be improved because of the role assigned to the coordinating council in site selection; 2) the development of a coordinated management plan would be facilitated due to the involvement of major stakeholders; 3) environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the major stakeholders; 4) centralized rate setting should improve equity and flow control; 5) centralized permitting by the state may be cost effective; 6) there would be maximum stakeholder involvement in all functions thereby ensuring greater equity; and 7) there would be an exclusive focus on dredged material management and disposal.

The disadvantages of this option are: 1) the ports and private sector do not have a role in site construction, ownership, and operation; 2) it is significantly different from the status quo so implementation may be difficult; and 3) obtaining approval for a state level coordinating council may take legislative action.

2.8.3.6 New Authority

Advantages of the new authority option are: 1) siting may be improved because of the role assigned to the new authority in site selection and that a centralized siting authority may enhance the ability to establish sites; 2) the development of a coordinated management plan would be facilitated due to the involvement of major stakeholders; 3) environmental consistency would be improved due to the development and implementation of siting guidelines and disposal standards and the broad geographic coverage of the major stakeholders; 4) representation would be improved because the option is designed to include key stakeholders; and 5) there would be an exclusive focus and clear authority on dredged material management and disposal.

The disadvantages of the new authority option include: 1) it would cost more and funding may be problematic; 2) political and public acceptance may prove difficult; 3) it would not be compatible with the existing system; and 4) legislative action would be required to establish the new authority.

2.8.3.7 Federal

The advantages of this option include: 1) siting a facility may be easier because of possible use of federal lands for sites; 2) funding would be more likely because of the federal role; and 3) some federal agencies such as the Corps have existing technical expertise and administrative structures for dealing with dredged material.

The disadvantages include: 1) congressionally-approved funding may be required; 2) federal oversight regulation may not ensure consistent implementation; 3) the federal government may not be perceived as representing local stakeholders; 4) it is not compatible with the existing system; 5) public and political acceptance may be difficult; 6) the entities involved have other responsibilities and maintaining a focus on dredged material may be difficult; and 7) congressional authorization may be required for a federal agency to take over these functions.

2.8.4 Ranking

Table 2 shows the numerical ranking after applying the evaluation criteria to the options and weighing the advantages and disadvantages. Scored on a scale of 1 – 10; the higher the score, the better the option. Implementation of any of the options discussed in this report will require compliance with state and national environmental regulations and a separate public/agency review and comment process. The options discussed here are not evaluated as part of this EIS.

2.8.5 Conclusion

- The most significant problems with the existing institutional arrangement in order of priority are:
  - lack of capacity and increasing difficulty in siting facilities for contaminated dredged material

- lack of a coordinated management plan for dealing with contaminated dredged material
- lack of assurance regarding the consistency and standards for disposing of dredged material in an environmentally sound manner (SMS now...)
- lack of assurance that the current method of disposal results in the most cost-effective means of disposal
- inadequate involvement by some stakeholders in disposal planning and decision-making.

- The highest priority problem is the inability to site disposal facilities to ensure long-term disposal capacity.
- A coordinated management plan is a need that could be met regardless of the institutional option.
- Enhanced funding is necessary regardless of the option implemented. Effective involvement of all stakeholders is necessary for the successful implementation of any option.
- Some mechanisms of ensuring a predictable revenue flow may be necessary regardless of the option.
- An enhanced status quo option may be a viable option.
- Of the options analyzed, an inter-agency combination has the most advantages. Option 4 appears to be the most promising option.
- The ports and DNR should be key stakeholders in any selected options because sites in industrialized port areas and aquatic areas have the greatest chance for successful implementation.
- Institutional options that vary with the disposal environment and by geographic area should be considered.
- Prior to implementing either the coordinating council or new authority options, consideration should be given to expanding their roles to cover all wastes.
- Identification of the problems with the existing system and evaluation of institutional options is highly judgmental and successful implementation of any option will require the involvement of the stakeholders in selecting the option.

Table D-2. Option evaluation chart.*

Option	**Siting**	**Coordinated Plan**	**Environmental Considerations**	**Cost Considerations**	**Representation**	**Implementation**
Status Quo	1	3	2	2	2	8
State/Local/Port	2	6	5	6	3	7
State/Local/Private	2	5	3	6	3	8
Federal/State/Port/Local	3	9	7	8	7	9
Coordination Council/State/Local	4	7	8	6	8	5
New Authority	5	8	9	7	9	4
Federal Lead	2	4	5	4	2	2

* Ranked on a scale of 1 - 10; higher the score, the better the option

APPENDIX E

PUBLIC PARTICIPATION AND OUTREACH

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PUBLIC PARTICIPATION AND OUTREACH

A. GENERAL PUBLIC INVOLVEMENT STRATEGY

The public outreach strategy that follows is based on the prior experience of the agencies and on recommendations made in the *Multiuser Confined Disposal Program Recommended Siting Process*, prepared for the Washington Department of Ecology, December 1995.

The public involvement program consists of workshop and hearing notices/news releases; public workshops and public hearings; development of a "pool" of citizen and scientific advisors from which expertise and knowledge from outside the MUDS Interagency Study Team can be incorporated into the planning and design; development of volunteer community criteria to guide the selection of communities who actively seek a site location; public workshops and/or meetings in areas based on a list of possible sites following the programmatic stage; and the creation of a public involvement/outreach subcommittee to coordinate public involvement activities.

Public Participation/Outreach Subcommittee

A subcommittee with appropriate members from each participating agency has been formed to help deal with public participation issues and to ensure that tasks are divided fairly and effectively among the agencies. The subcommittee has met several times and will meet again as necessary.

Citizen Advisors

Recognizing that direct citizen involvement in the planning process can provide valuable input from interested stakeholders in the community, the MUDS Interagency Study Team and consultant have begun developing a pool of local citizens, environmental groups, local governments, businesses and Tribes. Members of this pool have been and will continue to be used to provide outside input on issues (such as development of volunteer community criteria) through the mail, email, or by invitation to committee or outreach meetings.

Outside Technical and Scientific Participation

The MUDS agencies are planning to utilize technical and scientific advisors from outside the MUDS Interagency Study Team to increase the amount of expertise and information available to the study. The technical and scientific advisors will contribute to the program planning process and provide advice on study plans. The following methods will be used:

- <u>Document Review</u>. Outside expertise will be included in the document review process.

- Ad-hoc invitations to existing committees. Outside scientists and technical experts will be invited to participate in committee discussions and meetings as the committees work on various issues that arise during the MUDS programmatic and site-specific phases.
- Focus Groups. Focus groups are issue-oriented groups of citizens, scientists and/or other technical experts that can be called together on an ad-hoc basis to provide review and input on specific issues, topics, or questions.

B. PROGRAMMATIC EIS (PEIS) OUTREACH STRATEGY

The public participation and outreach effort for the Draft PEIS for the Puget Sound Confined Disposal Site Study is designed to actively involve the public as early as possible in the process of defining disposal alternatives. Public outreach will be accomplished using the three primary elements discussed in the following sections.

Press Releases, Newsletters and Mailings

The public will be informed of progress on the Puget Sound Confined Disposal Site Study and notified of opportunities to participate or provide input through several specific mailings. These include existing newsletters, such as *Soundwaves* (Puget Sound Water Quality Action Team) or *Confluence* (Washington Department of Ecology). Other possible media that may be used for public notification include newspapers and radio (press releases to announce hearings, meetings and/or milestones), the Internet (through connection to existing web pages developed by the Corps, Ecology and EPA), and by notices sent to existing user groups or stakeholder e-mail lists.

Use of Citizen Advisors and Outside Technical Advisors

The MUDS Interagency Study Team and public outreach consultant are developing a list of interested members of the general public that will receive general mailings and notices. The outreach consultant will also make direct contact with some members of the public, as well as local public officials, agency staff, and members of interest groups.

The MUDS Interagency Study Team outreach committee staff have developed a list of scientific advisors apart from the supporting agencies. These advisors will be asked to comment on technical aspects of the PEIS during the review process to assure that the project is supported by the best technical advice, knowledge, and expertise. Environmental groups, Tribes, and other stakeholder groups have been asked to recommend scientists and engineers to serve as advisors.

Informational Meetings and NEPA/SEPA Public Hearings

Three informational meetings and two public hearings are planned for March, 1999. The public hearings will meet NEPA and SEPA requirements. The informational meetings will feature a presentation on the Puget Sound Confined Disposal Site Study, include stations that will provide information on the study, and allow the public to ask questions about the project in an informal setting. Opportunities for written comments will be available at both the informational meetings and public hearings; verbal comments must be presented at the public hearings.

C. SITE-SPECIFIC EIS/FEASIBILITY REPORT OUTREACH STRATEGY

If the Puget Sound Confined Disposal Study continues into the site-specific phase, the MUDS Interagency Study Team will develop volunteer community criteria. Members of the public and local officials will be asked to participate in developing these criteria. Volunteer community criteria would be used to solicit interest from local communities near areas identified as potential confined disposal sites. Alternatively, communities may suggest other possible sites for consideration. The volunteer community criteria would balance environmental considerations and social, economic, and policy needs.

In addition, if the Puget Sound Confined Disposal Study continues to a site-specific phase, the agencies expect to include the following public outreach elements:

- Public announcements: press releases to media; use of existing newsletters; letters to potentially affected communities and counties asking for input
- Public workshops/meetings in communities near potential sites
- Development of site selection and volunteer community criteria
- Requests for volunteer site proposals following criteria development
- Scientific and citizen advisors to be invited to committee or other meetings, as necessary
- Public workshops and hearings to inform and solicit comment on work products
- Direct contacts by the outreach committee staff or consultants with interested members of the public, stakeholders, government officials and the media.