a viable implementation strategy that reflects changing conditions and concerns. The LTMS agencies are planning to review the San Francisco region's Comprehensive Management Plan every other year and review the overall program every 6 years.

2.1.4 LTMS Work Groups

The LTMS work groups have the responsibility of developing all of the LTMS concepts, work plans, and studies that fall under the five phases of the LTMS. As explained above, the LTMS work groups are organized into three study areas: the Ocean Studies (EPA and COE), the in-Bay Studies (COE and RWQCB), and the Upland Studies (COE and BCDC).

Below is a brief summary of the work that has been accomplished by each work group, as well as studies that have resulted from work group collaboration. The San Francisco Estuary Project's *Comprehensive Conservation and Management Plan Workbook* (SFEP 1996), as well as the *LTMS Status Report July 1995 — Accomplishments and Tasks Ahead* (LTMS 1995e), include more detailed outlines of tasks that have been completed.

2.1.4.1 Ocean Studies

Over 1,000 square miles off the Bay Area coast were surveyed to identify candidate disposal sites with the appropriate seafloor stability, sediment types, and topographic features to accommodate and contain dredged material following disposal. Thirteen reports were published in 1992 that focused on the resources at potential sites, geological and geophysical surveys, current patterns and circulation studies in the area of potential disposal sites, and modeling of potential deposition and water column turbidity at the sites. An EIS (EPA 1993a) was prepared for the designation of a deepwater dredged material disposal site, now known as the San Francisco Deep Ocean Disposal Site (SF-DODS).

2.1.4.2 In-Bay Studies

In-Bay studies focus on reaching a better understanding of the San Francisco Bay's complex estuarine system, which is influenced by river outflows, ocean tides, and multiple human uses of its waters and shores. Studies examined whether disposed material is influenced by water and sediment circulation around the Bay, the toxicity of contaminated sediments to bottom-dwelling mollusks, whether fish in disposal areas are exposed to more contaminants, and whether contaminants in sediments are distributed around the Bay via dredge disposal operations.

Twelve different studies to obtain a better understanding of the behavior and fate of sediments in the Estuary have been completed since 1992. At least six studies that focused on in-Bay environmental effects examined bioaccumulation and effects on fish habitat. Studies have also been conducted on the effects of suspended solids on estuary organisms. A complete list of studies is available in the LTMS Status Report (LTMS 1995e).

2.1.4.3 Upland/Wetland Reuse Studies

Placing material at upland sites — whether in a wetland, landfill, rehandling facility, or containment facility — raises planning, engineering, and political questions, as well as scientific questions. The upland/wetland reuse work group focused on a variety of subjects. These include the opportunities for and constraints of using dredged material as a resource for wetland restoration, landfill cover, and other uses; the potential for placing contaminated sediments in upland areas; and the development of demonstration projects. In addition, this work group examined the feasibility of the creation and operation of rehandling facilities, the potential for treating contaminated material for reuse, and regulatory and land use issues that could prevent wetland restoration using dredged material and other beneficial reuse projects.

In 1990, a comprehensive inventory of 75 upland/wetland reuse sites was completed to determine their suitability for beneficial reuse projects, rehandling facilities, or confined upland placement. Advances have also been made in efforts to identify dredged material reuse and non-aquatic disposal opportunities and constraints. At least 13 studies of upland disposal and beneficial reuse options have been completed. In 1994, the LTMS report *Tidal Wetland Restoration Potential Using Dredged Sediments* was completed (LTMS 1994g). In addition, an evaluation of regulatory and land use elements of dredged material reuse was completed in 1993.

2.1.4.4 Work Group Collaboration — Planning Studies

Work group collaboration has resulted in vast progress in planning studies, including those that focus on the identification of dredged material disposal needs and options, disposal alternatives, and cost estimates. A 1992 report and various follow-up papers focused on dredging project needs, methods to reduce dredging volume requirements, and techniques to eliminate unnecessary dredging. In addition, the LTMS work groups identified all available disposal and reuse options through reports completed between 1992 and 1994. The EIS/EIR contains discussions of the disposal options and the four alternative disposal plans selected and evaluated. A cost estimating model was also completed in 1994, and both benefit assessments and financial analyses of the different disposal options are included in this EIS/EIR (see sections 4.6 and 6.2). Collaboration of the work groups has also resulted in the development of sediment quality objectives by clarifying testing protocols for ocean, in-Bay, and upland disposal (see section 3.2.5).

2.2 HISTORICAL PERSPECTIVE LEADING TO THE LTMS

The LTMS objectives described above stem directly from the recent history of dredging and dredged material disposal in the San Francisco Bay region, and the problems that have emerged. The background leading up to this EIS/EIR is presented below.

2.2.1 Historical Dredged Material Management in the San Francisco Bay Region

The history of dredging and dredged material management in the Bay Area has been documented in a variety of recent sources, including *The Tule Breakers — The Story of the California Dredge* (Thompson and Dutra 1983); the *Status and Trends Report on Dredging and Waterway Modification in the San Francisco Estuary* (SFEP 1990); the *Comprehensive Conservation and Management Plan* (SFEP 1994); and the *LTMS Progress Report and Interim Management Plan* (LTMS 1994a). The following brief summary is drawn primarily from these sources.

Large-scale dredging has occurred in the Estuary for over 100 years. Many dredge-like machines were used beginning in the 1860s to convert vast tracts of delta marshland into dry farmland. Dredging for navigation purposes occurred as early as the 1850s to maintain channels for a commuter ferry and other vessels into Oakland, and dredges commonly worked the San Francisco waterfront's berthing areas and wharves in the 1860s and 1870s. Dredging to remove mining debris from navigable river channels was occurring by this time, as well, and the first proposal to use dredges to improve inland navigation between San Francisco Bay and Stockton appeared as early as 1870 (Thompson and Dutra 1983). Using processes that are not fundamentally different from those used today, these early dredges worked with self-dumping scows to dispose of the dredged materials away from the navigation channels. Dredged materials from San Francisco Bay navigation channels have continued to be disposed of primarily within the Estuary since then.

Through the years, maritime commerce and growth and development in the Bay Area have gone hand-in-hand. As the population grew, and commerce to and through Bay Area ports increased, more and deeper navigation channels were dredged to accommodate more vessel traffic and larger ships. Prior to 1972, dredged material was disposed at 11 sites within San Francisco Bay. In 1972, the Corps limited disposal to five high-energy sites where dispersion and eventual transport to the ocean was expected. In 1975, two of these sites (both in the South Bay) were de-designated because they were not dispersive.

The state and federal resource agencies also expressed their concerns and, frequently, voiced strong opposition to the high volumes and questionable chemical quality of the sediments disposed of at in-Bay sites. Agency concerns relating to declining sportfish catch in central San Francisco Bay, possible exposure of winter-run chinook salmon to dispersive sediments containing elevated levels of contaminants, and the need for more routine use of the solid phase bioassay in characterizing the suitability of dredged material for aquatic disposal helped create a climate in which the current multiagency LTMS emerged from its one-dimensional predecessor, the COE's Dredging Management Program.

Today, three designated in-Bay disposal sites remain available for use by various dredgers and projects. These are located in Carquinez Strait (SF-9), San Pablo Bay (SF-10), and near Alcatraz Island (SF-11) (see Figure 2.2-1). An average of approximately 4 million cubic yards (mcy) of sediment per year are dredged from the Central and South Bay and disposed at the Alcatraz site, which is the most heavily used of the existing in-Bay sites. Two additional aquatic disposal sites are restricted to disposal of clean sand from COE maintenance dredging projects only: the Suisun Bay site (SF-8) for dredged material from the Suisun Channel; and the San Francisco Bar Channel site, an ocean disposal site for material from maintenance dredging of the San Francisco Bar

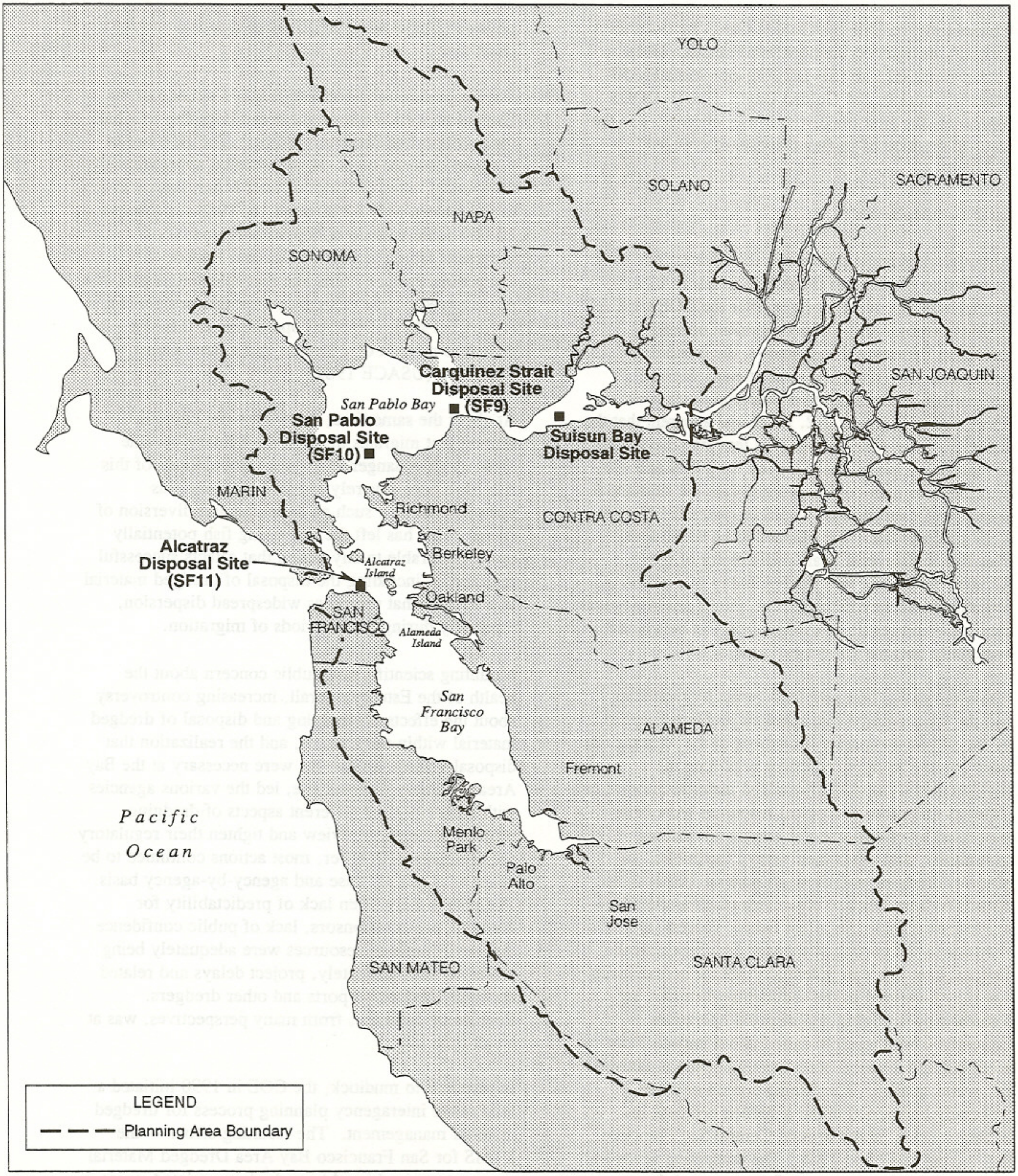


Figure 2.2-1. Location of the Carquinez Strait, San Pablo Bay, Suisun Bay, and Alcatraz Disposal Sites in San Francisco Bay

Channel just outside the Golden Gate. In 1993, EPA formally designated the new San Francisco Deep Ocean Disposal Site (SF-DODS) approximately 50 miles offshore of the Golden Gate. The SF-DODS represents the first major multi-user alternative to the historic practice of in-Bay disposal of dredged material.

2.2.2 "Mudlock"

Although sediments dumped at the Alcatraz site were expected to disperse to the ocean, in late 1982 a mound was discovered. Even after the COE tried various disposal and site management options — including flattening the mound — the mounding continued. The changing peak mound size in comparison to the amount of material dumped is illustrated in Figure 2.2-2. It became apparent that the capacity of the Alcatraz site was less than the amount of material disposed there during the 1980s and was certainly less than could accommodate the substantial volumes of material that would be generated by new work projects that were planned to be constructed over the next several years. Discovery of the Alcatraz mounding was the beginning of a period of fragmented agency management, public environmental concerns, and resulting dredging project delays that eventually became known as "mudlock."

While the navigation problems posed by mounding and the longer range management problems implied by the physical capacity limitations at the Alcatraz site were coming to light, concerns regarding the environmental impacts of dredged material disposal on fisheries and other ecological resources were being expressed by environmental groups, the fishing community, and other members of the public. In general, dredging and dredged material disposal can disturb or bury benthic organisms (such as clams, worms, or crabs), can affect fishing success by temporarily increasing suspended sediment near the disposal site, and can potentially release contaminants that may be bound in the sediments when they are disturbed by dredging and disposal operations. Concerns were therefore raised about impacts from dredging and disposal activities on aquatic organisms and water quality. The fishing community was especially concerned about a sudden decrease in fishing success in and around Central San Francisco Bay during 1987 and 1988. The competing needs and concerns of industry, ports, fishermen and the environment reached a dramatic peak beginning in 1989, when a flotilla of fishing boats and other vessels physically blockaded the Alcatraz disposal site for a short time.

The scope of public concern reached outside of the Estuary as well and brought ocean dumping to a halt for an important dredging project. The B1B ocean dredged material disposal site, located approximately 20 nautical miles offshore of Half Moon Bay, was used between May 12 through 16, 1988 for disposal of 18,000 cubic yards (six hopper bargeloads) of sediments from the Port of Oakland Harbor Deepening Project. This site was selected as part of a project-specific site designation for this project only (USACE 1988). Disposal operations at this site ceased as a result of a lawsuit and a State Court injunction (USACE 1989).

At about the same time, the winter-run chinook salmon that migrates through the Estuary became listed as an endangered species. Populations of this fish have been severely reduced by numerous upstream actions, such as damming and diversion of rivers. This has left the remaining fish potentially more vulnerable to any action that affects successful migrations, including the disposal of dredged material in a manner that promotes widespread dispersion, especially during peak periods of migration.

Mounting scientific and public concern about the health of the Estuary overall, increasing controversy about the effects of dredging and disposal of dredged material within the Estuary, and the realization that disposal volume limitations were necessary at the Bay Area's primary disposal site, led the various agencies with authority over different aspects of dredging projects to begin to review and tighten their regulatory requirements. However, most actions continued to be taken on a case-by-case and agency-by-agency basis. The results were often lack of predictability for dredging project sponsors, lack of public confidence that environmental resources were adequately being protected and, ultimately, project delays and related economic impacts to ports and other dredgers. Regulatory certainty, from many perspectives, was at an all-time low.

In response to mudlock, the COE in 1990 initiated a long range interagency planning process for dredged material management. The resulting effort — the LTMS for San Francisco Bay Area Dredged Material — was organized to address dredging-related issues in detail and to develop a comprehensive dredged material management plan.

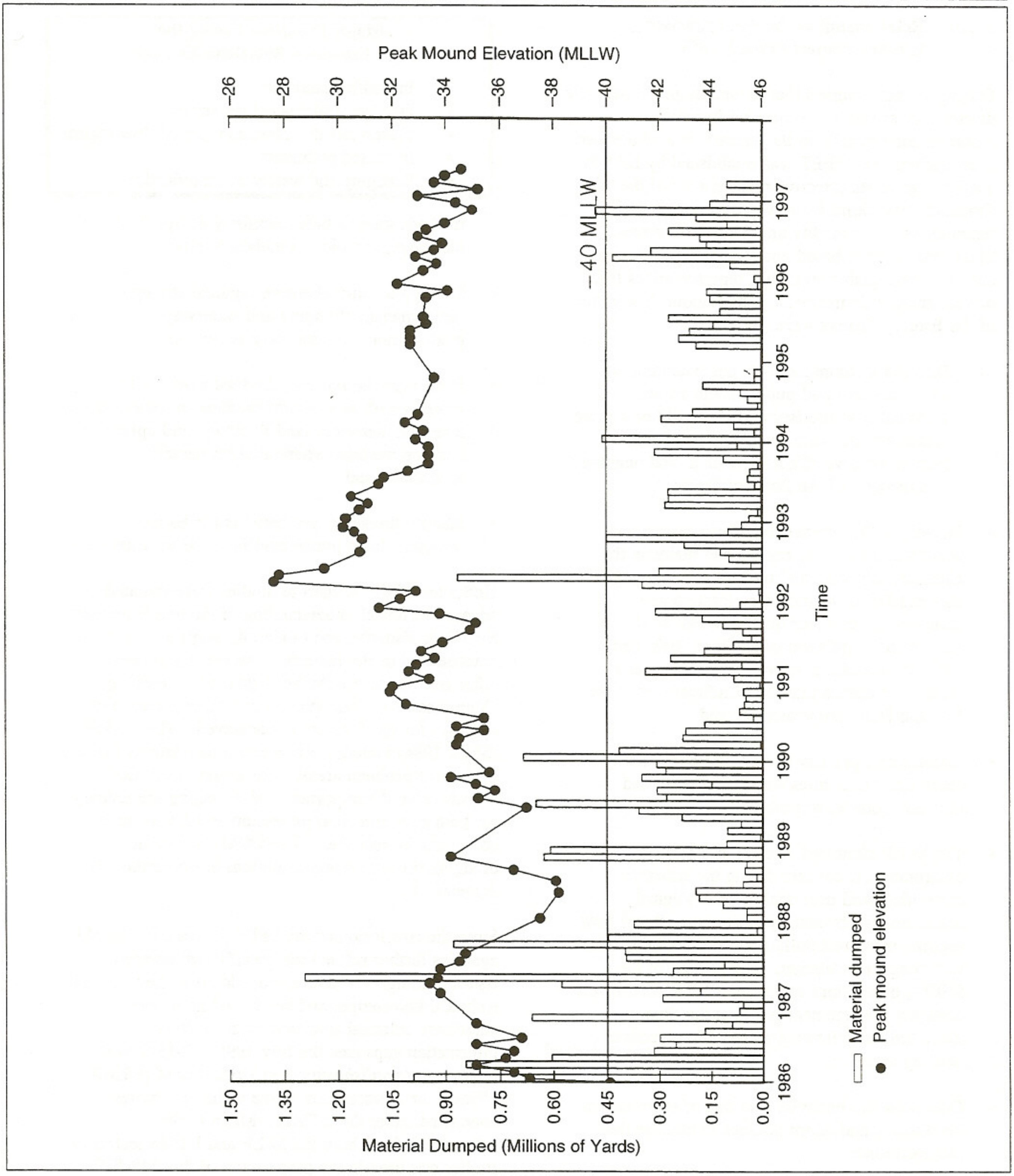


Figure 2.2-2. Alcatraz Disposal Site: Material Dumped and Peak Mound Elevations, 1986–1997

2.2.3 Relationship of the San Francisco Estuary Project to the LTMS

During the same period that mounding problems were discovered, efforts to restore and improve environmental quality of the Estuary as a whole were accelerating. The SFEP was established by EPA in 1987 to "promote effective management of the San Francisco Bay-Delta Estuary and to restore and maintain its water quality and natural resources." SFEP was a broad-based and cooperative program that brought together over 100 representatives from private and public interests in the region. The goals of the Estuary Project were to:

- Develop a comprehensive understanding of environmental and public health values attributable to the Bay and Delta and how these values interact with social and economic factors;Achieve effective, united, and ongoing management of the Bay and Delta;

- Develop a Comprehensive Conservation and Management Plan to restore and maintain the chemical, physical and biological integrity of the Bay and Delta, including restoration and maintenance of water quality; a balanced indigenous population of shellfish, fish, and wildlife; recreation activities in the Bay and Delta; and ensure that the beneficial uses of the Bay and Delta are protected; and

- Recommend priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution.

- The SFEP identified five critical areas of environmental concern facing the Estuary: intensified land use; decline of biological resources; freshwater diversion and altered flow regime; increased pollutants; and dredging and waterway modification. The portion of the SFEP's discussions and research that focused on dredging management issues at the time, identified the following as specific objectives needing attention:

- Determine the behavior and fate of sediments in the Estuary and adopt policies to manage their modifications;

- Determine the bioavailability of contaminants released by disposal of dredged material through methods such as bulk chemistry assays, toxicity bioassays, and bioaccumulation tests;

- Develop a comprehensive regional strategy to better manage dredging and waterway modifications and ancillary activities;

- Encourage the reuse of dredged material for projects such as wetlands creation or maintenance, levee maintenance, landfill cover, and upland building material where environmentally acceptable; and

- Identify threats to and benefits for Estuary resources from future modifications to waterways.

Major Problems Facing the San Francisco Bay/Delta Estuary

- Intensified land use
- Decline of biological resources
- Freshwater diversion and altered flow regime
- Increased pollutants
- Dredging and waterway modification

Under the SFEP, numerous studies were initiated to advance technical understanding of the San Francisco Bay/Delta Estuary, and to identify ways to improve management of the Estuary's resources and uses. After five years, the Project's goal of developing a Comprehensive Conservation and Management Plan (CCMP) for the Estuary was achieved. The CCMP (SFEP 1994) includes action recommendations in each of the five problem areas. The actions identified acknowledge the importance of managing the Estuary for both environmental protection and for its many competing human uses. The CCMP's specific dredging-related recommendations are presented in Appendix C.

Since the conclusion of the SFEP process, the LTMS agencies further refined the specific management issues needing to be addressed, identified key gaps in technical knowledge, and conducted numerous additional technical studies to address these information gaps (see the July 1995 LTMS Status Report, *Accomplishments and Tasks Ahead* [LTMS 1995e], for a description of the technical studies conducted under the LTMS). Much of the information from both the SFEP and LTMS technical studies was used in the preparation of this EIS/EIR.

Although the SFEP geographic area of focus included the Delta, the area of focus of the LTMS — a joint effort of federal and state agencies with jurisdiction over San Francisco Bay — did not. Instead, the LTMS focused on the San Francisco Bay, and did not consider Delta dredging projects that are carried out or permitted by the U.S. Army Corps of Engineers, Sacramento District. However, as a part of the LTMS, upland disposal options located in the Delta region were investigated and existing constraints regarding the use of dredged material in the Delta for levee maintenance, including salinity impacts and restricted barge access, considered. Currently, the LTMS is coordinating with agencies and programs in the Delta, including the Department of Water Resources, the Central Valley Regional Water Quality Control Board, local reclamation districts, and the CALFED program, to address these constraints and potentially expand opportunities for using dredged material for Delta levee maintenance. Perhaps these issues as well as others surrounding dredging and disposal issues in the Delta region could also be addressed through the establishment of a program similar to the LTMS.

2.2.4 National Dredging Policy

At the same time that this region has been developing a plan for dredged material management, national attention has also been directed toward reviewing dredging policies as a whole. In late 1993, an interagency working group was convened at the request of the White House to develop a new national dredging policy that would address existing problems with the dredging process. The "Interagency Working Group on the Dredging Process" was chaired by the Maritime Administration (MARAD) and consisted of EPA, COE, the U.S. Fish and Wildlife Service, and the National Oceanographic and Atmospheric Administration. This group acknowledged the important role ports play in the United States' economy, defense, and environment and also recognized that ports and their related activities can adversely affect the nation's ecological resources. The working group stressed the need to promote greater regulatory certainty, and the importance of long-term management strategies for addressing dredging and disposal needs at both the national and local levels. The working group also recommended the formation of regional dredging teams to better address dredging issues at the local level. The LTMS effort was expressly recognized in their report to the Secretary of Transportation, *The Dredging Process in the United States: An Action Plan for Improvement* (MARAD 1994), as a good example of effective local decisionmaking. Many of the issues identified in the MARAD report mirror the problems that have occurred in the San Francisco Bay region. Similarly, their proposed solutions include undertaking more LTMS-like cooperative efforts nationwide. The working group's proposal for elements of a national dredging policy, and their list of specific recommendations for improving the dredging process, are presented in Appendix D.

2.2.5 Relationship of the LTMS to the CALFED Bay/Delta Program

Another regional program that has overlapping interests and goals with LTMS is the Bay-Delta CALFED program (a joint effort between the California and federal governments), which is working to resolve issues surrounding water allocations and diversions, and the environmental impacts that result from them. A large component of CALFED is ensuring the integrity of the Bay-Delta system, including providing for bolstering Delta levees. Another principal aspect of the program involves actions to restore and protect critical species in the Estuary and reduce stresses on those species. CALFED will allocate hundreds of millions of state and federal funds to projects implementing these components. The use of dredged material for habitat and/or levee projects addressing CALFED concerns provides a way to leverage funds to meet the goals of both CALFED and the LTMS. The LTMS agencies have communicated their interest in coordinating with the CALFED program to meet mutual program objectives.

2.3 EIS/EIR SCOPING PROCESS

The EIS/EIR scoping process effectively began when the LTMS was initiated in 1990. Although much progress had been made toward better environmental protection and coordinated management since the inception of the LTMS, the agencies wanted to continue working toward a management system that addressed the overall LTMS goals in a comprehensive manner. Interested parties, invited to participate in the process of framing the dredged material management issues that needed to be programmatically analyzed in an EIS/EIR, played a major role in developing and reviewing Phase I and Phase II of the LTMS. This extended dialogue, afforded through the LTMS technical workgroups, Policy Review Committee meetings, and the Management and Executive Committee meetings, provided significant early opportunities for both formal and informal public input into the agency policy development process.

Comments related to dredged material management also arose during the public review and comment periods for individual projects (such as the Port of Oakland -42-foot Deepening Project), and during the review process for development of new dredged material disposal and reuse sites (in particular, the recently designated San Francisco Deep Ocean Disposal Site, and the beneficial reuse associated with the Sonoma Baylands Wetlands Enhancement Project). Public comments expressed on these and other projects were important additional sources of information to the LTMS agencies in deciding whether to prepare an EIS/EIR for the LTMS program, and what its scope should be.

EIS/EIR Interested Parties Group

George Armstrong	Department of Boating & Waterways
James Patterson	Department of Boating & Waterways
John Beuttler	United Anglers of California
Ellen Johnck	Bay Planning Coalition
Cynthia Koehler	Natural Heritage Institute
Jim McGrath	Port of Oakland
Jim Royce	Sierra Club
David Nesmith	Sierra Club
Barbara Salzman	Marin Audubon Society
Roberta Jones	Port of San Francisco
Mary Howe	State Lands Commission
James Trout	State Lands Commission

In 1992, the LTMS agencies decided to prepare a Policy EIS/ Program EIR as part of Phase III of LTMS to evaluate and solicit additional public input on different overall approaches for dredged material management in the region. An Interested Parties workgroup was formed to assist with the scoping and development of the EIS/EIR. The LTMS agencies published a Notice of Intent/Notice of Preparation (Scoping Notice) in July 1993, which announced the decision to prepare an EIS/EIR and listed a preliminary set of alternatives approaches.

The release of the Scoping Notice and the subsequent public comments, provided in writing and during the public meetings, began the formal scoping process for the EIS/EIR. There have been over 10 public scoping meetings, including with the workgroups and the LTMS Policy Review Committee (which also includes interested members of the public), since the formal scoping process began. The release of the LTMS Progress Report and Interim Management Plan in August 1994 afforded an additional opportunity for public comment on the dredged material management activities.

The major issues of concern raised by the public throughout the LTMS process to date can be broadly grouped into the following five overall issue statements:

1. There is a need to ensure adequate, suitable disposal capacity for projected volumes of dredged material;

2. There is a need to ensure appropriate environmental protection;

3. There is a need to improve coordination and integration of agency policies governing the management of dredged material in the region;

4. There is a need for a regional framework to facilitate the use of dredged material for beneficial purposes; and

5. There is a need to identify appropriate funding mechanisms to address these issues and to facilitate the overall goals of the LTMS.

Taken together, these overall issues of public concern were used to define the Need for Action evaluated in this EIS/EIR, as described below in section 2.4. They also formed the basis for the Evaluation Criteria used to compare the alternative management approaches, as discussed in section 2.5. A description of the process used to develop the specific alternatives evaluated in the EIS/EIR is presented in Chapter 5.

Proposed Action of the LTMS EIS/EIR

To select a long-term strategy that will guide the regional agencies' dredged material management decisions in the San Francisco Bay Area over the next 50 years.

2.4 PROPOSED ACTION

The proposed action evaluated in this EIS/EIR is *to select a long-term strategy that will guide the regional agencies' dredged material management decisions over the next 50 years.*

This document has been prepared by the LTMS agencies to evaluate alternative long-term management approaches, and to facilitate public comment on them. The California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) require an environmental review of proposed projects or actions that may significantly affect the quality of the environment. However, selection of a long-term strategy or overall policy approach for managing dredged material is different than evaluating a specific project. This EIS/EIR evaluates a "no-project action" of a policy or programmatic nature. Project-specific reviews and approvals, including NEPA and CEQA compliance as appropriate, will still be necessary, regardless of which overall long-term management approach is selected through this EIS/EIR.

2.4.1 Purpose for Action

The purposes of the proposed action closely mirror the LTMS goals described earlier. A fundamental purpose of the proposed action, described in broad terms, is *to distribute the dredged material among the three environments — in-Bay, ocean, and upland/wetland reuse (UWR) — in a manner that minimizes environmental impacts and maximizes environmental benefits in an economically sound manner*. This objective is discussed in terms of *dredged material placement distributions*. This EIS/EIR analyzes and compares the major environmental impacts and benefits of alternative overall management approaches, made up of different relative distributions of dredged material among upland, in-Bay, and ocean placement environments. Four of the five overall public concerns listed above (adequate suitable capacity, appropriate environmental protection, facilitating beneficial reuse, and identifying funding mechanisms) are addressed in part by this purpose for the proposed action.

A second purpose of the proposed action is *to identify guidelines for use during project planning to avoid or reduce potential environmental harm while conducting necessary dredging and disposal activities*. This objective is discussed in terms of *policy-level mitigation measures common to all alternatives*. These measures, discussed in more detail in Chapter 5, emphasize comprehensive analysis of environmental impacts and risks (including cumulative impacts), and mitigation of potential adverse environmental effects. Many of these policy-level measures already exist as regulatory or policy requirements of one or more of the LTMS agencies.

Three of the overall public concerns are addressed in part by this purpose for the proposed action (environmental protection, improved coordination of agency policies, and facilitating beneficial reuse).

A third purpose of the proposed action is to *develop policies to improve regulatory certainty across all disposal options*. The overall policies discussed in this EIS/EIR have been jointly developed by the LTMS agencies, and would be jointly adopted and implemented via the LTMS Management Plan (Phase IV of the LTMS). An understandable, consistent regulatory framework is one in which dredging interests can plan their projects with a greater degree of predictability, while the public can be confident that a proper dredged material management system is in place so that significant environmental impacts will not occur. Each of the public concerns outlined above is addressed to a degree by a management system that successfully improves regulatory certainty.

Finally, the EIS/EIR introduces for public comment a range of mechanisms that the agencies can consider for later implementation of the overall management approach selected via this EIS/EIR process. These are presented at this time so that the public may comment on them while still in the preliminary stages. Public comment on these implementation options will be used in the design of the subsequent LTMS Management Plan.

2.4.2 Need for Action

During the 7 years since the LTMS was initiated, the public has both formally and informally provided extensive comments on the dredged material management issues requiring attention, as described in section 2.3. The five major issues of public concern listed above have been restated to define the needs for the proposed action evaluated in this EIS/EIR. The action evaluated in this EIS/EIR is intended to:

1. Ensure adequate, suitable disposal capacity for projected volumes of dredged material;

2. Ensure appropriate environmental protection;

3. Improve coordination and integration of agency policies governing the management of dredged material in the region;

4. Develop a regional framework to facilitate the use of dredged material for beneficial purposes; and

5. Identify appropriate funding mechanisms to address these issues and to facilitate the overall goals of the LTMS.

Each of these issues is discussed below.

2.4.2.1 Need to Ensure Adequate Disposal Capacity for Projected Volumes of Dredged Material

The discovery of accumulation, or mounding, of disposed material at Alcatraz, the Bay Area's primary disposal site, highlighted three key issues associated with dredged material disposal capacity: (1) the need to reduce reliance on in-Bay disposal; (2) the need to ensure adequate capacity for contaminated material that cannot be placed at unconfined aquatic disposal sites; and (3) the need to establish multi-user options for beneficial reuse of dredged material.

Reduce Reliance on in-Bay Disposal. The mound at the Alcatraz site indicated that site capacity projections developed during the early 1970s were based on incorrect assumptions about the connection between dispersal and disposal rates. This was very important, because exceeding the physical capacities of the in-Bay disposal sites had the potential to cause navigational hazards should mounds develop near active shipping channels. In addition, since actual disposal capacity was less than projected, additional capacity at new sites would be needed to accommodate planned maintenance and new work dredging projects. This realization complicated the planning process for projects being considered because, at the time, no additional disposal capacity was available. The unanticipated shortfall in capacity at the Alcatraz site underscored the vulnerability and inflexibility of the management system's reliance on one primary aquatic disposal site. The need for a more diverse set of disposal options was clear.

After the initial mounding event at Alcatraz in 1982, and its reappearance in 1985, the agencies that would later form the LTMS began to develop cooperative management practices to control the mounding problems, and launched a search to identify alternative disposal or placement sites outside of the stressed Estuary.

Ensure Adequate Disposal Capacity for Contaminated Material. The immediate need to diversify aquatic disposal options, and/or to decrease reliance on the Alcatraz and in-Bay disposal sites, was partially met in 1994 by the designation of a new Deep Ocean Disposal Site by EPA. However, this new site did nothing to provide disposal capacity for dredged material that is contaminated, or otherwise unsuitable for unconfined aquatic disposal. Currently, the burden of identifying and providing alternate disposal sites for such material, and the associated additional disposal costs, falls on individual project sponsors. There remains a need to provide adequate capacity for the proper management of this material, and to facilitate its beneficial reuse whenever possible. In addition, there remains a need for adequate rehandling capacity so that such material can be processed (dewatered and adequately dried) for transport to appropriate disposal or reuse sites.

Establish Options for Beneficial Reuse. Few multi-user placement or rehandling sites exist in the Bay Area today for the beneficial reuse of dredged material. In addition, as mentioned above, only extremely limited capacity exists today to rehandle dredged material so that it can be transported to various beneficial reuse sites. Instead, beneficial reuse of dredged material to date has been accomplished on a project-specific basis, and dredging project sponsors typically have had to identify and prepare beneficial reuse sites themselves, and/or individually bear the costs for beneficial reuse. As long as there is a significant shortage of beneficial reuse sites that are available to a variety of users (so that acquisition, development, and operations costs can be shared equitably), and as long as mechanisms to efficiently move substantial volumes of dredged material to these sites (e.g., rehandling facilities) are not in place, the region's ability to realize the benefits associated with reusing dredged material as a resource will remain limited.

2.4.2.2 Need to Ensure Appropriate Environmental Protection

Perhaps the most prominent public concern regarding dredged material management is the concern about potential environmental impacts. The SFEP identified dredging and waterway modification as one of the five critical issues facing the Estuary, and public concern has been voiced regarding environmental impacts in each of the potential disposal environments: in-Bay, ocean, and upland/wetland reuse.

The potential impacts resulting from disposal of material at in-Bay disposal sites include the following:

- Redistribution of pollutants and/or release of contaminants during dredging and disposal;

- Burial of bottom-dwelling organisms;
- Resuspension of sediment particles and resulting turbidity;
- Changes in the native sediment characteristics near disposal sites and shifts in the sediment budget and/or dynamics within embayments;
- Impacts on migrating special status species such as the winter run Chinook salmon; and
- Degradation of pelagic and near-bottom habitat around disposal sites that may lead to reduced fishing success.

These potential impacts must be evaluated in the context of an estuarine ecosystem that is already stressed as a result of numerous anthropogenic activities (SFEP 1992b). In particular, the public has voiced concern over the lack of analysis that considers the frequency, duration, and magnitude of disposal in a cumulative impact study of the numerous planned and ongoing dredging projects in the Bay Area.

Public concerns about ocean disposal of dredged material include the potential for disturbance and for impacts to water quality (affecting birds, marine mammals, and fish), and the potential for impacts to the sea floor area around the disposal site (affecting benthic resources).

Significant public concerns were also expressed regarding the potential for environmental impacts to be associated with different kinds of upland disposal and/or beneficial reuse activities. For example, proposals to use dredged material from the Bay for levee enhancement in the Delta have raised concerns regarding effects on salinity in Delta waters. Although the Delta is not included in the geographic area of focus of the LTMS, as part of the LTMS studies, the use of dredged material from the Bay in the Delta region was investigated, and potential constraints, such as salinity impacts, considered. These issues are presently under discussion amongst the LTMS and Delta agencies and various programs (such as CALFED), yet perhaps could be addressed further through the establishment of a program for the Delta similar to the LTMS. Similarly, proposals for using dredged material to create tidal wetlands in the North Bay have raised concerns over the loss of existing seasonal wetland habitat.

Ultimately, ensuring environmental protection requires an overall dredged material management system that includes the following: an appropriate framework for sediment quality testing and interpretation; suitable placement sites that provide adequate capacity for all of the dredged material that is generated (both "clean" and "contaminated"); and appropriate site management and monitoring measures. All of these issues are addressed in various aspects of the alternative management approaches evaluated in this EIS/EIR.

2.4.2.3 Need to Improve Coordination and Integration of Agency Policies

Several state and federal regulatory agencies have responsibility for managing various aspects of dredging and dredged material disposal activities in the San Francisco Bay Area. Historically, these agencies have carried out their mandates more or less individually, while coordinating more formally only around specific issues or projects. During the 1980s, there was a growing public concern that the needs of the Bay Area maritime industry and other waterway-dependent economic sectors were not being met through the normal, issue-specific agency coordination. Specifically, project sponsors experienced delays in initiating and completing projects and there were general difficulties in planning during this period (see section 2.2). Additionally, although the minimum requirements of the federal Clean Water Act (CWA) and the Marine Protection, Research, and Sanctuaries Act (MPRSA) were not met individually, there was growing public concern that, in the absence of a coordinated plan or common decisionmaking framework, the environment was not receiving appropriate protection.

The agencies recognized that improved coordination and integration of policies governing material disposal would be necessary, and to address these concerns they initiated the LTMS. Although much progress has been made toward better environmental protection and coordinated management of dredging projects since the inception of LTMS, it is understood that the current system still lacks some significant elements that are essential to meet the overall LTMS goals (LTMS 1994a). Specifically, improved coordination is needed to increase predictability for project proponents and the public in the review and approval of dredging permits, and to design an interagency decisionmaking framework for determining the appropriate disposal or reuse option(s) for placement of dredged material from particular projects.

2.4.2.4 Need to Develop a Regional Framework to Facilitate Reuse of Dredged Material for Beneficial Purposes

Much of the LTMS discussion has focused on how dredged material can be beneficially reused. "Beneficial reuse" refers to managing dredged material as a valuable resource that can be used to create other benefits, rather than just as a waste product to be disposed of as efficiently as possible. There are no beneficial uses associated with disposal of material at the existing aquatic disposal sites. Potential reuse opportunities within the region include use of dredged material for levee stabilization and maintenance activities; habitat (e.g., wetland) restoration projects; landfill liner, cap, or daily cover; and construction fill. However, attempts to promote the large-scale beneficial reuse of dredged material have been hampered by financial, regulatory, and policy constraints, and by public concerns associated with habitat conversion.

Increasing beneficial reuse of dredged material will help diversify disposal options and promote better environmental protection and enhancement. National COE policy, and the legislative and policy mandates of the environmental agencies, indicate that beneficial reuse of dredged material should be a priority. However, the region currently lacks a coordinated and/or institutionalized framework to facilitate beneficial reuse of dredged material.

2.4.2.5 Need to Identify Appropriate Funding Policies to Support the Above Issues and Facilitate the Goals of the LTMS

Dredging and disposal costs for construction and maintenance of federal channels are shared by the federal government and local non-federal sponsors based on cost-sharing requirements set forth in federal law (e.g., the Water Resources Development Act [WRDA] 1986, WRDA 1992). As described in detail in Chapter 4 (section 4.8, Regulatory Framework), cost-sharing requirements vary depending on the type of project under consideration. Different policies apply depending on whether the proposed project represents maintenance dredging or new construction dredging and whether the project is used for commercial navigation or recreation. Projects funded by the federal government are generally constructed by the COE. (There is no cost-sharing for work by the U.S. Navy, which funds its own dredging, and cost-sharing also does not apply to dredging done by private parties.) Various mechanisms are used today to finance the 25 percent or more of capital costs that typically are the responsibility of the local sponsors of federally dredged projects. States, local governments, ports, special assessment districts, and the private sector are the main sources of such local sponsor financing.

The cost-sharing allocations also depend on whether the disposal method is aquatic or upland. Upland and beneficial reuse sites are not currently included in the definition of "general navigation features" described in the COE regulations, and thus are not normally included in federal cost-sharing. Therefore, the local sponsor currently must pay the often substantial costs of acquiring, developing, and using upland disposal or beneficial reuse sites, as well as the costs of post-construction monitoring and management of such sites.

Overall, then, the current cost-share requirements effectively direct material to available in-Bay sites, which are inexpensive compared to other placement alternatives due to ease of material handling, transport, and location. The "least costly, environmentally acceptable" policy, and the statutory requirement that local sponsors must pay for site development and monitoring in upland and beneficial reuse sites, both serve to focus disposal on existing aquatic sites, resulting in a substantial economic burden to non-federal sponsors who might otherwise wish to pursue the beneficial reuse of material at upland or wetland sites. This system can potentially create overall economic inefficiencies, as well. Such economic inefficiencies occur when dredging and disposal actions are considered on a project-by-project basis rather than a regional basis. In the face of declining in-Bay disposal limits, project-by-project decisions can lead to greater overall costs to the regional economy (for dredging and disposal for all projects combined) than would be the case if allocation of allowable disposal volumes at all the sites in all the placement environments were considered comprehensively. This EIS/EIR evaluates alternative management approaches that represent different long-term ways to comprehensively allocate disposal volumes among the placement environments (in-Bay, ocean, and upland or wetland reuse) by programmatically considering the overall impacts and benefits (including economic ones) of those alternatives.

2.5 EVALUATION CRITERIA FOR THE EIS/EIR ALTERNATIVES

The overall issues of public concern were also used to develop evaluation criteria for comparing the alternative management approaches considered in this EIS/EIR. The first issue — the need for adequate disposal capacity — is not directly used as an evaluation criterion because it is already captured in the Purpose for Action (section 2.4.1). The alternatives will not differ in their ability to address this issue, because only alternatives that satisfy this fundamental need will be considered in detail in this EIS/EIR. Similarly, the fifth issue — the need to identify appropriate funding policies to facilitate the goals of the LTMS — is not used as an evaluation criterion because overall funding mechanisms will not be selected based on this EIS/EIR. However, constraints of existing funding requirements are discussed, and some potential new funding approaches that can be considered are presented in Chapter 7 for preliminary public comment. Comments received will assist the LTMS agencies in their later consideration as to which, if any, of these should be pursued during development of the LTMS Management Plan to be developed subsequent to this EIS/EIR. The remaining three significant issues of concern identified through the public scoping process are directly incorporated into the EIS/EIR evaluation criteria, as follows.

- *Evaluation Criterion A: Potential Risks and Benefits to Ecological Systems*

  This criterion is used to compare the alternatives in terms of the degree to which they present potential environmental impacts or risks, and the degree to which they offer environmental benefits, in the in-Bay, ocean, and upland/wetland placement environments. The need to ensure appropriate environmental protection, and the need to facilitate beneficial reuse of dredged material, are the issues of concern addressed under this criterion. The degree of actual adverse impacts to Estuary resources that is associated with current volumes of in-Bay dredged material is impossible to accurately quantify with existing scientific information. This EIS/EIR therefore generally evaluates the alternatives in terms of the relative *risk* of adverse impacts occurring.

- *Evaluation Criterion B: Regulatory Certainty*

  The issue of concern addressed by this criterion is the need to improve coordination and integration of agency policies governing the management of dredged material. Under this criterion the EIS/EIR alternatives are compared in terms of the degree to which, in conjunction with the policy-level mitigation measures common to all alternatives, they would support an understandable, consistent regulatory framework that provides reasonable predictability for dredging project proponents while assuring the public that significant environmental impacts are avoided.

- *Evaluation Criterion C: Effects on Dredging Related Economic Sectors*

  This criterion is used to compare the EIS/EIR alternatives in terms of their potential effects on the socioeconomic sectors of the Bay Area economy that are most directly associated with dredging and navigation (federal versus non-federal dredgers, and "major" versus "small" dredgers). The different dredging-related sectors have different abilities to absorb or pass along any potential increases in the overall costs associated with dredged material management, and the alternatives differ in the degree to which each sector could be affected.

2.6 OTHER ISSUES OF PUBLIC CONCERN

The overarching issues identified by the public were included in the EIS/EIR objectives and subsequent evaluation criteria, as described above. However, additional issues were raised during the formal and informal scoping processes, related to specific environmental and economic issues associated with current dredged material management activities. Many of these issues would be addressed similarly under any of the overall management approaches being considered by LTMS. Other issues raised are outside the scope of this EIS/EIR. The following sections describe those issues addressed in, and not addressed in, this document.

2.6.1 Issues Addressed in Policy-Level Mitigation Measures Common to All Alternatives

A variety of specific concerns raised by the public about dredged material management are already addressed through existing regulations or policies. These existing requirements and guidelines serve to reduce or eliminate the potential that dredged material disposal or placement may have adverse effects under certain circumstances. Several such "policy-level mitigation measures" are common to all of the action alternatives evaluated in this EIS/EIR. Although these measures do not affect the assessment of alternatives or the selection of a preferred approach, they are nevertheless important aspects of appropriate dredged material management, and as such are discussed in this EIS/EIR and are directly included as part of all the alternatives considered. These issues and the policy-level mitigation measures that address them are summarized below. These measures are also discussed in detail in Chapter 5.

Material Suitability & Sediment Management. This issue relates to the potential impacts associated with dredged materials that contain elevated levels of pollutants. Such material is typically not suitable for unconfined aquatic disposal (referred to as NUAD material) and requires different management methods to ensure that any risks are properly addressed. It was suggested during the public comment period that the EIS/EIR should address options for how best to manage NUAD material.

This concern is addressed via guidelines defining material suitability for different placement options. Also, an overall LTMS policy is that dredged material will only be permitted for placement in an environment, and at a specific site, where it has been determined that it can be appropriately managed. Chapter 3 provides extensive background on how these determinations are made.

Pollutant Loading Reduction. An often-voiced concern relates to the need to reduce sources of pollution before they enter the sediments. Reducing the original source of pollution would, in the long term, reduce the pollutants in sediments that are dredged, as well as reduce the level of pollutants in the estuarine system overall. In particular, scoping comments suggested that the EIS/EIR include pollutant loading reduction as a primary means of addressing sediments with elevated contaminant levels.

Existing policies already implement a variety of ongoing regulatory efforts, and support non-regulatory efforts, to reduce overall pollutant loading to the Estuary. Some of these are described in Chapter 5.

Dredging Reduction. Members of the public have commented on the need to develop policies that will reduce the overall volume of dredging needed in the first place and, by extension, reducing the volume of dredged material needing disposal. Reducing "unnecessary" dredging is also a stated goal of the overall LTMS effort. Scoping comments suggested that the EIS/EIR evaluate different technologies to reduce the need for dredging and, for specific projects, evaluate the assumption that there is a need for continued dredging at all.

Existing reports have not adequately documented dredging needs assessments, nor have they fully analyzed ways to reduce dredging needs or the use of new technologies. A common, policy-level implementation measure is included that requires review of options for, and potential technologies to, reducing dredging needs on a project-specific basis; and a COE action subsequent to this EIS/EIR is to review and update, as necessary, the Dredged Material Management Plans for all its existing maintenance projects. Also, new LTMS long-range dredging estimates have been developed that reflect a significant decrease in projected dredging needs in the future, in part as a result of military base closures in the San Francisco Bay Area. All of the evaluations in this EIS/EIR are based on these new, lower, estimates of long-range dredging needs.

Habitat Conversion and Siting. There is significant public concern over the conversion of existing valuable habitats that may be present at sites proposed for wetland restoration with the use of dredged material. Concern has also been expressed over the permanent loss of existing habitat values at sites that may be used for rehandling facilities, or dedicated confined disposal facilities. In particular, scoping comments suggested that the EIS/EIR include an analysis of wetland resource values and functions for any proposed use of dredged material in upland or wetland reuse or disposal sites. This concern is addressed by the following policy-level requirements:

- Proposed habitat restoration projects using dredged material should be evaluated in the context of regional habitat goals developed independently (activities being conducted by the SFBRWQCB, the Estuary Institute, and the North Bay Initiative are among the present efforts that could result in habitat goals for certain areas of the Estuary).

- Only habitat restoration/creation projects having positive overall net benefits will be supported as LTMS projects.

- Projects whose purpose is not habitat restoration or creation and that would effectively result in a permanent loss of existing habitat values (such as would occur with new rehandling facilities and confined disposal facilities) must avoid adverse impacts to the maximum extent practicable, and must fully mitigate for the unavoidable adverse impacts they cause.

Testing Protocols and Streamlining Efforts. Public scoping comments were also directed toward the need for the EIS/EIR to ensure adequate characterization of sediments to be dredged, to support placement or disposal decisions. Comments suggested that existing testing protocols be evaluated in the EIS/EIR, and recommendations made for improving their application. Several policy-level measures address this concern, including the following:

- The use of tiered sediment evaluation procedures that generate adequate and appropriate information without incurring unnecessary costs;
- The use of an evaluation approach designed to appropriately address potential contaminant exposure pathways of concern on a project-by-project or disposal site-by-disposal site basis;
- The development of a Regional Implementation Manual (RIM) covering evaluation and testing needs in all placement environments;
- Sediment data tracking, that may allow streamlining of testing needs in the future;
- The development of a comprehensive sediment classification framework as a basis for potential further streamlining of future testing needs;
- Improved agency coordination through establishment of an interagency Dredged Material Management Office; and
- Other permit application streamlining efforts.

Use of Dredged Material on Levees. Comments were made about the unique set of environmental concerns associated with the reuse of dredged material for levee restoration and stabilization efforts. Public comments suggested that the EIS/EIR describe the potential impacts associated with use of dredged material on levees. While no specific future levee use sites are identified in this document, general policies that serve to minimize the risks that are unique to the use of dredged material on levees are presented in Chapter 5.

Disruption of Habitat. There is significant public concern over potential for dredging and dredged material disposal to result in degradation or disruption of wildlife habitat, and to cause fish and other wildlife to avoid the areas near dredging and disposal sites. The fishing community and resource agencies have long been concerned that dredging and disposal of dredged material has contributed to fish habitat degradation and interfered with migration.

To minimize the risk of habitat degradation, particularly regarding migrating special status fish species, policies regarding the timing of dredging and aquatic disposal are presented in Chapter 5. To facilitate regulatory certainty, a decisionmaking framework was prepared in consultation with the resource agencies to aid dredgers and the LTMS agencies in determining where and when special status species may be affected. These policies are area specific and are the same for all alternatives. However, there are differences among the alternatives in terms of habitat impacts related to the overall volume of dredged material that may be disposed at existing sites and the frequency at which disposal activities may occur; these are evaluated directly in this EIS/EIR.

2.6.2 Study Limitations: Issues Raised during Scoping that are Outside the Scope of this EIS/EIR

During the scoping process, the public commented on several elements of dredging and disposal that, while part of the LTMS effort, are outside of the scope of this EIS/EIR. Therefore, while developing the EIS/EIR alternatives and framing the analyses, these issues were not directly evaluated. In most cases, these issues will be addressed in the next LTMS phase: development and implementation of the Comprehensive Management Plan. A brief summary of the issues considered outside the scope of this EIS/EIR is presented below.

Impacts of Dredging. This analysis does not include detailed consideration of the potential impacts associated with the act of dredging itself. However, a general description of the generic impacts of dredging (section 3.1.1.3) and mitigation measures for special status species (section 5.1.2.2) are provided. Chapter

3 contains background information about dredging equipment and the dredging process, and the descriptions of the in-Bay environment in Chapter 4 contain information about potential impacts associated with disposal that are the same as or similar to impacts that may be associated with dredging; but the EIS/EIR analysis does not specifically evaluate dredging impacts. These are more appropriately considered at a site-specific and project-specific level.

Site-Specific Analyses: Designation of New In-Bay, Ocean, or Upland Disposal Sites. During the scoping process, many public comments focused on particular disposal sites. Suggestions were made to relocate specific sites, designate new sites, and/or close down existing sites. Evaluation of site-specific impacts is outside the scope of this policy- and program-level document. However, designation of any new disposal or placement sites will require site-specific environmental review that includes an analysis of the types of impacts described generally in this EIS/EIR.

The LTMS is not, in itself, directly making decisions about sediment quality or other specific dredging-related issues in the Delta, which is outside the designated LTMS study area.

This policy EIS/EIR analyzes and compares the major environmental differences among four overall dredged material management strategies over a 50-year planning horizon, and the scope of this environmental analysis corresponds with this broad level of planning. This type of analysis is quite different from the analysis of a specific proposed project. For the purposes of this policy EIS/EIR, the assessment makes use of information regarding existing, specific disposal sites as a way to describe existing impacts; and site-specific impacts may be also be used as a method of describing the types of impacts that could potentially occur under a given alternative. Nevertheless, the majority of the analysis presented is fairly broad: for example, a generic impacts discussion is provided in the beginning of Chapter 6, evaluating the general types of impacts that are likely to occur in each placement environment. Policy-level mitigation measures that have been identified to avoid or reduce the potential for adverse impacts are also included, as described earlier. However, it is recognized that their overall effectiveness depends upon site-specific evaluation and application. Neither the precise impacts of a specific project, nor all the mitigation measures necessary to adequately avoid or reduce those impacts, can be known as much as 50 years ahead of time. Project specific evaluations, including EIS/EIRs as appropriate, will still be necessary.

Evaluating the Need for Individual Dredging Projects, or for Specific Channel Depths. The need for individual projects and/or the necessary depths for those projects will vary on a case-by-case basis. Assessment of individual dredging projects is beyond the scope of this EIS/EIR. For ports in particular, determining the need for dredging will be based not only on site-specific aspects, but also on the port's competitive position compared to other ports in the region and, particularly for intermodal cargo, to other ports up and down the coast that compete for intermodal traffic. The need for deeper channels and berthing areas is only one factor affecting the distribution of intermodal trade. This competition will also vary due to factors such as rail connections and routes, origin and destination of intermodal cargo, alliances between rail and shipping carriers, etc. Such a complex and dynamic analysis is beyond the scope of this document.

Ports have no control over the increasing drafts of cargo ships. However, failure to provide sufficient channel depths will usually result in a loss of port calls and the revenue that would accrue to the regional economy. Instead of a project-by-project assessment of dredging needs, an analysis of historic dredging volumes, and of potential factors that might affect the historic volumes, is presented. From this analysis, a planning estimate of the expected volume of dredged material over the next 50 years was derived. This EIS/EIR evaluates how best to distribute the expected volume of material to each of the placement environments in an environmentally and economically sound manner. In order to prepare for a worst-case scenario, the high-range of the planning estimate is used.

Enforcement of Permit Terms and Conditions. Compliance with the specified terms and conditions of dredged material disposal or reuse permits or authorizations is necessary to ensure that activities will pose a minimal risk of environmental impact. Noncompliance can result in situations where risks or impacts are greater than expected. It is beyond the scope of this EIS/EIR to identify specific terms and conditions for individual projects. Implementation measures, including site management and monitoring requirements and standard permit terms and conditions, will be described as appropriate in the LTMS Comprehensive Management Plan.

Evaluation of Economic Impacts on Specific Projects or Dredgers. The potential economic impacts and benefits associated with the overall policy alternatives evaluated in this EIS/EIR are discussed on a regional scale, and not at a project-specific level. The EIS/EIR discusses how different alternatives might affect different user groups including federal and non-federal dredgers, major dredgers, and small dredgers. However, economic impacts associated with a particular dredging project or dredging user can only be determined on a project-specific basis and, therefore, are not considered in this policy EIS/EIR.

Site Management & Monitoring to Determine Adverse Impacts. Site management and monitoring is an essential component of any dredged material management strategy. However, the particular monitoring and management needs of a particular site are best determined on a site-specific basis. Therefore, this EIS/EIR does not recommend specific site management and monitoring activities for existing sites. However, the EIS/EIR does identify the potential impacts of concern that are associated with disposal in each of the three placement environments. These identified impacts will be used in the subsequent Management Plan to develop guidance for site management and monitoring at each of the existing disposal sites. Public comments on site management and monitoring needs will be addressed in the LTMS Management Plan.

2.7 SELECTING A PREFERRED ALTERNATIVE LONG-TERM APPROACH

Initially the LTMS agencies considered a broad range of possible approaches for managing dredged material including a return to pre-LTMS conditions, placing all dredged material in a single environment, placing all SUAD material in a single environment, and placing various percentages in a variety of environments. For reasons discussed in Chapter 5, the LTMS agencies eliminated all of the options except for those which included placement in a variety of environments. As further described in Chapter 6, based on the generic analysis, the LTMS agencies further eliminated high disposal volumes in any environment due to adverse impacts. Three alternatives which include placement of low and medium amounts of material in three placement environments and the No-Action alternative have been carried through the detailed analysis.

The LTMS agencies decided not to identify a preferred alternative in the Draft EIS/EIR. To continue to encourage such public involvement, the Executive Committee decided against selecting a preferred alternative before the public had the opportunity to provide specific comments on the alternatives. The LTMS agencies requested the help and participation of reviewers in identifying the preferred alternative that best supports the environmental and economic goals and allows for reasonable and effective implementation.

Based on consideration of public comments, the preferred alternative has been selected for the Final EIS/EIR. The LTMS agencies have selected a long-term approach that emphasizes beneficial reuse and ocean disposal of dredged material, with limited in-Bay disposal. However, the management goal of emphasizing beneficial reuse and ocean disposal cannot be achieved immediately. Therefore, a transition period will be required. In particular, policy and management actions will need to be taken by respective LTMS agencies and upland/wetland reuse sites will need to be made available (limited capacity for reuse exists today). The implementation portion of this EIS/EIR discusses the measures that can be taken to achieve the preferred placement emphasis. As upland/wetland reuse sites are developed, less material will be placed in the Bay to fully achieve the goals of the preferred alternative. The transition toward full implementation of the preferred alternative is discussed in greater detail in Chapter 6 (section 6.5). Finally, the LTMS approach that the San Francisco Bay region has used to address dredged material management is unique to this region. It makes sense, then, that the outcome of such an effort should also be unique and designed to address the specific needs and issues of this region.

2.8 FUTURE ACTIONS

Fully implementing the long-term approach selected as a result of this EIS/EIR process will require several different kinds of actions on the part of the LTMS agencies, in order to achieve an appropriate balance between minimizing environmental risk and maximizing environmental benefit in a cost-efficient manner. Several steps are within the existing authorities of the LTMS agencies, and can be implemented fairly rapidly. Other actions that could more fully achieve the placement distributions of the selected alternative are outside the agencies' current authorities. This section outlines the immediate steps the agencies can take. Chapter 7 discusses further steps that would be needed to more fully implement the preferred alternative, and provides a preliminary description of potential financing options that can be considered in the future.

2.8.1 Finalizing the Policy EIS/EIR

The first step, after thoroughly reviewing the public comments on the Draft EIS/EIR, was for the LTMS agencies to identify the preferred alternative. The selected preferred alternative, Alternative 3, was one of the alternatives presented in the Draft EIS/EIR.

The next step, after reviewing comments on the Final EIS/EIR, will be for the COE and EPA to sign a Record of Decision (ROD), thus finalizing the EIS/EIR and Phase III of the overall LTMS process. The state lead agency, the State Water Resources Control Board, will also certify the final document pursuant to the requirements of the California Environmental Quality Act. The LTMS agencies will adopt the selected alternative as specified in the ROD, and the policy-level mitigation measures associated with it, as the overall approach that will guide the LTMS agencies' implementation actions in Phase IV of the LTMS process.

2.8.2 Development of the LTMS Comprehensive Management Plan

While the EIS/EIR and ROD are being finalized, the LTMS agencies will produce and circulate for public review a draft Management Plan. The Management Plan is intended to implement those policies that are within the LTMS agencies current authorities. A number of potential implementation mechanisms will be considered to achieve the distribution of dredged material targeted in the EIS/EIR preferred approach, as described in Chapter 7.The LTMS agencies will seek public comment on potential implementation options to help them further develop the Comprehensive Management Plan.

The LTMS Comprehensive Management Plan will contain the specific guidance used by each of the LTMS agencies to make decisions about dredging management activities. This Management Plan will replace the existing LTMS Interim Management Plan (LTMS 1994a) as the regional decisionmaking framework for dredged material disposal. The Management Plan will be reviewed and updated every other year or as necessary to reflect changing statutory, regulatory, scientific, or environmental conditions. Specific issues to be addressed in the Comprehensive Management Plan include the following:

- Site monitoring and management requirements and actions for each of the existing dredged material disposal and placement sites;
- Allowable disposal or placement volume limits, as needed, for existing sites;
- Descriptions of new site designation effort(s), as appropriate;
- Description of the coordination measures under which the LTMS agencies will jointly manage dredging project proposals (e.g., the interagency Dredged Material Management Office, when instituted);
- Description of processes to ensure public input and review opportunities;
- Discussion of Related Planning Efforts such as wetlands planning, the Regional Monitoring Program, Regional Implementation Manual for Testing; and
- The process for the periodic review and update of subsequent Management Plans and LTMS policies.

2.8.3 Other Agency Regulatory and Policy Changes

In addition to the work to be jointly undertaken within the LTMS as outlined above, individual agencies will take the following actions as appropriate after completion of the Final EIS/EIR:

- EPA: Designate a permanent allowable disposal volume limit for the San Francisco Deep Ocean Disposal Site.
- BCDC: Revise the Bay Plan and associated regulations to incorporate new policies pertaining to dredging activities; and issue a new Coastal Zone Management (CZM) consistency determination for COE Maintenance Dredging using the findings in this EIS/EIR.
- SFBRWQCB: Revise the Basin Plan to incorporate new dredging policies; and continue to issue Water Quality Certifications (under Section 401 of the CWA) for dredging projects using the findings in this EIS/EIR.

- COE: Confirm or revise Dredged Material Management Plans for existing maintenance dredging projects in San Francisco Bay, and perform NEPA reviews as needed, including supplementing the 1975 Composite EIS for Maintenance Dredging, using the findings in this EIS/EIR.

- SWRCB: Revise statewide policies as appropriate to support the selected alternative.

2.9 NON-STANDARD STRUCTURE OF THE EVALUATION IN THIS EIS/EIR

This section outlines the content of each of the chapters in this Policy EIS/Programmatic EIR, and describes why the document has a somewhat non-standard structure compared to more typical "project" EIS/EIRs.

Chapter 1 of this EIS/EIR presents an Executive Summary of the entire document. The reader is directed to Chapter 1 for a brief overview of the following: the dredged material management problems being addressed; the alternative long-term management approaches being considered on a policy or programmatic basis; the environmental and socioeconomic resources that could potentially benefit or be adversely affected by implementation of any of the alternative management approaches; and what steps the LTMS agencies will take to implement a new management approach upon finalization of this EIS/EIR.

This Chapter 2 presents the following: an introduction to the LTMS process; the LTMS goals and objectives; the purpose and need for agency action evaluated in this EIS/EIR; the public issues of concern identified through formal and informal scoping processes; and the evaluation criteria that will be used to compare the alternative management approaches.

Chapter 3 provides background information on technical and scientific issues that are important to developing and understanding appropriate dredged material management actions. Information is presented on the following: dredging and the kinds of equipment used in typical dredging projects; how sediments move within the Estuary system, and the consequences this can have for managing dredged material; physical-chemical characteristics of sediments and how environmental concerns related to those characteristics can vary in aquatic and upland environments; the behavior of chemicals that can become contaminants in dredged material; contaminant exposure pathways in aquatic versus upland environments, and control measures for those pathways; sediment quality testing approaches for determining when dredged material may be suitable for disposal at estuarine, marine, or upland sites; and management options for contaminated dredged material that is unsuitable for unconfined aquatic disposal. The new LTMS 50-year dredging volume planning estimates used in the EIS/EIR are also described in Chapter 3.

Chapter 4 describes the environmental setting for the LTMS planning area, and identifies those resources of most concern in terms of being adversely or beneficially affected by dredged material disposal. The overall environmental setting of the planning area is presented first for each placement environment (estuarine, marine, and upland), followed by a more detailed discussion of the subset of resources specifically at issue for dredged material management. A description of current socioeconomic conditions in the region is also presented in Chapter 4, as well as an overview of the current regulatory setting under which dredging and dredged material disposal occur.

Chapter 5 presents a discussion of the avoidable impacts, and how they are addressed by the policy-level mitigation measures common to all alternatives. This chapter also describes the alternatives development process, including discussions of the following: the planning variables used to develop an initial range of alternative management approaches; the screening process used to refine the initial range of alternatives; and a description of the alternatives carried forward for full evaluation in the EIS/EIR.

Chapter 6 contains the analysis and evaluation of the alternatives. First, an evaluation of the "generic" impacts and benefits potentially associated with disposal in each of the placement environments is presented. This analysis is generic in that it evaluates the potential impacts and benefits of different levels of dredged material disposal or reuse separately for each placement environment, whereas the alternative LTMS management approaches each consist of combinations of different levels of disposal in each placement environment. Based on the generic analysis, disposal scenarios that could potentially result in significant adverse impacts in individual placement environments (e.g., "high" volumes of disposal at in-Bay sites), or that would not meet the overall LTMS goals and objectives, are eliminated from further consideration. The generic analysis is

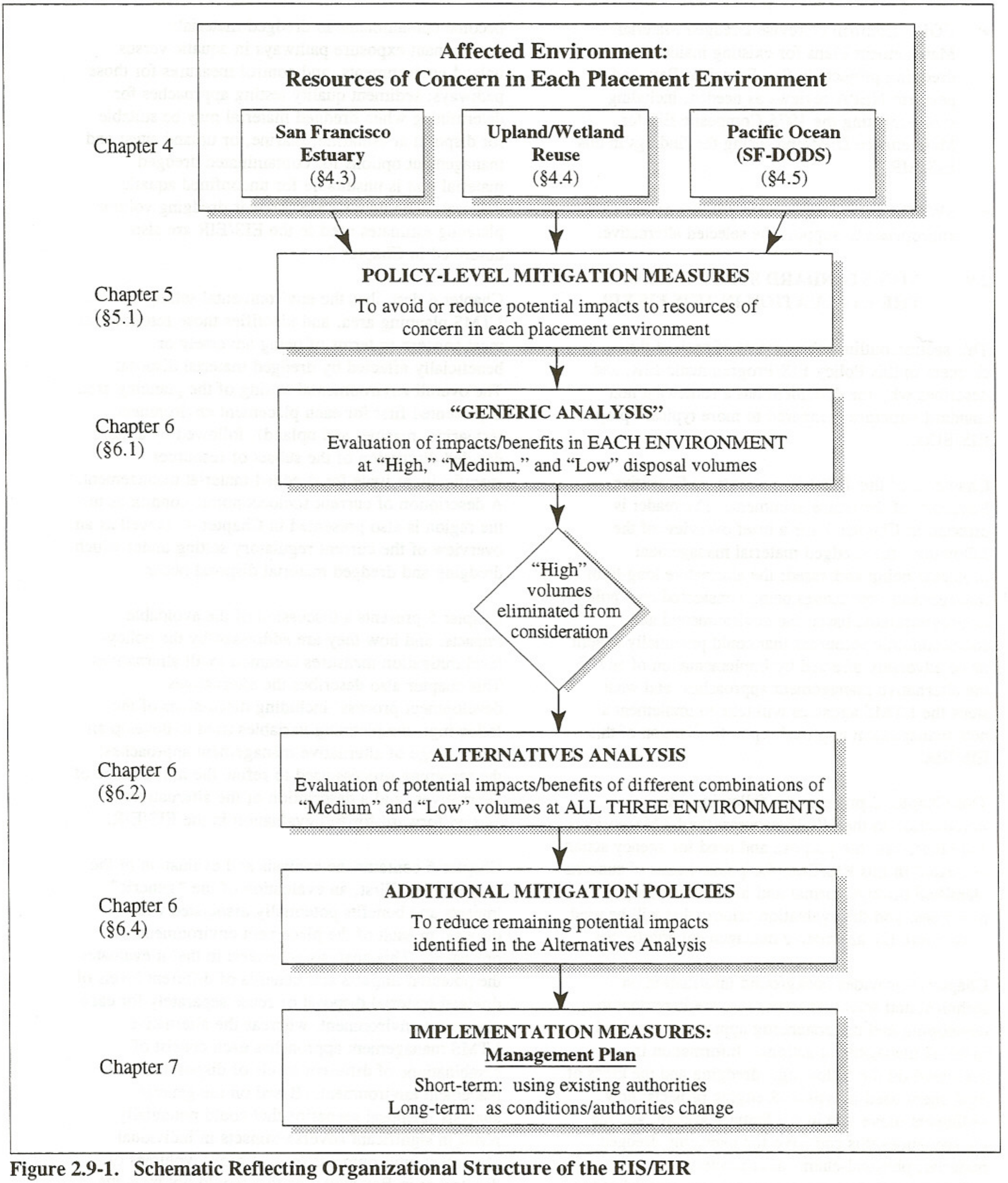


Figure 2.9-1. Schematic Reflecting Organizational Structure of the EIS/EIR

therefore the final step in the alternatives development process. Following the generic analysis, the three remaining alternative long-term management approaches are evaluated by comparing their potential impacts and benefits with each other, and with the No-Action alternative (current conditions).

Chapter 7 describes actions that the agencies will take immediately following finalization of the EIS/EIR process to implement the selected alternative approach. In addition, this chapter presents a preliminary set of implementation options that could be used in the LTMS Management Plan, or subsequent versions of it, to more fully achieve the desired long-term distribution of dredged material between the three placement environments called for in the selected alternative. Public comment on these implementation options will be used to develop the LTMS Management Plan.

Chapter 8 summarizes the cumulative impacts and benefits of the alternatives evaluated in the EIS/EIR, as required under CEQA. Chapters 9, 10, and 11 present additional CEQA-required comparisons of the alternatives including, respectively: Short-Term Uses versus Long-Term Productivity; Irreversible Environmental Changes or Irretrievable Commitments; and Growth-Inducing Impacts.

A variety of supporting information is also presented in the appendices, bound separately as Volume II of this EIS/EIR.

The structure and sequencing of the information presented in this EIS/EIR, as outlined above, differs from the "standard" approach recommended in CEQA and NEPA. The LTMS agencies have determined that there are compelling reasons for adopting this structure. In this case, a more systematic, step-by-step discussion than provided for in the "standard" EIS/EIR structure is needed to assist readers in understanding the complex issues associated with dredged material management in the Estuary region. In particular, this EIS/EIR uses a multiple-step policy design and evaluation process. A special chapter on dredging and technical sediment management issues (Chapter 3), provides background information necessary to understanding why certain resources are described as being of concern (in Chapter 4), while other resources are quickly screened out as being generally unaffected by dredged material disposal or reuse. Similarly, the policy-level mitigation measures (discussed in Chapter 5), many of which represent existing agency requirements, ensure that many kinds of potential adverse impacts will be avoided. By further screening out some impacts that could otherwise theoretically occur, these policy-level measures provide for a more focused evaluation of potential impacts and benefits in Chapter 6. The "generic" impacts analysis in Chapter 6, also not "standard" under the CEQA format, provides the last screening step in the analysis, resulting in an appropriately focused evaluation of the final set of management approach alternatives. The organizational structure of this EIS/EIR is shown schematically in Figure 2.9-1.

CHAPTER 3.0 DREDGING AND DREDGED MATERIAL CHARACTERISTICS — AN OVERVIEW

This chapter provides an overview of the dredging process and the sediment characteristics that affect disposal and reuse of dredged material. A basic understanding of how dredged sediments and any associated contaminants behave in different circumstances (for example, at upland versus aquatic placement sites) is critical to managing dredged material in a manner that minimizes potential environmental impacts and risks, and that maximizes environmental, societal, and economic benefits. The first section (section 3.1) describes the dredging process itself, including the basic types of dredging and disposal equipment, with an emphasis on how the dredging method used affects the feasibility of various management options. The next section (section 3.2) discusses the major physical, chemical, and biological characteristics of Bay area sediments in general — and dredged material in particular — that provide the basis of appropriate dredged material management.

3.1 DREDGING IN THE SAN FRANCISCO BAY REGION

Each year, over 4,000 commercial, ocean-going vessels navigate into or through the San Francisco Bay/Delta Estuary (the Estuary), carrying over 50 million tons of cargo to eight public and numerous other private ports and harbors between Sacramento and Redwood City. The Estuary has also been an important center of naval and other military operations through the years. In addition, over 1,000 commercial fishing vessels operate out of San Francisco Bay, and over 200 marinas provide slips for over 33,000 recreational boats. Together, these activities fuel a substantial maritime-related economy of over $7.5 billion annually. However, the facilities supporting these activities are located around the margins of a bay system that averages less than 20 feet deep, while modern, deep-draft ships often draw 35 to 40 feet of water or more. Extensive dredging — in the range of 2 million to 10 million cubic yards (mcy) per year — is therefore necessary to create and maintain adequate navigation channels in order to sustain the region's diverse navigation-related commercial and recreational activities. Effective management of the large volumes of dredged material generated throughout the Estuary is a substantial challenge. The following sections discuss dredging and disposal methods used in the Estuary, and the amount of dredged material anticipated to be generated over the 50-year LTMS planning period.

3.1.1 Dredging and Disposal Methods

3.1.1.1 General

This section provides a brief overview of the dredging process, including types of dredges, types of impacts that may be associated with dredging, transportation systems, and the placement or disposal practices commonly used in navigation-related dredging projects as described in the joint EPA/COE national guidance document, *Evaluating Environmental Effects of Dredged Material Management Alternatives — A Technical Framework* (USEPA and USACE 1992). The indicated references provide a more detailed description of different kinds of dredges, transport equipment, and disposal practices.

The removal or excavation, transport, and placement of dredged sediments are the primary components of the dredging process. In design and implementation of any dredging project, each part of the dredging process must be closely coordinated to ensure a successful dredging operation.

The excavation process commonly referred to as "dredging" involves the removal of sediment in its natural or recently deposited condition, using either mechanical or hydraulic equipment. (Dredging sediments in their natural condition is referred to as new work construction; dredging recently deposited sediments is referred to as maintenance dredging.) After the sediment has been excavated, it is transported from the dredging site to the placement site or disposal area. This transport operation, in many cases, is accomplished by the dredge itself or by using additional equipment such as barges, scows, and pipelines with booster pumps.

Once the dredged material has been collected and transported, the final step in the dredging process is placement in either open-water, nearshore, or upland locations. The choice of management alternatives involves a variety of factors related to the dredging process including environmental acceptability, technical feasibility, and economic feasibility of the chosen alternative.

3.1.1.2 Dredging Process, Equipment, and Techniques

The dredging equipment, techniques used for excavation and transport of the material, and the disposal alternatives considered must be compatible. The types of equipment and methods used by both the COE and private industry vary considerably throughout the United States. The most commonly used dredges are illustrated in Figure 3.1-1. Dredging equipment and dredging operations resist precise categorization. As a result of specialization and tradition in the industry, numerous descriptive, often overlapping, terms categorizing dredges have developed. For example, dredges can be classified according to the basic means of moving material (mechanical or hydraulic); the device used for excavating sediments (clamshell, cutterhead, dustpan, and plain suction); the type of pumping device used (centrifugal, pneumatic, or airlift); and others. However, for the purpose of this document, dredging is accomplished basically by only two mechanisms:

- *Hydraulic dredging* — Removal of loosely compacted materials by cutterheads, dustpans, hoppers, hydraulic pipeline, plain suction, and sidecasters, usually for maintenance dredging projects.
- *Mechanical dredging* — Removal of loose or hard compacted materials by clamshell, dipper, or ladder dredges, either for maintenance or new-work projects.

Hydraulic dredges remove and transport sediment in liquid slurry form. They are usually barge-mounted and carry diesel or electric-powered centrifugal pumps with discharge pipes ranging in diameter from 6 to 48 inches. The pump produces a vacuum on its intake side, which forces water and sediments through the suction pipe. The slurry is transported by pipeline to a disposal area. Hopper dredges are included in the category of hydraulic dredges for this report even though the dredged material is simply pumped into the self-contained hopper on the dredge rather than through a pipeline. It is often advantageous to overflow excess water from hopper dredges to increase the sediment load carried; however, this may not always be acceptable due to water quality concerns near the dredging site.

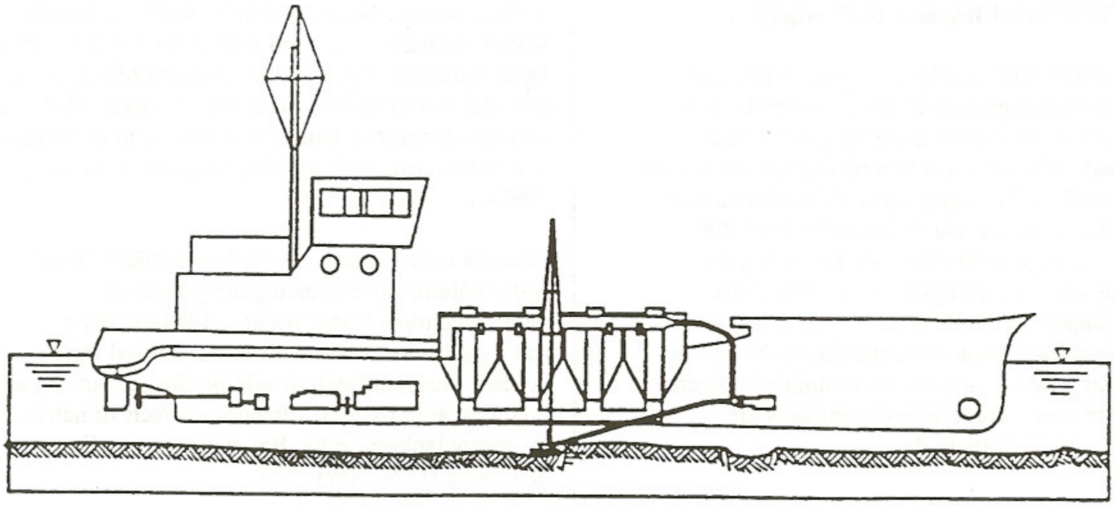
Mechanical dredges remove bottom sediment through the direct application of mechanical force to dislodge and excavate the material at almost *in situ* densities. Backhoe, bucket (such as clamshell, orange-peel, and dragline), bucket ladder, bucket wheel, and dipper dredges are types of mechanical dredges. Sediments excavated with a mechanical dredge are generally placed into a barge or scow for transport to the disposal site.

Selection of the dredging equipment and method used to perform the dredging depends on the following factors:

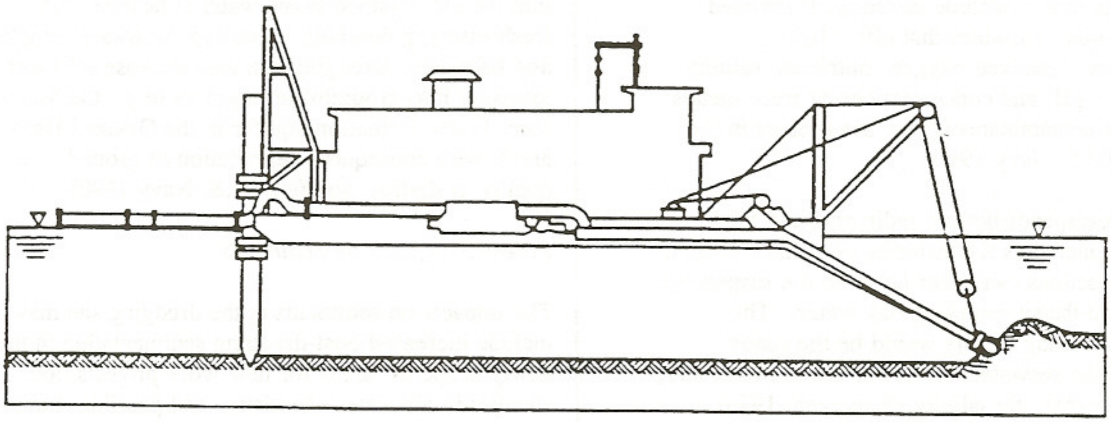
- Physical characteristics of the material to be dredged;
- Quantity of material to be dredged;
- Dredging depth;
- Distance to disposal area;
- Physical environment of the dredging and disposal areas;
- Contamination level of sediments;
- Method of disposal;
- Production rate required (e.g., cubic yards per hour);
- Types of dredges available; and
- Cost.

Water quality at the dredging and disposal sites is a particularly important consideration in the choice of dredging equipment. Hydraulic dredging can virtually eliminate disturbance and resuspension of sediments at the dredging site, and is often the first choice when dredging occurs in enclosed waterbodies or in locations near aquatic resources that would be especially sensitive to temporary increases in suspended solids or turbidity. However, because hydraulic dredging typically entrains additional water that is many times the volume of sediment removed, water management and water quality must be controlled at the disposal site. In contrast, mechanical dredging creates little additional water management concern at the disposal site because little additional water is entrained by mechanical dredging equipment; therefore mechanical dredging is usually the first choice when disposal site capacity limitations are a primary concern. However, typical mechanical equipment often creates more disturbance and resuspension of sediments at the dredging site.

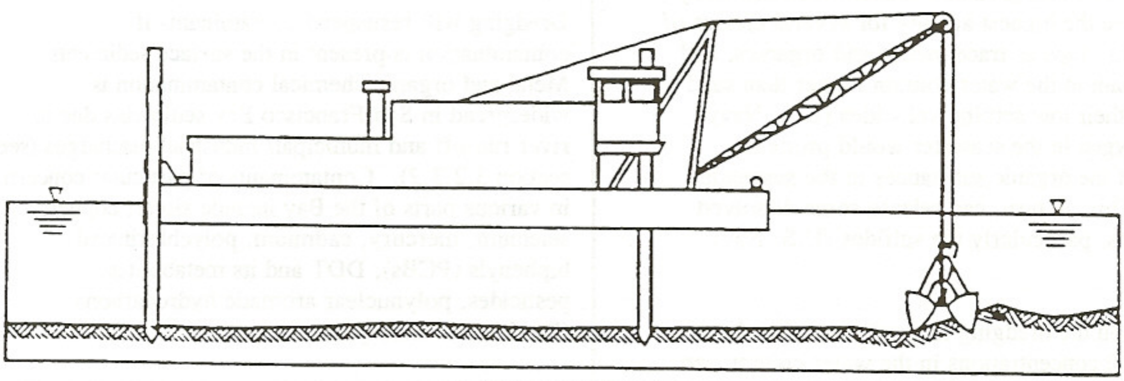
More detailed descriptions of dredging equipment and dredging processes are available in Engineer Manual (EM) 1110-2-5025 (USACE 1983), Houston (1970), and Turner (1984).



a. Self-Propelled Hopper Dredge



b. Cutterhead Pipeline Dredge



c. Clamshell Dredge

Source: USEPA and USACE (1992)

Figure 3.1-1. Types of Dredges

3.1.1.3 The General Impacts of Dredging

This section describes briefly the types of impacts associated with dredging activities in general. Most of the impacts from dredging are temporary and localized and, with the exception of impacts associated with a changed bottom topography (potential change in local hydrodynamics and in the makeup of the benthic resources present in the dredge area), the impacts end when the dredging ends. The most substantial impacts tend to be on water quality, the potential for resuspension of contaminants buried in the sediments, and the impacts on biological resources in the dredge area. These types of impacts are therefore discussed in more detail below.

Potential Impacts on Water Quality

Water quality variables that can be affected by dredging operations include turbidity, suspended solids, and other variables that affect light transmittance, dissolved oxygen, nutrients, salinity, temperature, pH, and concentrations of trace metals and organic contaminants if they are present in the sediments (U.S. Navy 1990).

Dredging resuspends bottom sediments and thus temporarily increases the turbidity of surface waters. Chemical reactions can occur between the suspended materials and the surrounding Bay water. The primary controlling factors would be the redox potential of the seawater, the pH of the seawater and, to a lesser degree, the salinity (Pequegnat 1983). ("Redox potential" refers to the reduction-oxidation potential, which is a measure of the availability and activity of oxygen to enter into and control chemical reactions.) The fine-grained sediment fractions (clay and silt) have the highest affinity for several classes of contaminants, such as trace metals and organics, and tend to remain in the water column longer than sand because of their low settling velocities (U.S. Navy 1990). Oxygen in the seawater would promote oxidation of the organic substances in the suspended materials This, in turn, can release some dissolved contaminants, particularly the sulfides (U.S. Navy 1990).

Depending on the dredging method used, dissolved oxygen (DO) concentrations in the water column can be substantially reduced during dredging if the suspended dredged material contains high concentrations of oxygen demanding substances (e.g., hydrogen sulfide). The reduction of DO during dredging is minimal (1 to 2 ppm) and transitory in surface waters, but can be more severe in bottom waters (reduction of up to 6 ppm for 4 to 8 minutes). Most estuarine organisms are capable of tolerating low DO conditions for such short periods. Reduced DO concentrations would be expected to be localized and short term, with minimal impacts (U.S. Navy 1990).

Nutrient enrichment can increase turbidity in the water column by enhancing the growth of phytoplankton. If this occurs, it is typically a transient phenomenon with minimal local impact. In the Bay area, nutrients would be flushed out of the dredging area by tidal currents. Effects of nutrients on phytoplankton in the Bay would generally not be detectable (U.S. Navy 1990).

Depending on the location of the dredging, deepening navigation channels can increase saltwater intrusion into the Delta (since saline water is heavier than freshwater), potentially impacting freshwater supplies and fisheries. Dredging can also increase saltwater intrusion into groundwater aquifers (e.g., the Merritt Sand/Posey formation aquifer in the Oakland Harbor area), with consequent degradation of groundwater quality in shallow aquifers (U.S. Navy 1990).

Potential Impacts on Sediments

The impacts on sediments at the dredging site may include increased post-dredging sedimentation in the newly deepened areas for new work projects, local changes in air-water chemistry, and possible slumping of materials from the sides of the dredging areas.

Potential Resuspension of Contaminants

Dredging will resuspend contaminants if contamination is present in the surface sediments. Metal and organic chemical contamination is widespread in San Francisco Bay sediments due to river run-off and municipal/ industrial discharges (see section 3.2.3.2). Contaminants of particular concern in various parts of the Bay include silver, copper, selenium, mercury, cadmium, polychlorinated biphenyls (PCBs), DDT and its metabolites, pesticides, polynuclear aromatic hydrocarbons (PAHs), and tributyltin.

Dredging of contaminated sediments does present the potential for release of contaminants to the water column, and for the uptake of contaminants by organisms contacting resuspended material. However, most contaminants are tightly bound in the sediments and are not easily released during short-term resuspension. Chemical reactions that occur during dredging may change the form of the contaminant and thus alter its bioavailability to organisms. These chemical reactions are determined by complex interactions of environmental factors, and may either enhance or decrease bioavailability, particularly of metals.

Potential Impacts on Biological Resources

The impacts of dredging on biological resources can be short term or long term, direct or indirect. There can be short-term impacts from the dredging, and long-term impacts associated with habitat modification. Short-term impacts could include local changes in species abundance or community diversity during or immediately after dredging. Long-term impacts could include permanent species abundance or community diversity changes caused by changes in hydrodynamics or sediment type, or a decline or erratic trend beyond the normal range of variability in the years following new dredging (U.S. Navy 1990). Direct impacts would be directly attributable to the dredging activity, such as a direct loss of mudflat habitat or a temporary turbidity-induced reduction in productivity in an eelgrass bed immediately adjacent to a dredging site. Indirect effects on organisms include those effects which are not immediately measurable as a consequence of dredging operations. Such effects might, for example, involve population changes in one species that are caused by dredging's effects on its predators, prey, or competitors. Indirect effects may be manifested over extended periods of time and/or at some distance away from the dredging site. The differentiation between direct and indirect effects is not always clear.

Dredging involves the removal of substrate and benthic organisms at the dredging site, resulting in immediate localized effects on the bottom life. Besides the decimation of organisms at the dredging site, there is the removal of the existing natural or established community with widely varying survival of organisms during dredged material excavation. Aside from the initial physically disruptive effects, a long-term environmental concern is the recovery (repopulation) of bottom areas where dredging has occurred (Hirsch, DiSalvo, and Peddicord 1978). Dredging thus opens the area for recolonization on a new substrate that may resemble the original substrate or be completely different in physical characteristics. Recolonization may include the same organisms or opportunistic species that have environmental requirements that are flexible enough to allow them to occupy a disturbed site (Reilly et al. 1992).

Recolonization of the dredging site can begin quickly, although re-establishment of a more stable benthic community may take several months or years after the dredging operation has occurred (Oliver et al. 1977; Conner and Simon 1979). Oliver et al. (1977) found that most of the infauna were destroyed at the center of the dredging area. Communities inhabiting highly variable and easily disrupted environments, such as those found in shallow water, recovered more quickly from dredging operations than communities in less variable environments such as in deep or offshore waters. Seasonal changes in the environment were considered most important in shallower water where the organisms are more likely to be affected by the changing seasons (Reilly et al. 1992).

Oliver et al. (1977) noted two phases of succession after a disturbance. In the first phase, opportunistic species such as some polychaetes would move into a disturbed area. The second phase involved recruitment of organisms associated with undisturbed areas around the disturbed site. Recovery at the disturbed dredging site depends on the type of environment and the speed and success of adult migration or larval recruitment from adjacent undisturbed areas (Hirsch, Disalvo, and Peddicord 1978).

The effects of habitat loss or alteration at the dredge site may extend beyond the boundaries of the dredging operations. However, dredging-induced habitat alterations are minor compared to the large-scale disturbance of benthic habitat in San Francisco Bay from naturally occurring physical forces (Reilly et al. 1992). The result of these forces is a state of non-equilibrium in benthic species composition typical of shallow estuaries. Naturally occurring habitat disturbances arise from seasonal and storm-generated waves, and from seasonal fluctuations of riverine sediment transport into San Francisco Bay. Human influences on benthic habitat include not only dredging and disposal, but also waste discharges, sediment deposition from hydraulic mining, filling of Bay margins, fresh water diversions, and introduction of exotic species. When the disturbance ceases, recolonization of the benthic substrate occurs; re-establishment of a more or less stable benthic community can take several months or years (Reilly et al. 1992).

The suspension of sediments during dredging will generally result in localized, temporary increases in turbidity that are dispersed by currents or otherwise dissipate within a few days, depending on hydrodynamics and sediment characteristics (e.g., USACE and Port of Oakland 1998). Where dredging occurs in relatively polluted areas, contaminants in the sediments are likely to be dispersed into the water column, resulting in localized, temporary increases in contaminant concentrations that may affect fish and invertebrates.

Although the increases in turbidity are transient, they can have several types of longer-term consequences for sensitive biological resources. Increased turbidity can reduce the survival of herring eggs, which are attached to hard surfaces on Central Bay shorelines, potentially resulting in reduced recruitment and, ultimately, reduced abundance of this important resource species in the Bay. In certain locations, at critical times of year, increased turbidity can affect the survival of the larval or juvenile stages of sensitive fish species, as well as the feeding and migration of adults. Short-term impacts on critical foraging areas, such as eelgrass beds, during the nesting season of marine birds such as the endangered California least tern, can affect the birds' nesting success.

The effect of dredging on fish varies to some degree with the life stage of the fish. Early life stages of fish are more sensitive than adults. Adult fish would be motile enough to avoid the areas of activity; it is assumed that fish will leave the affected areas until dredging is done. Turbidity could reduce visibility, causing difficulty in locating prey. Suspended sediments can have other impacts, including abrasion of the body and clogging of the gills. Generally, bottom-dwelling fish species are most tolerant to suspended solids, and filter feeders are the most sensitive. In San Francisco Bay, dredging between December and February could disrupt the spawning of the Pacific herring and result in mortality to eggs. Depending on the location of dredging, such activity could affect the migration of steelhead and chinook salmon. Dredging in the Central Bay during summer can affect juvenile Dungeness crabs, for which the Central Bay provides an important nursery habitat. Larval and juvenile fishes and invertebrates are also vulnerable to entrainment in dredging equipment.

Waterbirds that feed or rest in the vicinity of the dredging activity may be disturbed and, as a result, move to areas where they incur higher energetic costs or experience greater risks.

Potential Impacts on Other Resource Areas

Emissions from dredging equipment in the Bay area typically causes temporary adverse impacts on air quality, depending on the size and location of the project.

Noise from the dredge can cause significant impacts on sensitive receptors located near the dredge area.

Dredging can impact submerged cultural resources (e.g., ship wrecks) if such resources are present in the dredge area. For the ports and major navigation channels in the Bay area, this is usually not an issue because the channels have been dredged previously.

In terms of socioeconomic impacts, dredging activities have a minor beneficial impact on employment, requiring a relatively small work force which can easily be met by the large population in the Bay area. Deeper navigation channels are critical to Bay area ports' ability to compete for vessel cargo with other U.S. west coast ports, so dredging has a regional beneficial economic impact on the Bay area. Dredging has a beneficial impact also on recreational and commercial activities in that dredging helps to maintain harbors and marinas, which support fishing, boating, and associated activities.

Dredging impacts on vessel transportation are typically minimal. The dredge represents an obstacle that other vessels have to maneuver around, but the location of the dredge is posted in the *Notice to Mariners* so it can be easily avoided.

Depending on the location, dredging can affect recreational fishing but such impacts are typically temporary and insignificant.

Dredging can impact submerged utilities but, with proper notice, these utilities can be relocated to avoid impacts.

3.1.1.4 Transportation of Dredged Material

Transportation methods generally used to move dredged material include the following: pipelines, barges or scows, hopper dredges, and sometimes trucks. Pipeline transport is the method most commonly associated with cutterhead, dustpan, and other hydraulic dredges. Dredged material may be directly transported by hydraulic dredges through pipelines for distances of up to several miles, depending on a number of conditions. Longer