Draft Environmental Impact Statement for

Designation of an Ocean Dredged Material Disposal Site off Humboldt Bay, California

Prepared by:

EPA

U.S. Environmental Protection Agency
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San Francisco, California

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In association with:

Jones & Stokes Associates, Inc.
Bellevue, Washington

March 1995

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DRAFT
ENVIRONMENTAL IMPACT STATEMENT
FOR DESIGNATION OF AN
OPEN OCEAN
DREDGED MATERIAL DISPOSAL
SITE OFF HUMBOLDT BAY, CALIFORNIA

U.S. Environmental Protection Agency
Region IX
San Francisco, California

Comments on this administrative action should be addressed to:

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Comments must be received no later than:

____________________, 1995, 45 days after publication of the notice of availability in the Federal Register for the DEIS.

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FOR DESIGNATION OF AN
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SITE OFF HUMBOLDT BAY, CALIFORNIA

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Regional Administrator

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Abbreviations and Acronyms

CAA	Clean Air Act
CEQA	California Environmental Quality Act
CO	carbon monoxide
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
CZM	coastal zone management
CZMA	Coastal Zone Management Act
CZMP	California Coastal Zone Management Plan
DDLS	Dredge Data Logging System
DEIS	draft environmental impact statement
DO	dissolved oxygen
EIR	environmental impact report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FWCA	Fish and Wildlife Coordination Act
HC	hydrocarbons
HOODS	Humboldt Open Ocean Disposal Site
L-P	Louisiana-Pacific Corporation
LC	London Convention
MHHW	mean higher high water
MLLW	mean lower low water
MMS	Mineral Management Service
MPRSA	Marine Protection, Research and Sanctuaries Act
NCUAQMD	North Coast Unified Air Quality Management District
NDS	Nearshore Disposal Site
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
ODMDS	ocean dredged material disposal site
PM	particulate matter
PM_{10}	particulate matter smaller than or equal to 10 microns in diameter
ROG	reactive organic gases
SBDs	seabed drifters
SHPO	State Historic Preservation Officer
SMMP	site management and monitoring plan
SO_2	sulfur dioxide
USCG	United States Coast Guard
USFWS	U.S. Fish and Wildlife Service

WRDA .... Water Resources Development Act
ZSF .... Zone of Siting Feasibility

Units of Measure and Conversions

cm/s	centimeters per second
ft	feet
gm^2	grams per square meter
$g/C/m^2/day$	grams of carbon per square meter per day
m	meters
mg/l	milligrams per liter
mg/m^2	milligrams per square meter
mm	millimeters
nmi	nautical miles
ppt	parts per thousand
yd^3	cubic yards
μg/g	microgram per gram
μg/kg	microgram per kilogram
μg/l	microgram per liter
μm	micro meters

To Convert From	To	Multiply By
cubic yards	cubic meters	0.7646
nautical miles	miles	1.1508
miles	kilometers	1.6093
short tons	pounds	2,000
meters	feet	3.2808
centimeters	inches	0.3937
feet	fathoms	0.1667

Executive Summary

The proposed action is the designation of an ocean disposal site for dredged material from Humboldt Bay, California. The site is located in the Pacific Ocean at a depth of 49 to 55 meters (160 to 180 feet) approximately 3 to 4 nautical miles northwest of the mouth of Humboldt Bay. The site would be used for disposal of dredged material from federal projects permitted under Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended. This site, known as the Humboldt Open Ocean Disposal Site (HOODS), has been used on an interim basis for disposal of material dredged from the navigation channels in Humboldt Bay since September 1990.

Continued use of the proposed site is not expected to cause significant long-term adverse environmental effects. The sediments and the benthic community have been altered by previous disposal operations at the proposed site. The smothering effect on the benthos caused by sediment inundation is expected to continue, but impacts would be localized and are not considered significant. No significant environmental impacts are expected to occur outside of the HOODS. Impacts on water quality, which would be temporarily experienced during disposal operations, are expected to be minimal. Short-term effects on organisms in the water column would be negligible.

Few of the potentially adverse environmental effects of dredged material disposal at the proposed site are likely to be irreversible or to involve any irretrievable commitment of resources. A site management and monitoring plan (SMMP) is incorporated into this draft environmental impact statement (DEIS). Implementation of the SMMP will be a requirement of site use.

The seven alternatives considered for dredged material disposal are No Action, disposal off the continental shelf, upland disposal, beach nourishment, the SF-3 site, the nearshore disposal site (NDS), and the HOODS. After detailed field investigations and analysis of each alternative, EPA Region IX determined that ocean disposal at a designated dredged material disposal site was the only viable alternative for the proposed action. The preferred alternative identified in this DEIS is the HOODS. This decision is based on the potential for disposal activities to adversely affect the alternative sites, the demonstrated need for an ocean disposal site for dredged material, and the insignificance of the long-term environmental impacts at the HOODS.

Section 1

Introduction

Section 1. Introduction

1.1 GENERAL INTRODUCTION

This draft environmental impact statement (DEIS) evaluates the proposed designation of an ocean dredged material disposal site (ODMDS) northwest of the mouth of Humboldt Bay, California. The purpose of this action is to provide an environmentally acceptable site for disposal of materials dredged from Humboldt Bay by the U.S. Army Corps of Engineers (Corps). The preferred site for final designation is the Humboldt Open Ocean Disposal Site (HOODS) (Figure 1-1).

The U.S. Environmental Protection Agency (EPA) has the authority to designate ODMDSs under Section 102 of the Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972 (33 USC 1401 et seq.). The Act established a permitting program for ocean disposal of dredged material. The permitting program requires the determination of environmental impacts, designation of sites, enforcement of permit conditions, and management of disposal sites. It is the EPA's policy to publish an environmental impact statement (EIS) for all ODMDS designations (39 FR 37119, October 21, 1974).

The EPA promulgated final Ocean Dumping Regulations to implement the MPRSA in 40 CFR 220-229 (January 11, 1977). The regulations set forth criteria and procedures for the selection and designation of ocean disposal sites. In addition, the regulations designated interim ocean sites for the disposal of dredged material to allow the necessary time for site designation studies as required by EPA regulations. Use of the interim designated sites was dependent on compliance with the requirements and criteria contained in the EPA's Ocean Dumping Regulations (40 CFR 220-229).

The Corps, in close cooperation with the EPA, with federal and state resource agencies, and with members of the concerned public, has conducted studies of the ocean area offshore of Humboldt Bay for the purpose of characterizing the physical, chemical, and biological environment of these ocean waters. The EPA requested the Corps San Francisco District to assist with the preparation of the ODMDS designation EIS because the Corps will use the site for disposal of sediments dredged from Humboldt Bay. The EPA retains responsibility for selection of the preferred alternative, for authorizing the site, and for publication of the EIS and related public coordination.

The final designation process is being conducted in accordance with the requirements of the MPRSA, as amended (33 USC 1401 et seq.); the EPA's Ocean Dumping Regulations (40 CFR 220-229); and other applicable regulations.

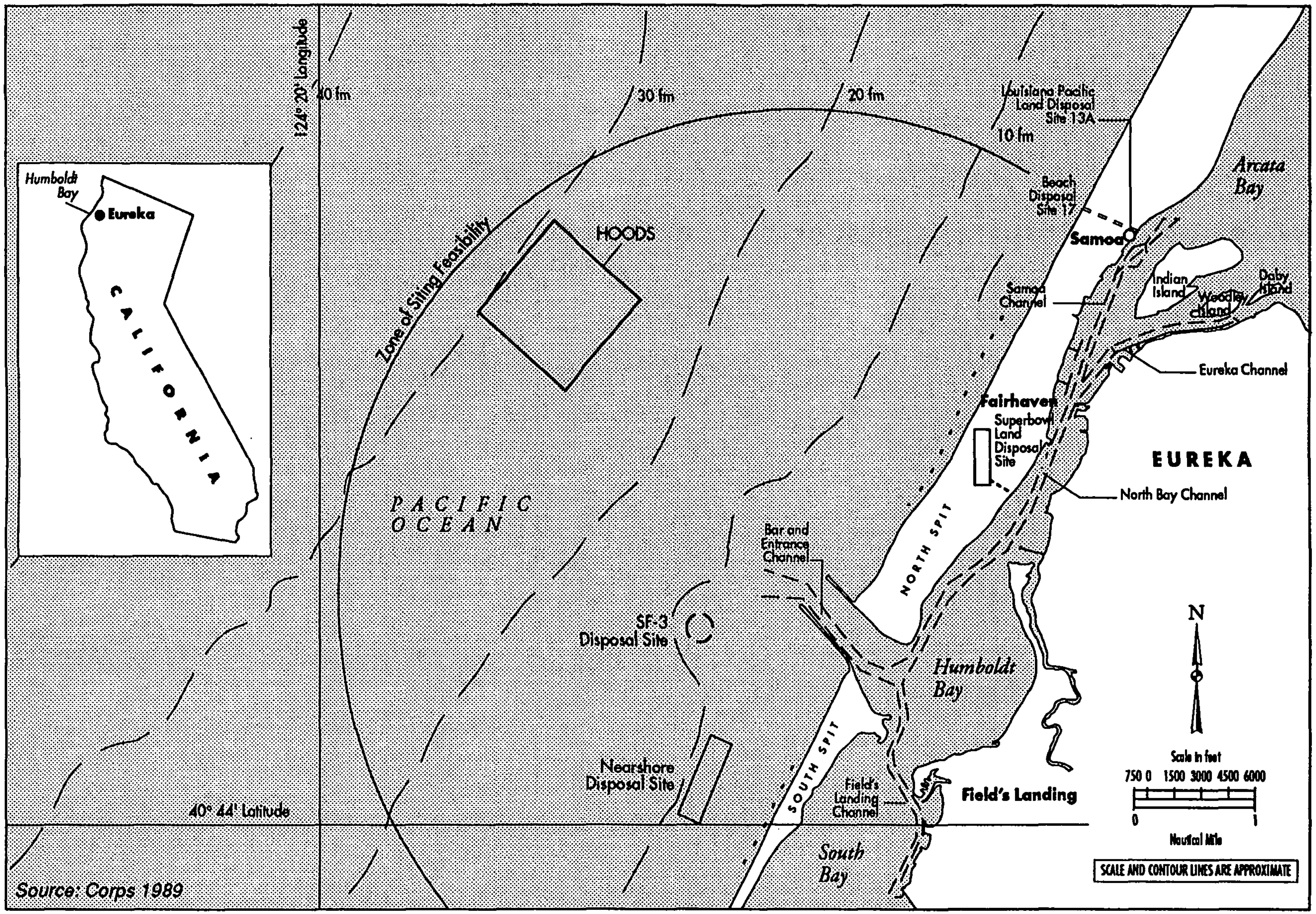


Figure 1-1. Location of Past and Present Ocean and Land Dredged Material Disposal Sites Near Humboldt Bay, California

1.1.1 Background

Humboldt Bay is a deep-draft harbor located near Eureka, California. The natural transport of sediment in the area results in shoaling at the Harbor entrance and within Humboldt Bay. To provide for safe navigation into and through the Harbor, the Corps has conducted annual maintenance dredging of the Harbor and entrance channels since 1931.

The Corps currently has two dredging cycles each year, one in the fall and one in the spring. During the fall, the Corps dredges the Bar and Entrance and North Bay Channels, removing 145,000 to 1,400,000 cubic yards (yd^3) of sediment. During the spring, a smaller quantity of material (1,900 to 192,000 yd^3) is dredged from the Eureka, Samoa, and Field's Landing Channels, as well as the North Bay Channel. (Corps 1994a, 1994b.)

Several ocean sites have been used to dispose of the dredged materials from Humboldt Bay; however, there is currently no permanently designated ODMDS. Interim disposal sites were selected, based on historical use, by the EPA in consultation with the Corps. The three ocean sites that have been used are the SF-3 disposal site, the Nearshore Disposal Site (NDS), and the HOODS (Figure 1-1).

The SF-3 site has been used for dredged material disposal since the 1940s. Interim designation of the SF-3 site was originally issued for a 3-year period between 1977 and 1980 but was later extended by the EPA to February 1, 1983. An additional extension until December 31, 1988, was granted to allow completion of field studies, environmental evaluation, and preparation of an EIS for designation of SF-3 as an ODMDS.

In the mid-1980s it was discovered that dredged materials placed at the SF-3 disposal site were not dispersing as had been anticipated. The mounding at the SF-3 site caused adverse surface wave conditions and resulted in navigation hazards to commercial fishing and recreational boats traversing the site. The commercial fishing community expressed concern to the Corps. In light of mounting concern, the site was closed in 1988.

Because of the problems associated with disposal at the SF-3 site, the Corps decided that an investigation of other potential sites near Humboldt Bay should be undertaken to select a permanent disposal site that would not interfere with navigation and that would minimize impacts on the ocean environment.

In 1988 and 1989, the Corps disposed of sand dredged from the Bar and Entrance Channel and the North Bay Channel at the NDS. The material was disposed at the NDS because of the impacts on navigation associated with disposal at the SF-3 site and to keep the material within the littoral cell. Concerns have also been raised about the use of the NDS, including the effect of the disposal on navigational safety and commercial fisheries resources, and dispersion of disposed sediments toward the Harbor mouth.

The Corps was authorized by EPA to use the SF-3 site to dispose of dredged materials from Humboldt Bay on one occasion in 1990.

The Corps has used the HOODS for disposing of dredged material from Humboldt Bay since fall 1990. The HOODS was sized to provide the capacity for 50,000,000 yd^3 of dredged material (Corps/HBHRCD 1994). Between 1990 and 1994, the HOODS has been used on 10 occasions for dredged material disposal. Approximately 2,860,000 yd^3 have been disposed of at this site.

1.1.2 Local Need

Humboldt Bay is the second largest coastal estuary in California. The Bay consists of two shallow basins, South Bay and Arcata Bay, which are connected by a narrow channel (Figure 1-1). The Bay is the only naturally enclosed, deep-draft harbor for major commercial shipping between San Francisco, California, and Coos Bay, Oregon. The Harbor provides berthing for deep-draft vessels serving the forest products industries, shallow-draft vessels serving the petroleum and chemical industries, and a large commercial fishing fleet. In 1993, 154 deep-draft vessels called on Humboldt Bay, representing the shipment of 1,125,544 short tons of cargo (Corps/HBHRCD 1994). This accounted for approximately 70% of the total tonnage shipped through the Harbor. The fishing industry is the third largest economy in Humboldt Bay, supporting approximately 500 vessels and delivering catches with an average annual dockside value of $10-20 million (Corps/HBHRCD 1994). Other beneficial uses of the Bay include hunting, sport fishing, and educational and recreational use.

Natural sediment transport processes result in the shoaling of the Harbor and entrance channels and thereby create hazards to vessel navigation into and within the Harbor. Shoaling occurs rapidly in the Bar and Entrance Channel as a result of the large volume of littoral material that is transported by ocean currents along the northern California coast. The Bar and Entrance Channel requires annual dredging to maintain safe depths for deep-draft vessels. To provide safe passage for deep-draft vessels into and through the Harbor, it is necessary to dredge the Harbor entrance and inner Harbor channels on an annual basis. The other in-bay channels, taken individually, require less frequent dredging; however, each year there is a need to dredge specific in-bay channels.

Between 1982 and 1994 (excluding 1989), an average of 802,000 yd^3 of material was dredged annually by the Corps to maintain sufficient operating depths (Corps 1994a, 1994b, 1995). No upland disposal sites that have the capacity to contain the volume of material generated during maintenance dredging have been identified. The Corps has disposed of this material at the HOODS since 1990. The Corps has asked the EPA to propose the HOODS as a designated ODMDS for disposal of dredged materials from Humboldt Bay.

1.1.3 Federal Dredging Operations

The only federal dredging operation presently occurring in the Humboldt Bay region is the annual maintenance dredging of the Bay and Harbor by the Corps. The Corps uses a self-propelled hopper dredge for dredging the Harbor. As noted earlier, the Corps performs maintenance dredging in two phases each year. During the spring, the Corps dredges the Bar and Entrance Channel and portions of the North Bay Channel. During the fall, the Corps dredges the interior channels (i.e., the Samoa, Eureka, Field's Landing Channels and portions of the North Bay Channel) as needed. The Corps splits the maintenance dredging operations into two phases to take advantage of periods of relatively calm weather and ocean conditions. The average volume of material dredged annually during these operations is 802,000 yd^3.

The Bar and Entrance Channel and the southern portion of the North Bay Channel lie within an exposed ocean environment subject to large swells, breaking seas, and strong currents. This area contributes 84% of the total annual dredge volume (687,400 yd^3) of the project. The remaining average annual volume dredged from the interior channels (Samoa, Eureka, Field's Landing, and North Bay Channels) during fall is 106,100 yd^3.

The Corps has utilized three ocean disposal sites for placement of sediments dredged from Humboldt Bay navigation channels. These include the SF-3 disposal site, the NDS, and the HOODS. The SF-3 site has been used since the 1940s, most recently in April 1990. The NDS has been used twice, once in 1988 and again in 1989. Only sand is suitable for disposal at the NDS, because the purpose of disposal at the NDS is to maintain the disposed sand in the littoral zone and nourish the south spit of Humboldt Bay. The HOODS has been used on 10 occasions for dredged material disposal since the fall of 1990. It is anticipated that the HOODS will be used for all future maintenance dredge disposal under Section 103 permitting authority until a permanent EPA designation is complete.

In addition to the discharge of materials from the annual maintenance dredging operations, the Corps is also proposing to dispose of dredged material generated from the proposed Humboldt Harbor and Bay Deepening Project at the HOODS. The proposed Harbor and Bay Deepening Project is scheduled to occur in 1997. The proposed project would generate 5,600,000 yd^3 of spoils. The Corps is proposing to dispose of all of this dredged material at the HOODS, except for 26,000 yd^3 which would be disposed at the Louisiana-Pacific upland disposal site (Corps/HBHRCD 1994). The Corps has recently published its Draft Feasibility Report and EIS/EIR for the proposed deepening project (Corps/HBHRCD 1994).

The Corps does not issue permits for its own projects. However, each Corps project is subject to the same suitability determination as nonfederal projects requiring permits, including the EPA Ocean Dumping Criteria at 40 CFR 227 and sediment testing requirements in accordance with EPA/Corps 1991 Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual (the Green Book).

1.1.4 Non-Federal Dredging Operations

To date, non-federal dredging and disposal operations at Humboldt Bay have not utilized ocean disposal. For dredging work at Humboldt Bay for the years 1977 through 1988, the Corps issued 16 permits for non-federal projects, authorizing the dredging and disposal of approximately 350,000 yd^3 of sediment. These projects typically involved dredging of local public marinas and forest product berthing facilities. Disposal was usually at upland locations, with at least one occurrence of disposal in the surf zone along the North Spit (the beach disposal site shown in Figure 1-1).

Should there be a future need for non-federal dredging operations to utilize an EPA-authorized ocean disposal site, those projects would be assessed on an individual project basis in accordance with the provisions of EPA/Corps 1991 Green Book testing requirements; EPA's Ocean Dumping Regulations; 40 CFR 220-225, 227-228; and the Corps dredged material disposal permitting procedure under Section 103 of the MPRSA.

1.2 PURPOSE OF AND NEED FOR ACTION

The Corps considers maintenance dredging of Humboldt Bay essential to the continued safe navigation of vessels into and within the Bay. Upland disposal sites do not have the capacity to receive dredged materials from annual dredging operations. At present, there is also no permanently designated open ocean disposal site for dredged materials from the Bay.

Since expiration of the interim designation of the SF-3 site in 1988, ocean disposal has been authorized by the EPA on a case-by-case basis under Section 103 of the MPRSA at the SF-3 site, NDS, and the HOODS. However, use of interim sites would be terminated under provisions of the Water Resources Development Act (WRDA), which would not allow disposal of dredged material at interim ocean sites under Section 103 of the MPRSA after January 1, 1997, unless the site has received final designation. The purpose of the proposed action is to respond to the need for a permanently designated ODMDS to receive dredged materials from Humboldt Bay.

1.3 ALTERNATIVES CONSIDERED

The proposed action is the designation of an ODMDS for disposal of dredged materials from Humboldt Bay. A number of alternatives were considered to identify the most suitable and least environmentally damaging site: No Action, upland disposal, disposal off the continental shelf, beach nourishment, disposal at site SF-3, disposal at the NDS, and disposal at the HOODS.

If the No Action alternative were implemented, there would be no regionally designated ocean disposal site. The HOODS could continue to be used under MPRSA Section 103 permit authority. In the short term, the EPA and the Corps would continue to evaluate ocean disposal sites on a case-by-case basis; however, use of interim sites would be terminated on January 1, 1997, under provisions of WRDA, which specifies using only permanently designated ocean disposal sites for disposal of dredged materials.

Upland disposal alternatives are not practicable due to the limited availability and capacity of upland disposal areas, increased costs, and vessel safety.

The Corps conducted a Zone of Siting Feasibility (ZSF) analysis for the proposed Humboldt Bay ODMDS (Corps 1989). Disposal off the continental shelf was not considered feasible due to operational constraints on the Corps' maintenance dredging for the Humboldt Bay region. U.S. law defines the continental shelf as the seaward extension of the coast to a depth of 183 meters (m) (600 feet [ft]). Seaward of Humboldt Bay, the continental shelf break (the 600 ft contour line) occurs at an approximate distance of 10 nautical miles (nmi) from shore.

The ZSF analysis defined an area within which disposal of dredged material would be feasible based on operational and economic criteria. Candidate disposal sites within this zone were then evaluated according to environmental and important resources criteria. The analysis concluded that the ZSF boundary for an ODMDS located outside Humboldt Bay should be set at a radius of 4 nmi from the end of the Humboldt Harbor jetty heads. The 600 ft line is not encountered within the 4 nmi operational radius outside Humboldt Bay as set by the ZSF. Therefore, for Humboldt Bay, it is not feasible to designate an ocean disposal site beyond the continental shelf.

The HOODS, SF-3, and the NDS are all historical sites located within the ZSF. These three potential sites were evaluated according to criteria established in the EPA's Ocean Dumping Regulations. The HOODS is the preferred alternative for designation.

1.4 REGULATORY FRAMEWORK

An international treaty as well as federal and state laws and regulations apply to the designation of an ODMDS. The relevance of these statutes to the proposed action and related compliance requirements for the proposed site are described below.

1. **Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (26 US Treaties and Other International Agreements 2403: Treaties and Other International Acts Series 8165)**

The principal international agreement governing ocean dumping is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, also known as the London Convention (LC). This agreement became effective August 30, 1975, after ratification by 15 contracting countries, including the United States. Ocean dumping criteria, incorporated into MPRSA permits for ocean dumping, have been adapted from the provisions of the LC. Thus, when material is found to be acceptable for ocean disposal under MPRSA, it is also acceptable under the LC.

2. The Marine Protection, Research and Sanctuaries Act of 1972, as amended (33 USC 1401 et seq.)

The MPRSA regulates the transportation and disposal of materials in the ocean and prohibits ocean disposal of certain wastes. Section 102 of the MPRSA gives the EPA designating authority for multiple-user, long-term, dredged material disposal sites. Section 102 of the MPRSA also allows the EPA to promulgate environmental evaluation criteria for all dumping permit actions and to retain review authority over Corps MPRSA 103 permits. The EPA's regulations for ocean dumping are published as 40 CFR 220-229. This DEIS is for designation of an ocean disposal site rather than permitting of dredged material disposal; therefore, it only relates to the criteria of 40 CFR 228.

Section 103 of the MPRSA sets forth requirements for obtaining Corps permits to transport dredged material for the purpose of ocean disposal. Under Section 103, those using ocean disposal must comply with both EPA and Corps requirements for transportation and disposal of dredged material in the ocean. The permitting regulations promulgated by the Corps under the MPRSA appear in 33 CFR 320-330 and 335-338. Based on an evaluation of compliance with the regulatory criteria of 40 CFR 227, both the EPA and the Corps may prohibit or restrict disposal of material that does not meet the criteria. The EPA and the Corps also may determine that ocean disposal is inappropriate because of ODMDS management restrictions or because options for beneficial use exist (i.e., using spoils beneficially).

3. Water Resources Development Act of 1992 (PL 102-580)

Section 506 of the WRDA amends Section 102(c) of the MPRSA. These amendments require, in part, that a site management plan be developed for each designated ocean disposal site. This site management plan is required to include:

- a baseline assessment of conditions at the site;
- a program for monitoring the site;
- special management practices necessary for protection of the site;
- consideration of the quantity and contaminant levels of the material to be disposed at the site;
- consideration of the active life of the site and management requirements after site closure; and
- a schedule for review and revision of the site management plan.

Section 506 of the WRDA further requires that after January 1, 1995, a site management plan must be developed and approved before final designation is issued. After January 1, 1997, no permit for dumping may be issued under Section 103 of the MPRSA for a site unless the site has received final designation.

In the case of this proposed action, the final designation is scheduled for fall 1995. Thus, a site management plan is required to be developed and approved, pursuant to the WRDA, before the final designation may be issued. A site management and monitoring plan has been developed and incorporated into this DEIS (Appendix A).

4. The National Environmental Policy Act of 1969 (42 USC 4341 et seq., as amended)

The National Environmental Policy Act (NEPA) requires that environmental consequences and alternatives be considered before a decision is made to implement a federal project. It also establishes requirements for preparation of an EIS for major federal projects having potentially significant environmental impacts, including opportunities for public review and comment. NEPA regulations specifically require integration with requirements of the Fish and Wildlife Coordination Act (FWCA), the National Historic Preservation Act, the Endangered Species Act, and other applicable laws and executive orders. This DEIS has been prepared to fulfill NEPA requirements and to satisfy EPA policy.

The President's Council on Environmental Quality has published regulations for implementing NEPA in 40 CFR 1500-1508. EPA NEPA regulations are published in 40 CFR 6, and Corps regulations for implementing NEPA are published in 33 CFR 220.

5. The Clean Water Act of 1977 (33 USC 1251 et seq., as amended)

The Clean Water Act (CWA) was passed to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Specific sections of the CWA control the discharge of pollutants and wastes into aquatic and marine environments. Section 404 established a program to regulate the discharge of dredged material into waters of the United States inside the boundary drawn to differentiate coastal waters from oceanic waters.

The preferred site for designation (HOODS) lies outside of state territorial waters. Both alternative sites (SF-3 and NDS) lie within state waters. Section 401 of the CWA applies to ocean disposal of dredged material within state waters. This section requires the State of California, prior to any discharge, to certify that the permitted action complies with all effluent limitations and state water quality standards. The Section 401 water quality certification by the state would not be applicable if the HOODS is selected for designation. However, if either of the two alternative ocean sites is selected, state certification would be required.

6. **The Clean Air Act of 1990 (42 USC 7401 et seq., as amended)**

The Clean Air Act (CAA) is intended to protect and enhance the nation's air quality by regulating the emission of air pollutants through the development and execution of air pollution prevention and control programs. The CAA is applicable to permits and planning procedures related to disposal within the 2.6 nmi territorial sea limit (3 statute miles). The HOODS is not within state territorial waters. The SF-3 site and the NDS are located within the state territorial sea, and are within the North Coast Air Basin. Air quality issues related to permitting and planning procedures for the alternative disposal sites would fall under the jurisdiction of the North Coast Unified Air Quality Management District. Air quality issues associated with the transport of dredged material to the HOODS have been evaluated as part of the Corps EIS/EIR for the proposed Harbor deepening project (Corps/HBHRCD 1994).

7. **The Fish and Wildlife Coordination Act of 1958 (16 USC 661 et seq.)**

The FWCA is intended to protect aquatic resources. The FWCA requires that water resource development programs consider fish and wildlife conservation. The FWCA also requires that the lead agency consult with both state and federal fish and game agencies and fully consider their recommendations in decision-making. Section 106 (e) of the MPRSA requires compliance with the FWCA.

8. **The Coastal Zone Management Act of 1972 (16 USC 1456 et seq.)**

The Coastal Zone Management Act (CZMA) regulates development and use of the coastal zone and encourages states to develop and implement coastal zone management (CZM) programs. Federally permitted projects occurring within state territorial waters must be certified as consistent with approved state CZM programs under Section 307(c) of the CZMA. The Coastal Zone Reauthorization Amendments of 1990 (Section 6208) require that any federal agency conducting or supporting activities which affect the coastal zone prepare a determination of consistency with the state's coastal management program. No federal agency activities are categorically exempt from this requirement. Although the preferred site for designation lies beyond state territorial waters, the EPA has a policy of preparing a coastal consistency determination for all site designations even if they are beyond state territorial limits, because dredged materials are transported through state waters. Transport of dredged materials through state waters to the HOODS has been evaluated as part of the Corps EIS/EIR for the proposed Harbor deepening project (Corps/HBHRCD 1994).

9. **The Endangered Species Act of 1973 and Amendments (16 USC 1531 et seq., as amended)**

The Endangered Species Act (ESA) was enacted to protect threatened and endangered species. Section 7 of the ESA requires that lead federal agencies consult with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) regarding any federal project which could jeopardize the continued existence of federally listed threatened or endangered species, or destroy or adversely modify any designated critical habitat of such species. During the site designation process, the USFWS and NMFS evaluate potential impacts of ocean disposal on threatened or endangered species. These agencies are asked to certify, or concur with the sponsoring agency's findings, that the proposed activity will not adversely affect the endangered or threatened species. Documentation of the Section 7 consultation is presented in Section 5 of this DEIS.

10. The National Historic Preservation Act of 1966 (16 USC 470 et seq.)

The National Historic Preservation Act (NHPA) is intended to preserve and protect historic and prehistoric resources. Federal agencies are required to identify cultural resources that might be damaged, destroyed, or otherwise made inaccessible by a project, and to coordinate project activities with the State Historic Preservation Officer (SHPO). This consultation process is documented in Section 5 of this DEIS.

11. Executive Order 11514, Protection and Enhancement of Environmental Quality (May 1977), as amended by Executive Order 11991

Executive Order 11514 requires the Corps to prepare NEPA documents that are concise, clear, and supported by evidence that the necessary analyses have been made. It also establishes a NEPA and CAA dispute resolution procedure.

12. Executive Order 11593, Protection and Enhancement of the Cultural Environment (36 FR 8921, May 15, 1971)

Executive Order 11593 requires federal agencies to initiate measures necessary to direct their policies, plans, and programs in such a way so that federally owned sites, structures, and objects of historical, architectural, or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the people. Compliance with this order was coordinated with the California SHPO and is documented in Section 5 of this DEIS.

13. Executive Order 12372, Intergovernmental Review of Major Federal Programs (47 FR 3959, July 16, 1982)

Executive Order 12372 requires federal agencies, to the extent permitted by law, to utilize the state process to determine official views of state and local elected officials and communicate with state and local officials as early in the program planning cycle as is reasonably feasible to explain specific plans of action. The Resources Agency of California was contacted to notify appropriate state agencies.

14. The California Coastal Act of 1976 (PRC Section 3000 et seq.)

The California Coastal Act establishes the California Coastal Zone Management Plan (CZMP), which has been approved under the federal CZMA. All federal actions that affect the CZMP must be certified as consistent with this state program (see "Coastal Zone Management Act of 1972," above).

15. **The California Environmental Quality Act of 1986 (PRC Section 21001)**

The California Environmental Quality Act (CEQA) establishes requirements similar to those of NEPA for consideration of environmental impacts and alternatives and for preparation of an environmental impact report (EIR) prior to implementation of applicable projects. This proposed action is a federal action involving site designation outside state boundaries and therefore does not fall under the purview of CEQA. However, if either of the alternative sites is selected for designation, CEQA would apply. Actions requiring state approval are subject to CEQA.

1.5 RELATIONSHIP TO PREVIOUS NEPA ACTIONS AND OTHER MAJOR FACILITIES IN THE VICINITY OF THE PROPOSED SITE

The only known NEPA actions or facilities in the project area that could possibly be affected by or affect the designation of an ODMDS for the Humboldt Bay region are the annual maintenance dredging operations in Humboldt Bay and the Corps' proposed Humboldt Harbor and Bay Deepening Project. Discharge of dredged material from the annual maintenance dredging program has been permitted on a case-by-case basis under Section 103 of the MPRSA. However, use of interim sites will be terminated under provisions of the WRDA, which would not allow disposal of dredged material at interim ocean disposal sites under Section 103 after January 1, 1997, unless the site has been permanently designated. If an ocean disposal site is not designated, the Corps would not have the option of ocean disposal after 1997, and would have to utilize other disposal options (i.e., upland disposal) which could adversely affect the maintenance dredging program and the economies related to navigation into and within the Harbor.

The Harbor and Bay Deepening Project proposed by the Corps will generate approximately 5,600,000 yd^3 of dredged material. If no permanently designated ODMDS is available for the project, the EPA can permit the Corps to dispose of the material at the HOODS or another interim site under Section 103 of the MPRSA until January 1, 1997. However, there are no other upland or ocean disposal sites other than the HOODS which could contain the volume of dredged material generated from the proposed project, and the lack of a designated ODMDS after January 1997 would adversely affect the project.

Section 2

Alternatives

Section 2. Alternatives

This section describes each disposal alternative considered and selection of the preferred alternative. Evaluation of a reasonable range of alternatives is required by NEPA as part of 40 CFR 1502.14. Once the need for an ODMDS is established, potential sites are screened for feasibility through the ZSF process. The feasible alternative sites are evaluated according to the EPA's 5 general disposal site selection criteria and 11 specific disposal site selection criteria (40 CFR 228.5-228.6 [a]) (Table 2-1). The detailed discussion of each specific criterion can be found in Sections 3 and 4.

2.1 DESCRIPTION OF ALTERNATIVES

2.1.1 The No Action Alternative

The EPA has the authority under MPRSA Section 102 (c) to designate a recommended site for disposal of dredged material. Selection of the No Action alternative would mean that there would not be an EPA-designated ocean disposal site for material dredged from Humboldt Bay. The Corps would either continue requesting approval from the EPA under the MPRSA Section 103 for disposal of sediment at the HOODS or other ocean disposal sites on a case-by-case basis until January 1, 1997, or it would cancel dredging operations in Humboldt Bay because upland disposal would not provide the capacity needed to contain the average annual quantities of sediment dredged from Humboldt Bay's federal navigation channels.

2.1.2 Upland Disposal

Several upland disposal sites were considered for disposal of dredged materials from Humboldt Bay. The "Superbowl" site (Figure 1-1), a 60-acre site on the North Spit, was originally designed to contain 1,000,000 yd^3. This site was used once in 1979. Presently the site has capacity for approximately 400,000 yd^3 of dredge material. The Superbowl site was eliminated from further consideration because it does not have the capacity to serve as the permanently designated site. However, this site could be used for future smaller dredging projects requiring upland disposal if sensitive areas (wetlands and endangered plant species) are avoided.

Table 2-1. List of EPA's Five General and Eleven Specific Site Selection Criteria

General Site Selection Criteria - 40 CFR 228.5

(a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbances in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(c) If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Sections 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

(d) The sizes of the ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

(e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

Specific Site Selection Criteria - 40 CFR 228.6(a)

(1) Geographical position, depth of water, bottom topography, and distance from the coast;

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

(3) Location in relation to beaches and other amenity areas;

(4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packaging the waste, if any;

(5) Feasibility of surveillance and monitoring;

(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;

(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;

(9) Existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;

(10) Potentiality for the development or recruitment of nuisance species in the disposal site; and

(11) Existence at, or in close proximity to, the site of any significant natural or cultural features of historical importance.

The Louisiana-Pacific site, also on the North Spit, was also excluded from consideration as the designated site because of its small capacity. However, the Corps is proposing to use this site during the Harbor and Bay Deepening Project for the disposal of 26,000 yd^3 of dredged material considered to be unsuitable for ocean disposal.

Several other land disposal sites were originally considered for permanent designation, but they were not investigated further because of the potential for adverse effects on wetlands, prohibitive costs, inadequate capacity, or conflicts with other land uses.

2.1.3 Beach Nourishment

Much of the material dredged from Humboldt Bay consists of sand; therefore, beach nourishment warrants consideration as a disposal alternative. Sediment dredged from the Bar and Entrance and North Bay Channels and the Field's Landing Channel in the area north of Buhne Point is predominantly medium- to fine-grained sand. Sediments in the southern reach of the Field's Landing Channel and the Samoa and Eureka Channels have historically been silty sand (much finer grained than the native material on the beach) that would not be suitable for beach nourishment.

At this time, disposal of the Bar and Entrance and North Bay Channels' dredged material onto the beach face of the spits is not considered practicable. The bulk of the sediment suitable for beach nourishment is located in areas that are exposed to rough sea conditions where stationary dredging plants are not suitable. Use of a hopper dredge would require that the material be deposited in a sheltered area in the back bay adjacent to one of the spits, thereby producing adverse effects on in-bay biota near the disposal site. A stationary hydraulic dredge would then slurry it across the spit to the beach for final disposal, causing further localized adverse effects. This approach to beach nourishment would increase the cost of dredging, increase adverse impacts on the Bay, and increase operational time.

2.1.4 Disposal off the Continental Shelf

The EPA Ocean Dumping Regulations state in Section 228.5(e) that the "EPA will, whenever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used." As described in the ZSF (Corps 1989), the Corps must site the ODMDS within a 4 nmi radius from the center point at the end of the Humboldt Bay jetties. This limitation reflects the constraints on dredging and disposal operations for the Humboldt Bay area. Disposal off the continental shelf would require use of a site located 10 nmi or farther from Humboldt Bay, a distance beyond the point at which dredged material disposal is considered feasible. Because historical sites (NDS, SF-3, and the HOODS) exist on the continental shelf within the ZSF, this alternative will not be considered in this DEIS.

2.1.5 The Nearshore Disposal Site

Another approach to beach nourishment would be nearshore disposal within the longshore current system. The Corps has used a nearshore disposal area known as the NDS for this purpose. The site is located 2 nmi southwest of the Harbor mouth. Two disposal episodes were conducted at this site and were considered test disposals to investigate whether material placed at the NDS remained in the littoral zone and promoted beach nourishment. The NDS has been monitored by periodic bathymetric surveys to determine sediment movement.

The Humboldt Fishermen's Marketing Association and the Commercial Fishermen's Wives of Humboldt have objected to disposal at this site (Corps/HBHRCD 1994). Their concerns relate to potential adverse impacts on navigational safety in the vicinity of the southern approach, and commercial fishery resources in the nearshore area. Egg-brooding Dungeness crab females, juvenile Dungeness crab, and juvenile English sole are of primary concern.

2.1.6 Disposal Site SF-3

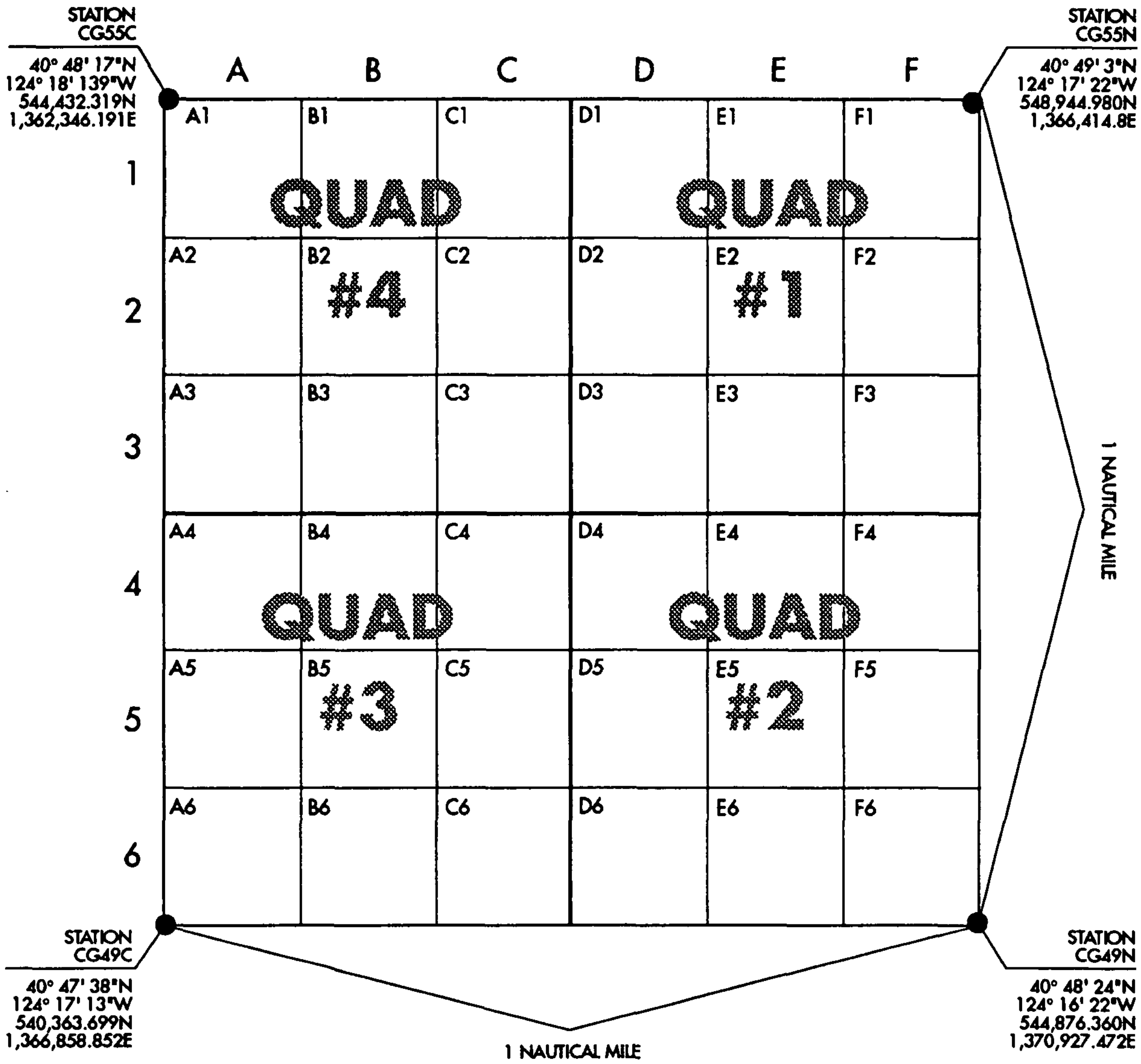
This disposal site has been used by the Corps since the 1940s for disposal of sediment dredged from Humboldt Bay. This former EPA interim disposal site lost its interim status on December 31, 1988. The Corps has used the SF-3 site for disposal of dredged material on several occasions since the site lost its interim status. Approval for this disposal was granted under Section 103 of the MPRSA. The most recent use occurred in April 1990. The SF-3 site is located approximately 1.1 nmi southwest of the Harbor mouth (Figure 1-1). The SF-3 site is 457 m (1,500 ft) in diameter.

2.1.7 Preferred Alternative

The preferred alternative for designation of a site for disposal of dredged material from Humboldt Bay is the HOODS, which has been used for disposal of dredged material since autumn 1990. The HOODS is 1 square nmi in size (Figure 2-1) and is located between the 49 m and 55 m (160 ft and 180 ft) depth contours.[1] It is positioned within the coordinates 40°48'25"N, 124°16'22"W; 40°49'3"N, 124°17'22"W; 40°47'38N, 124°17'22"W; 40°48'17"N, 124°18'12"W (Figure 2-1). The site lies approximately 3 to 4 nmi from the mouth of Humboldt Bay.

The HOODS has been identified as the preferred alternative for the following reasons: the site is located within a distance that is economically and operationally feasible

[1] All ocean depths reported in this DEIS are relative to mean lower low water (mllw).



Source: Corps 1994b

Figure 2-1. Humboldt Open Ocean Disposal Site

(Corps 1989); the site reflects the preference of the local boating and fishing community; use of the site will minimize unavoidable adverse ecological effects; and the site complies with the EPA's siting criteria (40 CFR 228.5-228.6 [a]).

2.2 DISCUSSION OF ALTERNATIVES

2.2.1 Alternatives Not Considered for Further Analysis

The No Action, upland disposal, beach nourishment, and disposal off the continental shelf alternatives were eliminated from further consideration. These alternatives are not cost effective and/or would increase navigational and operational hazards. The No Action alternative would result in evaluation of disposal on a case-by-case basis until 1997. After 1997, dredged material disposal would not be permitted at undesignated sites.

Upland disposal is not a viable option for the large quantities of suitable dredged material removed annually as part of the Corps' maintenance dredging at Humboldt Bay. Although this alternative has been eliminated from further evaluation as a designated site in this DEIS because of excessive cost and the present lack of land availability, it remains an option for disposal of smaller quantities of unsuitable material.

2.2.2 Compliance of the Three ODMDS Alternatives with the EPA's 5 General Criteria for Selection of Sites (40 CFR 228.5 [a])

a. "The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation."

As part of the site selection process, the Corps conducted several information surveys of the local fishing and other maritime operators active in the Humboldt Bay area. The Corps requested information on navigation routes into and out of Humboldt Bay, as well as preferred areas for dredged material disposal and nondisposal within the ZSF. The selection of the HOODS as the preferred alternative was in part based upon the information gathered from these surveys, and it is believed that disposal at the HOODS has not interfered with commercial fishing, sport fishing, recreational activities, or navigation in the Humboldt Bay area.

In contrast, the SF-3 site and the NDS are both objected to by local members of the commercial and recreational fishing community because of their perceived negative impacts on safe navigation.

b. "Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery."

None of the alternative ODMDS sites are located near or within any sanctuary boundaries. The dredged material is composed primarily of coarse- and fine-grained sand and some clay/silt. Results of dispersion modeling indicate that dredge materials settle to the bottom rapidly and are initially contained within the disposal sites (0.26 nmi) (Borgheld and Pequegnat 1983, Scheffner 1990). The shoreward edge of the HOODS is 3 nmi offshore, and disposal at this preferred site would minimize any potential for water quality impacts to beaches, shorelines, sanctuaries, or limited fisheries or shellfisheries.

c. "If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Sections 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated."

The MPRSA site selection process is designed to identify a preferred alternative that minimizes or avoids unacceptable impacts to the physical, biological, and socioeconomic environment. The continued use of any site designated as an ODMDS will be evaluated as part of the site management and monitoring program established for the site. The management and monitoring program will be administered jointly by the EPA and the Corps.

d. "The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as part of the disposal site evaluation of designation study."

The specific locations and sizes of the ocean disposal sites have been defined in order to minimize the area affected by the disposal of dredge materials and to facilitate monitoring of the sites. Evaluation of the continued acceptability of the designated ODMDS will be accomplished through the implementation of the site management and monitoring program.

e. "EPA will, where feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used."

None of the ODMDS site alternatives lies beyond the edge of the continental shelf. The existing historical sites are all located on the continental shelf. Furthermore, based on the ZSF conducted by the Corps, disposal of dredged materials from Humboldt Bay off the continental shelf is not considered to be feasible.

2.2.3 Compliance of the Three ODMDS Alternatives with the EPA's 11 Specific Criteria for Selection of Sites (40 CFR 228.6 [a])

Detailed discussions of the 11 general criteria are contained in Section 3, "Affected Environment" and Section 4, "Environmental Consequences". A summary table of these comparisons (Table 2-2) is presented here to support the decision-making process in selecting the preferred alternative over the other viable alternatives.

2.2.4 Selection of the Preferred Alternative

The EPA and the Corps have determined that a site must be designated for disposal of materials dredged from Humboldt Bay. The HOODS was selected as the preferred site alternative for the following reasons:

- The HOODS is a historical site which lies within the ZSF.
- The HOODS has the capacity necessary to sustain the maintenance dredging program for Humboldt Bay.
- Use of the HOODS would comply with EPA's 5 general and 11 specific site selection criteria.
- Use of the HOODS would comply with all international, federal, state, and local regulations.
- Use of the HOODS would result in minimal environmental impact.

Table 2-2. Comparison of Alternative Ocean Disposal Sites Based on EPA's Eleven Specific Site Designation Criteria

40 CFR 228.6(a) Criteria	Site SF-3	NDS	HOODS
1. Geographical position, depth of water, bottom topography and distance from coast.	• located 1.1 nmi WSW of harbor entrance • site depth 12 m (40 ft) • relatively flat bottom topography with mostly sandy substrates • located 1.2 nmi from coast	• located 2 nmi SSW of harbor entrance • site depth 15-18 m (50-60 ft) • relatively flat bottom topography with mostly sandy substrates • located 0.6 nmi from coast	• located 3-4 nmi W of harbor entrance • site depth 49-55 m (160-180 ft) • relatively flat bottom topography with substrates ranging from sandy to silty • located 3-4 nmi from coast
2. Location in relation to breeding, spawning, feeding or passage areas of living resources in adult or juvenile stages.	• typical demersal fish community but lower abundance and diversity than nearshore reference site • general commercially important fish species spawn in waters of this depth • lower Dungeness crab abundance than at NDS • minimal use by marine mammals and birds	• typical demersal fish community but lower abundance and diversity than nearshore reference site • general commercially important fish species spawn in waters of this depth • greater Dungeness crab abundance than other sites considered • minimal use by marine mammals and birds	• typical demersal fish community but lower abundance and diversity than SF-3 • fewer commercially important fish species spawn at this depth • lower Dungeness crab abundance than NDS • minimal use by marine mammals and birds
3. Location in relation to beaches and other amenity areas.	• located 1.2 nmi from public beaches	• located 0.6 nmi from public beaches	• located 3 nmi from public beaches
4. Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any.	• sediment composition approximately 85% sandy-silt, 15% silt and silty-sand • the site will be used over a 50-year period • dredge material disposal for the annual maintenance dredging of Humboldt Bay with average disposal volumes of 106,089 cubic yards in spring and 687,401 cubic yards in fall • self propelled hopper dredges will be used to dredge and dispose of the material	• sediment composition approximately 85% sandy-silt, 15% silt and silty-sand • the site will be used over a 50-year period • dredge material disposal for the annual maintenance dredging of Humboldt Bay with average disposal volumes of 106,089 cubic yards in spring and 687,401 cubic yards in fall • self propelled hopper dredges will be used to dredge and dispose of the material	• sediment composition approximately 85% sandy-silt, 15% silt and silty-sand • the site will be used over a 50-year period • dredge material disposal for the annual maintenance dredging of Humboldt Bay with average disposal volumes of 106,089 cubic yards in spring and 687,401 cubic yards in fall • self propelled hopper dredges will be used to dredge and dispose of the material
5. Feasibility of surveillance and monitoring.	• U.S. Coast Guard has surveillance responsibility • monitoring is feasible at the site • dredge data logging system used for surveillance	• U.S. Coast Guard has surveillance responsibility • monitoring is feasible at the site • dredge data logging system used for surveillance	• U.S. Coast Guard has surveillance responsibility • monitoring is feasible at the site • dredge data logging system used for surveillance

Table 2-2. Continued

40 CFR 228.6(a) Criteria	Site SF-3	NDS	HOODS
6. Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any.	• currents predominantly NW in winter and offshore and SW in summer, but relatively non-dispersive	• currents predominantly shoreward but relatively non-dispersive	• currents relatively non-dispersive
7. Existence and effects of current and previous discharges and dumping in the area (including cumulative effects).	• site used as an interim disposal site since the 1940s • last disposal event occurred in fall 1990 • sediments did not disperse from the site as anticipated • site was closed due to navigational safety concerns by interaction of waves with accumulated dredge material	• site has been used for disposal of dredged material from Humboldt Bay on two occasions in 1988 and 1989 • site has not been used since 1989 due to navigational safety concerns like those at SF-3 site	• site has been used for disposal of dredged material from Humboldt Bay on 10 occasions between fall 1990 and fall 1994
8. Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific significance and other legitimate uses of the ocean.	• navigational safety concerns • no other activities in area	• navigational safety concerns • no other activities in area	• fewer navigational safety concerns than SF-3 or NDS site • no other activities in area
9. Existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys.	• water quality good • lower density and diversity of demersal fish than nearshore reference site • possible spawning area for commercially important fish species • lower abundance of Dungeness crab than at other sites	• water quality good • lower density and diversity of demersal fish than nearshore reference site • possible spawning area for commercially important fish species • greater Dungeness crab abundance than at other sites considered	• water quality good • lower density and diversity of demersal fish than SF-3 site
10. Potentiality for the development or recruitment of nuisance species in the disposal site.	• unlikely to recruit nuisance species	• unlikely to recruit nuisance species	• unlikely to recruit nuisance species
11. Existence at, or in close proximity to, the site of any significant natural or cultural features of historical significance.	• no known significant natural or cultural features	• no known significant natural or cultural resources	• three potential shipwreck sites are located in HOODS

Section 3

Affected Environment

Section 3. Affected Environment

3.1 OCEAN DISPOSAL SITE CHARACTERISTICS

3.1.1 Historical Use of the Disposal Sites

The SF-3 disposal site has been used by the Corps to dispose of maintenance dredge material since the 1940s. The most recent use of SF-3 was in the spring of 1990. It is estimated that a total of 20 to 25 million yd^3 of material dredged from Humboldt Bay federal navigation channels has been disposed of at SF-3.

The NDS has been used for two fall disposal episodes. In September 1988 and September 1989, approximately 837,000 yd^3 and 585,000 yd^3 of sand were deposited at the NDS respectively. Material deposited at the NDS was dredged from the Bar and Entrance and North Bay Channels.

The HOODS has been used for disposal of sediments dredged from Humboldt Bay by the Corps on an interim basis since the fall of 1990. As of autumn 1994, the site will have been used on 10 occasions (Table 3-1). A total of approximately 2,861,289 yd^3 of dredged material has been disposed of at the site (Corps 1994a, 1994b).

The HOODS lies in the mud-sand transition zone. The site has been divided into four quadrants (Quads 1 through 4), each containing nine cells (Figure 2-1). The site has been divided to facilitate the disposal of dredged materials into areas of the site containing substrates similar in character to the dredged material. Quads 2 and 3 contain sandier substrates, while Quads 1 and 4 contain finer substrates.

In the fall of 1990, 683,000 yd^3 of dredge materials were dumped into Quad 2 Cell E5 to monitor the long-term fate of dredged materials at the site.

3.1.2 Proposed Use of the Preferred Alternative Site

The preferred alternative ODMDS will be used for the disposal of all suitable materials dredged by the Corps for new work in, and maintenance dredging of, the Humboldt Bay federal navigation channels. In addition to annual maintenance dredging, the Corps is currently proposing to deepen and widen the navigation channels and dispose of that portion of the dredged materials suitable for unconfined open ocean disposal at the ODMDS (Corps/HBHRCD 1994). All permit applications and Corps civil works projects

Table 3-1. Volumes (cubic yards) of Dredged Material Disposed at the HOODS, the NDS, and Site SF-3 by the Corps (1982-1994)

Year	Fall	Spring	Total	Location of Dredged Material Disposal
1982	490,447	98,000	588,447	Site SF-3 only
1983	1,010,676	1,900	1,012,576	Site SF-3 only
1984	494,000	12,830	506,830	Site SF-3 only
1985	1,414,156	163,500	1,577,656	Site SF-3 only
1986	1,119,776	64,250	1,184,026	Site SF-3 only
1987	698,431	93,605	792,036	Site SF-3 only
1988	836,966	130,254	967,220	Site SF-3 in Spring, NDS in Fall
1989	585,000			NDS in Fall, no disposal in Spring
1990	414,208	123,203	537,411	Site SF-3 in Fall, HOODS in Spring
1991	682,000	192,224	874,224	HOODS
1992	145,000	152,912	297,912	HOODS
1993	536,350	150,395	686,745	HOODS
1994	509,200	90,000	599,200	HOODS
Annual Average	687,401	106,089	802,024	

Source: Corps 1994a, 1994b, 1995

will be evaluated for suitability for ocean disposal at the site in accordance with the EPA Ocean Dumping Regulations (40 CFR 220-227).

3.1.3 Quantities and Characteristics of Maintenance Dredging Sediments

Between 1982 and 1994 (1989 excluded), the Corps has dredged an annual average of 802,000 yd^3 of sediment from Humboldt Bay (Table 3-1). Dredging operations typically occur twice yearly for maintenance of federal navigation channels at Humboldt Bay. Dredging of the Samoa, Eureka, and Field's Landing Channels occurs in the spring (March-April). Depending upon need, portions of the North Bay Channel may also be dredged in the spring. The average annual volume of material dredged in the spring is 106,089 yd^3. Larger average annual quantities of materials are dredged in the fall (687,401 yd^3) when the Corps performs maintenance dredging of the Bar and Entrance Channel and portions of the North Bay Channel.

In September 1992, the EPA, the Corps, and the Northern Coast Regional Water Quality Control Board developed testing requirements for sediments dredged annually from the Humboldt Bay channels (Corps 1994b). To better define contaminants of concern and to determine how frequently the sediments should be tested, the agencies agreed to conduct baseline studies of existing sediment quality in the harbor channels. The baseline studies include three sediment evaluations. Two evaluations have already been conducted (October 1993, March 1994) and are summarized below. The third evaluation will occur in 1995.

Based on analyses of dredged sediment composition, sand will usually account for 80% to 90% of the total material dredged from Humboldt Bay (Corps/HBHRCD 1994). Sediments dredged from the Bar and Entrance and North Bay Channels and the Field's Landing Channel north of Buhne Point have historically been composed of sand (grain size >0.075 mm). Sediments dredged from these channels may be determined to be acceptable for ocean disposal without further testing. This determination would be based on acceptable existing information including grain size, sediment chemistry, bioassays, and reports of spills and other contaminants.

Sediments dredged from the Eureka and Samoa Channels and the Field's Landing Channel south of Buhne Point have been composed of predominately (more than 50%) silt and clay (grain size <0.075 mm) with some (less than 50%) fine sand. Sediment chemistry and toxicity testing were conducted on samples from these channels. The samples contained relatively few detectable organic contaminants, and the concentration of detected contaminants was not significant. Toxicity tests of sediments from these channels also did not indicate significant levels of toxicity compared to reference samples. (Corps/HBHRCD 1994.) Thus far, all sediments that would be dredged during maintenance dredging activities have been considered environmentally acceptable for ocean disposal.

The Corps is proposing to deepen and widen the navigation channels in Humboldt Bay. Physical and chemical sediment sampling for the proposed Humboldt Bay channel deepening project was conducted in December 1991 (EVS Consultants 1993) to determine the suitability of dredged materials from the channel deepening project for disposal at the ODMDS, in compliance with MPRSA Section 103. The proposed project would generate approximately 5,600,000 yd^3 of dredged material to be disposed at an ODMDS and approximately 26,000 yd^3 of material, unsuitable for unconfined aquatic disposal, which would be disposed at an upland disposal site. (Corps/HBHRCD 1994.)

3.1.4 Existence and Effects of Current and Previous Discharges and Dumping in the Area

This section describes significant discharges into the ocean in the vicinity of the ODMDS alternatives where potential cumulative or synergistic impacts are possible. There are two significant discharges into the marine environment offshore of Humboldt Bay (Figure 3-1). The Simpson Paper Company and the Louisiana-Pacific Corporation both operate pulp mills on the Samoa Peninsula and discharge wastewaters outside of Humboldt Bay.

3.1.4.1 The Simpson Paper Company

The Simpson Paper Company owns a pulp mill located near the community of Fairhaven on the Samoa Peninsula in Humboldt County, California (Figure 3-1). The company discharges through an outfall into ocean waters adjacent to the Samoa Peninsula. The Simpson plant is not operating currently, but it is discharging fresh water through its outfall. Historically, the discharge consisted of:

- process wastewater from kraft pulping, pulp bleaching, and pulp drying;
- solids from its water treatment plant;
- power boiler effluent;
- sawmill effluent;
- treated sanitary sewage; and
- stormwater.

Effluents are discharged from an 866 m (2,840 ft) outfall through a 58 m (189 ft) multiple-port diffuser at an average depth of 10.6 m (35 ft).

As authorized under its National Pollutant Discharge Elimination System (NPDES) Permit, the Simpson Paper Company is prohibited from discharging wastewater in violation of effluent standards or prohibitions established under Section 307(a) of the Clean Water Act, and it is prohibited from discharging sewage sludge.

The outfall is approximately 3 nmi east of the HOODS, 3 nmi north of the SF-3 site, and 3.5 nmi north of the NDS. It is not expected that there would be either a cumulative or synergistic effect from the disposal of dredged material and wastewater effluent discharged by the Simpson Paper Company at any of the ODMDS alternatives considered

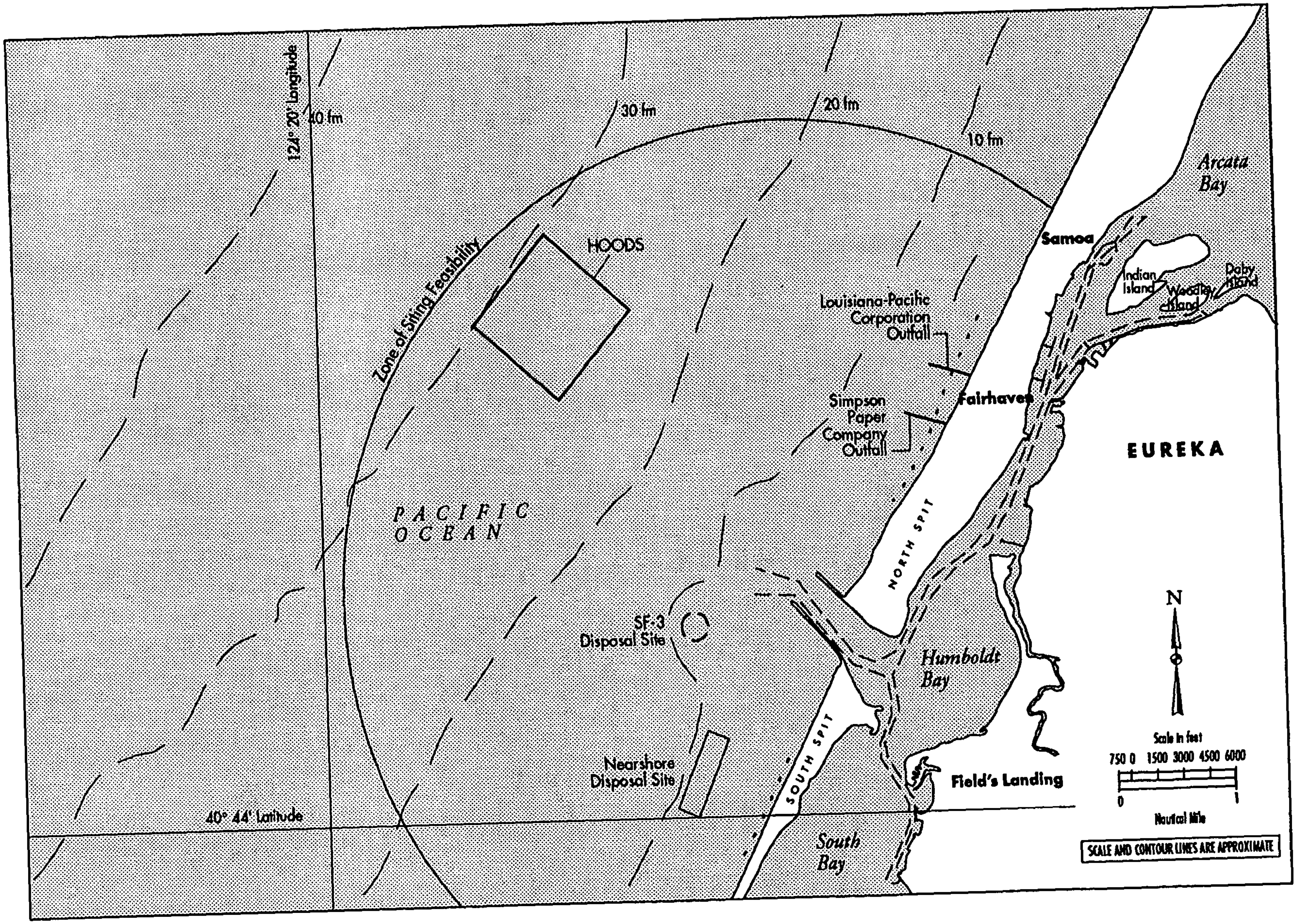


Figure 3-1. Approximate Locations of Louisiana-Pacific Corporation and Simpson Paper Company Ocean Outfalls

in this DEIS. Prevailing currents would direct discharge plumes up or down the coast, depending upon the seasonal current regime, not offshore toward the HOODS. Based upon past receiving water monitoring and marine biological monitoring in the vicinity of the outfall, impacts from effluent pollutants would be expected to occur in close proximity to the point of effluent discharge. Combined impacts from dredged material disposal in the nearshore area at either SF-3 or the NDS with effluent disposal from the Simpson Paper Company would not result in a significant cumulative effect on the nearshore aquatic environment.

3.1.4.2 The Louisiana-Pacific Corporation

The Louisiana Pacific Corporation (L-P) owns and operates a market bleached kraft pulp mill located near the community of Samoa, California, on the Samoa Peninsula in Humboldt County (Figure 3-1). Under its NPDES Permit, L-P is prohibited from discharging wastewater in violation of effluent standards or prohibitions established under Section 307(a) of the Clean Water Act, and it is prohibited from discharging sewage sludge. The L-P Corporation discharges effluents similar to those discharged historically by the Simpson Paper Company into the Pacific Ocean through a 975 m (3,200 ft) outfall with a 152 m (498 ft) multiple-port diffuser at an average depth of 12.6 m (41.5 ft).

The discharge outfall is approximately 3.5 nmi east of the HOODS, 3.5 nmi north of the SF-3 site, and 4 nmi north of the NDS. As previously stated for the Simpson Paper Company outfall, it is not anticipated that the use of any of the alternative sites would result in any adverse cumulative or synergistic impacts.

3.1.5 Feasibility of Surveillance and Monitoring

Surveillance and site management are conducted by the United States Coast Guard (USCG), the EPA, and the Corps. Under Section 107(c) of the MPRSA, the USCG conducts surveillance to discourage unauthorized disposal (33 USC 1417). Additional surveillance, site management, and enforcement responsibilities are delegated to the EPA (40 CFR 22.36) and the Corps (33 CFR 226). The Corps utilizes a Dredge Data Logging System (DDLS) as a surveillance tool on contract hopper dredging at Humboldt Bay. The DDLS is installed on the hopper dredge and provides full-time, hard-disk records of all pertinent dredge performance data (position, draft, date and time, work and disposal area, etc.).

Monitoring is practicable at all three alternative sites. The accessibility of the SF-3 site and the NDS may at times be more restricted than at the HOODS because SF-3 and the NDS are located in shallower water (14 to 17 m [45 to 56 ft] deep) and are subject to a more rigorous wave climate than the HOODS (49 to 55 m [160 to 180 ft] deep). However, these conditions have not interfered with the collection of bathymetric and biological data at SF-3 and the NDS in the past.

3.2 PHYSICAL ENVIRONMENT

3.2.1 Meteorology

The northern California coast has a moderate climate. Average minimum and maximum temperatures for Eureka are 5°C (41°F) (January) and 17°C (62°F) (August). Temperatures of 0°C (32°F) or lower can occur nearly every year along the coast. Maximum temperatures seldom exceed 27°C (80°F). Fog is common in the coastal region from late spring until early fall. It usually remains until late morning and returns again in the early evening. Winds generally blow from the south and southwest in the winter, and from the north and northwest in the summer.

The Humboldt Bay area is noted for its high precipitation (97 centimeters [cm] [38 inches] of rainfall annually) and associated episodic storms. Most of the rainfall occurs between mid-October and mid-May. During the winter, storms are most severe, with high wind and squall conditions occurring frequently.

3.2.2 Air Quality

The study area lies within the North Coast Air Basin, which includes Del Norte, Humboldt, and Trinity Counties. Onshore air pollution sources in Humboldt County are regulated by the North Coast Unified Air Quality Management District (NCUAQMD). Primary sources of air pollution are forest products industries and agricultural operations (Corps/HBHRCD 1994). The NCUAQMD presently is in compliance with all state and federal air quality standards except the state's 24-hour standard for PM_{10}, which has been violated several times between 1985 and the present (Herr pers. comm. in Corps/HBHRCD 1994).

The Corps' existing maintenance dredging program involves ships dredging and hauling dredged material for ocean disposal. Exhaust emissions from these ships contain reactive organic gases (ROG), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2), and hydrocarbons (HC), all of which are released to the atmosphere during operations. The proposed designation and the disposal at an ODMDS of material from the maintenance dredging would not increase the loading of these pollutants above the present level. However, dredge operation during the proposed harbor deepening project may have a short-term significant impact on air quality (Corps/HBHRCD 1994).

3.2.3 Physical Oceanography

The dominant circulation influence offshore of Humboldt Bay is the California Current. The California Current system is a broad (540 nmi), sluggish current flowing southward off the Oregon and California coasts. It is the eastern boundary current of the large clockwise current circulation pattern that occupies most of the North Pacific Ocean. The California Current is largely wind-driven, affected to a lesser degree by tides and coastal topography.

The California Current system along the northern California coast undergoes seasonal fluctuation. Three basic oceanographic regimes that influence the waters and hydrographic conditions within the nearshore environments of northern California have been described: the upwelling, Davidson Current, and oceanic regimes (Pirie and Steller 1987, Pequegnat et al. 1990). Each of these regimes is dominant during specific times of the year; however, current conditions are influenced by wind events such that it is possible for the regimes to occur any time of the year. Pequegnat and Mondeel-Jarvis (1991) describe the three regimes as follows:

- **The upwelling regime.** This regime occurs most commonly in the spring and early summer months and is characterized by strong winds from the north and northwest and a southerly current on the shelf of 26 to greater than 100 cm/sec (0.5 to greater than 2.0 knots). Nearshore waters associated with this regime have low temperatures, high nutrient concentrations, and moderately high salinities (at least for the North Pacific Ocean).

- **The Davidson Current regime.** This regime is associated with the storms common in the late fall and winter and is characterized by strong south and southwest winds, large waves, and a northerly current of up to 50 cm/sec (1 knot). During these periods, nearshore waters have low salinities, high concentrations of suspended sediment, moderate nutrient concentrations, and saturated dissolved oxygen concentrations.

- **The oceanic regime.** This regime is common in late summer and early fall, when winds are light and from no predominant direction. During these periods, the California Current, normally offshore, moves closer to shore and causes low nutrient concentrations, high temperature, and moderate salinities in the nearshore environment.

3.2.3.1 Nearshore Circulation

Nearshore currents in the northern California region are determined by the alignment of the coast, the width of the continental shelf, oceanic currents, topography, bathymetry, winds, tides, density structure of the water, waves, and river discharge. At any location or time, one or more of these forces can be the predominant influence on local currents.

Some limited data have been collected on current systems in the vicinity of the two nearshore disposal sites (SF-3 and the NDS). In a report on sediment transport at the SF-3 disposal site, Borgheld and Pequegnat (1986) state that existing current data for the shelf area near the SF-3 disposal site are generally inadequate to permit precise estimation of sediment transport. Borgheld and Pequegnat (1986) utilized a nearshore current data set collected by Winzler and Kelly Consulting Engineers (1984) along the north spit of Humboldt Bay in their description of dredged material transport at the SF-3 site. The time periods summarized by Winzler and Kelly Consulting Engineers have been used to produce a year-long summary of the currents in the vicinity of these stations. Winzler and Kelly Consulting Engineers (1984) noted that the major current signal was best correlated with local winds, and that tidally produced currents were of secondary importance. Borgheld and Pequegnat (1986) believe that the proximity of the SF-3 site to the mouth of Humboldt Bay increases the importance of surface tidal currents in the formation of nearshore currents and the bottom currents as well. Borgheld and Pequegnat (1986) describe currents in the nearshore area as unidirectional, with the predominant winter movement offshore and to the northwest; less vigorous transport is characteristic of the summer conditions, with current motion generally offshore and to the southwest.

In November 1988, the Corps San Francisco District, in cooperation with the Corps Waterways Experiment Station - Coastal Engineering Research Center, released 475 seabed drifters (SBDs) at SF-3 and the NDS to investigate current direction at both disposal sites. The SBDs were released at five sites. One was released at the center of SF-3, and the other four were released at the edges of the NDS.

The total SBD recovery was extremely high (67%) compared to similar studies at other sites. Recovery of drifters released from the SF-3 site and the offshore edge of the NDS was noticeably lower than from the northern and southern boundaries and the inshore boundary of the NDS. There was an even stronger distinction in direction of flow from SF-3 as compared to direction of flow from the NDS. No NDS seabed drifters were found north of the entrance channel to Humboldt Bay, whereas all but one of the SF-3 recoveries indicated northward transport of the SBDs, either across or around the entrance channel.

Although this SBD study was short and indicative only of bottom current trajectories (not of sediment transport specifically), the results do support the hypothesis that sediment from the NDS was more likely to disperse shoreward and away from the entrance channel than sediment from the SF-3 site under the conditions existing at the time of the study.

3.2.3.2 Offshore Circulation

Offshore current data are available for several sites near the HOODS. Long-term current measurements were collected for the U.S. Department of the Interior's Mineral Management Service (MMS) as a component of the Northern California Coastal Circulation Study (MMS 1989). These data were made available to the Corps for subsequent analysis for the site designation process. The current data were collected at two mooring sites: Mooring E60 at a depth of 60 m (197 ft) supported a 1 current meter array at depths of 10 m (33 ft) and 15 m (49 ft), and mooring E90 at a depth of 90 m (295 ft) supported a

3 current meter array with meters at depths of 15, 45, and 75 m (49, 148, and 246 ft) (Figure 3-2). The current meters were deployed during four time periods between 1987 and 1989. Summary plots of the four recorded periods are shown in Figure 3-3. The current vectors (representing current velocity in different directions) shown in the figure indicate current direction upcoast (positive vector value) and downcoast (negative vector value). Summary computations in the form of northerly (+U) and easterly (+V) component averages, velocity magnitudes, standard deviation, and percent magnitudes above 50 cm/sec are shown in Table 3-2.

In general, these data indicate 10 m to 15 m deep current velocities on the order of 25 cm/sec (0.5 knot); 45 m deep current velocities of 20 cm/sec (0.4 knot); and bottom current velocities of 15 cm/sec (0.3 knot).

3.2.3.3 Waves

Low-pressure storms are the most important source of storm waves reaching the California coast during winter months. These storms originate near Japan and proceed eastward across the Pacific, with the intensity of the waves decreasing southward along the California coast. The summer months are dominated by the high-pressure storms, with predominant wave action generated by the prevailing west/northwest winds along the coast.

Borgheld and Pequegnat (1986) utilized wave data from two wave rider buoys offshore of Humboldt Bay and described a seasonal wave spectra pattern. During the winter months, the wave spectra are dominated by longer period swells (periods greater than 12 seconds between waves). During the rest of the year, the spectra demonstrate a greater predominance of waves with shorter periods (i.e., less than 12 seconds between waves).

3.2.3.4 Tides

The Humboldt area experiences mixed tides. Mixed tides refer to two sets of tides each day (two high and two low tides). The sets of tides are not equal in amplitude. The tidal range between mean lower low water (MLLW) and mean higher high water (MHHW) is 1.95 m (6.4 ft) at the south entrance jetty to Humboldt Bay. Extreme low tides have been observed, as low as 0.6 m (2 ft).

3.2.4 Water Quality

Ocean water temperatures along the California coast respond to seasonal current changes, wind direction, insolation, and upwelling. The temperature of the nearshore waters of northern California normally ranges from 9°C to 14°C (48°F to 57°F). The salinities of the nearshore environment range from less than 25 parts per thousand (ppt) during periods of high runoff to greater than 34 ppt when deeper water is advected to the surface during periods of intense upwelling (Pequegnat and Mondeel-Jarvis 1990).

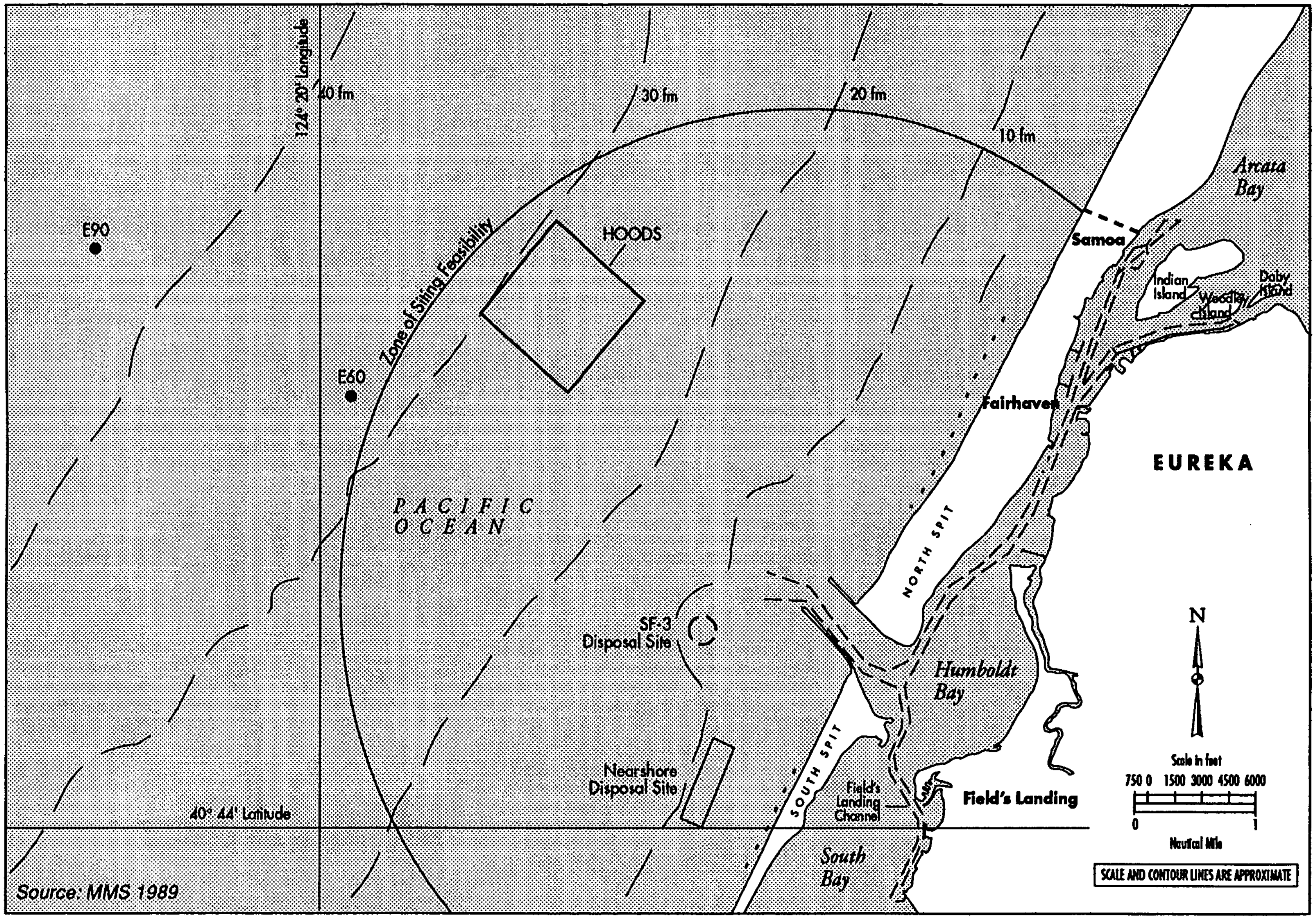
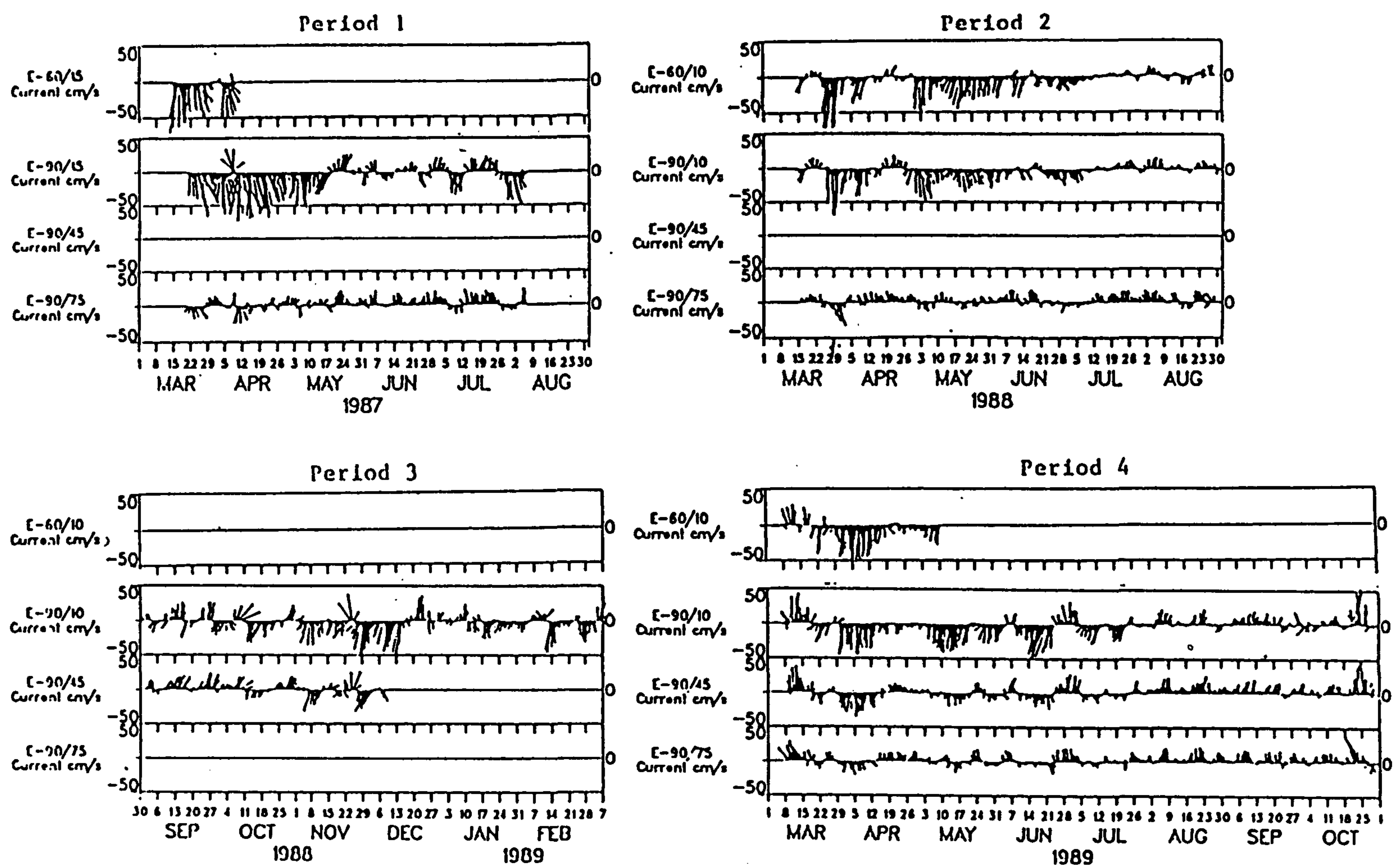


Figure 3-2. Approximate Location of Current Meter Stations E60 and E90



Source: MMS 1989

Figure 3-3. Record of Four Periods of Current Meter Deployment at Sites E60 (15 m) and E90 (15 m, 45 m, 75 m)

Table 3-2. Current Speed and Direction from Current Meter Mooring Stations E60 and E90

Mooring Number/ Depth (m)	Average U[1] (cm/sec)	Average V[2] (cm/sec)	Average Velocity (cm/sec)	Standard Deviation (cm/sec)	% of Time Exceeding 50 cm/sec
Period 1					
E-60/15	-1.90	-4.36	30.51	17.63	15.29
E-90/15	-5.37	14.08	27.12	17.03	11.08
E-90/45					
E-90/75	2.46	3.52	15.54	8.28	0.00
Period 2					
E-60/10	-6.70	-8.40	17.82	14.45	3.79
E-90/10	-2.88	-6.81	17.63	13.51	3.24
E-90/45					
E-90/75	0.41	4.06	14.90	8.06	0.10
Period 3					
E-60/10					
E-90/10	-4.49	-5.48	22.12	12.71	3.25
E-90/45	1.89	-0.44	16.65	10.23	0.45
E-90/75					
Period 4					
E-60/10	-7.82	-12.23	24.79	13.96	4.42
E-90/10	-3.74	-3.68	20.60	13.12	3.26
E-90/45	2.47	1.91	14.80	9.46	0.58
E-90/75	1.11	3.93	15.79	8.79	0.17

[1] U - Positive values indicate current flow to the north; negative values indicate current flows to the south.
[2] V - Positive values indicate current flow to the east; negative values indicate current flows to the west.

Pequegnat and Mondeel-Jarvis (1990) describe temperature and salinity changes in nearshore waters adjacent to Humboldt Bay in relation to the hydrographic regimes as follows:

- **The upwelling regime.** During upwelling periods, the nearshore water temperature drops to below 10°C (50°F) and the salinity rises to over 33.6 ppt. During intense upwelling periods, the sea surface temperature may drop to less than 8°C (46°F), with salinities greater than 34 ppt. The water column is not stratified shoreward of the upwelling front. The distance offshore at which the upwelling front is found depends on both the wind velocity and the wind duration but is typically more than 4 nmi offshore during periods of moderate upwelling.

- **The Davidson Current regime.** Because the northerly flowing Davidson Current is associated with winter storms, the nearshore surface waters tend to be cool (less than 11°C [52°F]) and of low salinity (less than 32 ppt) because of high runoff. The nearshore waters also tend to be highly stratified, primarily due to the vertical salinity gradient.

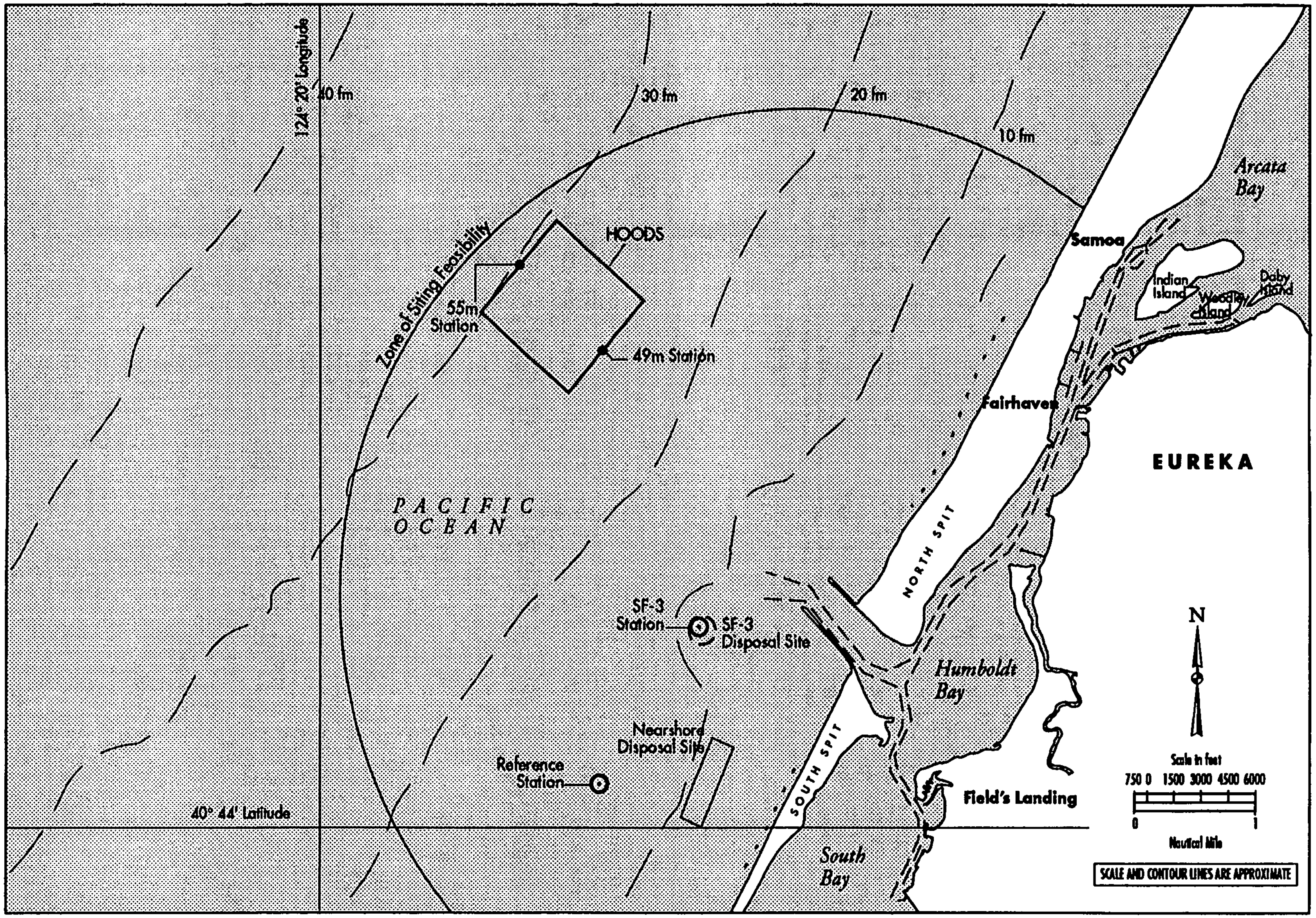
- **The oceanic regime.** During periods of light and variable winds, the warm surface water offshore tends to move onshore. Consequently, the sea surface temperature typically rises to greater than 13°C (55°F) and the salinity is usually less than 33.5 ppt. The waters are usually vertically stratified with respect to temperature and, to a lesser extent, salinity.

As part of this designation effort and an earlier effort to designate the SF-3 site, water column characteristic studies were performed at the preferred site (the HOODS), the SF-3 site, and a nearshore reference site (Figure 3-4). The studies were conducted at the HOODS in September 1990 and April 1991, and at SF-3 in May 1983 and July 1983. They included the evaluation of temperature, salinity, and density (SIGMA-t) profiles at two stations located at the shoreward and seaward boundaries of the HOODS (in 49 m [160 ft] and 55 m [180 ft] of water respectively). These same profiles were also collected at SF-3 and at a reference station (both in approximately 21 m [70 ft] of water). (Pequegnat and Mondeel-Jarvis 1991, Winzler and Kelly Consulting Engineers 1984.)

3.2.4.1 Dissolved Oxygen

The surface layers of the ocean are usually saturated with dissolved oxygen (DO), and DO concentration generally decreases with depth. During upwelling conditions, the oxygen concentration in the surface waters may be less than 50% of the saturation concentration; this low oxygen concentration is associated with the deeper, low-oxygen water that is advected to the surface.

During nearshore field surveys conducted in May 1983 at the SF-3 disposal site and at a reference site, DO levels ranged from a high of 8.2 milligrams per liter (mg/l) (98% saturation) to a low of 6.4 mg/l (70% saturation) near the bottom. During the July 1983



Sources: Pequegnat and Mandeel-Jarvis 1991, Winzler and Kelly 1984

Figure 3-4. Location of Offshore and Nearshore Field Surveys for Water Column Characteristics survey of these sites, DO levels were higher. Supersaturated water (9.7 mg/l [117% saturation]) was present near the surface. The lowest level detected was 6.8 mg/l (77% saturation) near the bottom (Winzler and Kelly Consulting Engineers 1984).

In offshore field surveys conducted in September 1990 at the HOODS, DO levels ranged from 6.2 mg/l (105% saturation) to 3.5 mg/l (55% saturation) at the 49 m (160 ft) station; DO values at the 55 m (180 ft) station ranged from 5.9 mg/l (100% saturation) to 2.2 mg/l (35% saturation).

In April 1991, DO concentrations at the 49 m (160 ft) and the 55 m (180 ft) stations were supersaturated (115% and 123% respectively). Oxygen concentration in near-bottom samples were lower (66% and 62% of saturation respectively).

3.2.4.2 Turbidity

Coastal waters generally have higher turbidities than open ocean waters because coastal waters are more subject to particulate inputs from land. Wastewater dischargers, river runoff, and resuspension of small particles by waves and currents are the major contributors to nearshore turbidity. Nearshore turbidity values will increase during the spring runoff season due to increased sediment loading from river waters. This has a direct effect on primary production because the amount of sunlight available to phytoplankton directly affects primary algal productivity and biomass.

Within the study areas, suspended sediments and phytoplankton are the main factors affecting water clarity. Changes in light transmittance with depth are a reflection of these two factors. Occurrences of high concentrations of phytoplankton are typical of the upwelling regime. Periods of high concentrations of sediment load occur during the Davidson Current regime. It is expected that transmittance would decrease in surface waters during these periods. During oceanic regime conditions, when surface waters containing low phytoplankton and low sediment concentrations move into the study areas, transmittance would be high. Below the surface layer, phytoplankton would tend to increase in concentration, resulting in lower transmittance. (Pequegnat and Mondeel-Jarvis 1990.)

Results of field studies at the HOODS indicated that water was clearer at mid-depth than at the surface but decreased in transmissivity near the bottom. It is suspected that this decrease in transmissivity near the bottom could be caused by either suspended sediment, sinking phytoplankton, or detritus.

3.2.5 Regional Geology

The northern California continental shelf has a complex morphology that has developed because of active tectonic movements in the area. The study area lies in close proximity to the Gorda-Pacific-North American triple junction, which is usually defined as the juncture of the San Andreas fault and the Mendocino Escarpment. North of the

Mendocino Escarpment, the coastline can be divided into two major sections based on the coastal morphology and underlying geologic structure.

The coast north of Trinidad Head is generally steep and rugged; offshore islands and seastacks are common. Beneath this section of the coast lies the Franciscan Formation. The beaches are generally steep, coarse-grained, and limited in lateral extent (the only major exception is Gold Bluffs Beach, just south of the Klamath River).

The study areas lie within the second major morphologic area, the area between Cape Mendocino and Trinidad Head. The coast in this area has been formed over underlying Tertiary marine deposits and features a coastal plain dissected by meandering rivers and streams. The shore consists of relatively broad, flat beaches. The only major bay along the coast, Humboldt Bay, is found in this area.

The continental shelf north of Cape Mendocino is relatively narrow, ranging from 5.2 to 19 nmi in width. The surface of the shelf shows little relief except in areas near the major headlands where seastacks and underwater promontories are common. The lack of shelf relief, which is surprising considering the active tectonism, is due to the rapid sedimentation in the area. The shelf area has been called the Eel River Shelf by Borgheld (1985) because the modern sedimentation is dominated by material supplied by the Eel River. Sedimentation rates vary but apparently range from 0.5 to 2.0 cm (0.8 inch) per year (Borgheld 1985, 1986). This rate is rapid for shelf areas supplied by all but the world's largest rivers. The rate is high because sediment yield from the local rivers is higher than that of any watershed of comparable size in the United States.

3.2.6 Sedimentation Patterns

Sedimentation patterns on the Eel River Shelf are produced by a number of processes acting together. Sediments are supplied to the shelf in a series of short-term deposition events. The pulsed nature of the sediment supply system is extremely important in the production of the sediment stratification on the shelf.

Numerous rivers and streams empty directly onto the coast in this area. Of these, two deliver the majority of the sediment to the coast. The major supplier is the Eel River, which delivers an average of 27,282,000 tons of suspended sediment per year to the continental shelf (Borgheld 1985). The Mad River supplies approximately one tenth of this amount to the shelf, an average of 2,774,000 tons of suspended sediment per year. The rivers along the northern California coastline have short drainage basins and highly variable stream flows. These rivers characteristically carry the majority of their sediment load during two or three flood events per year. (Borgheld 1985.)

Borgheld (1988) has documented a secondary sediment supply system in the study area that is produced by the ebb-tidal plume exiting Humboldt Bay. This plume acts like an additional river sediment plume by supplying sediment to the shelf. It delivers less sediment than the Eel River but delivers the majority of its sediment during spring tides rather than during river flooding.

Each major sediment supply event (i.e., major flood or major spring tide) deposits a layer of sediment on the shelf. The layer is generally thickest near the sediment source and decreases in thickness with distance from the source. Therefore, floods tend to produce layers that are thickest near river mouths, and the layers produced by the ebb-tidal plume from Humboldt Bay tend to be thickest near the bay mouth.

Once deposited, a layer is mixed physically by waves and currents, and biologically by benthic organisms (bioturbation). The amount of physical mixing is primarily controlled by the size of incoming waves and the water depth; wave mixing is more intense in shallower water. Borgheld (1986) collected box cores near the mouth of the Eel River and noted that the flood history of the river has been preserved in the sediments near the river mouth. Thick layers (up to 10 to 12 cm [4 to 5 inches] thick) have been deposited during past floods of the river. In shallower water, generally less than 40 m (131 ft) deep, these layers were subsequently destroyed by sediment remobilization and mixing caused by incoming waves. In water depths greater than 40 m (131 ft), many of the sediment layers were preserved, since presumably the water depths were too great for the incoming waves to significantly remix the bottom sediments. Instead, the mixing that occurred was generally limited to bioturbation.

Biological mixing occurs during the day-to-day activities of organisms that live in the bottom (infauna) or near the bottom (epifauna). It is unlikely that biologically produced mixing is uniform on the continental shelf, but no detailed study of this mixing in the study area has been conducted. Borgheld (1985) noted that the biological mixing history of a layer was apparently related to the layer thickness; thick layers had little if any biological mixing, while thin layers were commonly intensely mixed.

Wave mixing has an additional effect on the shelf's sediment distribution: areas where the bottom sediments are continually resuspended by wave action tend to have coarser sediments than deeper areas less influenced by waves. Fine-grained sediments (silts and clays) settle slowly compared to larger particles, and their continual resuspension effectively prevents them from accumulating in an area influenced by wave activity.

3.3 BIOLOGICAL ENVIRONMENT

The area of study described herein encompasses the region identified by the Corps in 1989 as the Zone of Siting Feasibility (ZSF). Within ZSF boundaries, three candidate sites have been chosen for disposal of material dredged from Humboldt Bay. These sites are the HOODS, SF-3, and the NDS.

Commercially important biological resources include groundfish (e.g., English sole, Dover sole, Pacific sanddab, rockfish), Dungeness crab, and salmon, all of which seasonally occur in the region, including the sites proposed for dredged material disposal. A variety of seabirds and marine mammals also occur in the region, including the disposal sites. Of lesser importance commercially, but of great importance ecologically, are the planktonic communities (phytoplankton and zooplankton) and benthic communities (polychaete worms and clams) that provide food for higher trophic level organisms (fish, marine mammals, and birds).

3.3.1 The Plankton Community

The open waters off Humboldt Bay are part of the California Current region, where biological components from a variety of marine biotic provinces mix. Few endemic (native) species or distinct neritic assemblages (organisms that occur on the coastal shelf) are found in this pelagic environment, but warm-water species from the central Pacific province and warmer-water cosmopolitan species occasionally occur. (Jones & Stokes Associates 1981.)

Plankton biomass and species composition in this region are influenced by the southern-flowing California Current and the Davidson Current that flows sporadically northward in winter. In addition, the upwelling of cold, nutrient-rich deep water during late spring and summer fertilizes surface waters, promoting phytoplankton production.

3.3.1.1 Phytoplankton

Phytoplankton are chlorophyll-bearing microscopic algae that passively drift or have limited means of locomotion and are, therefore, carried by waves and currents. Phytoplankton form the basis of marine food chains by using solar energy to convert inorganic nutrients into organic matter through photosynthesis. The distribution and abundance of phytoplankton depend on light intensity, nutrient concentrations, intensity of grazing, turbulence, turbidity, upwelling, and circulation. The abundance and variety of phytoplankton in surface waters, in turn, influence the subsequent production of zooplankton and other organisms.

Phytoplankton concentrate in surface waters where light is available, but vertical distribution is mainly affected by turbulence, stratification, and limited mobility (i.e., dinoflagellates). Phytoplankton biomass (as indicated by chlorophyll a concentration) is usually lower offshore (15 to 20 milligrams of chlorophyll a per square meter [mg chlorophyll a/m^2] in the upper 150 m [500 ft]) than nearshore (approximately 300 mg chlorophyll a/m^2 in the upper 150 m [500 ft]) (Owen 1974).

Phytoplankton populations in the coastal waters of northern California are generally composed of diatoms, dinoflagellates, coccolithophores, and flagellates (Hood et al. 1990). Primary production and phytoplankton biomass increase after persistent upwelling periods during the late spring and summer when cold, nutrient-rich waters induce intense blooms of diatoms. Photosynthetic carbon production rates can be 2 to 10 times higher in areas of pronounced upwelling than in open ocean waters. The rate of primary production in northern California coastal waters is about 150 grams of carbon per square meter per year

($g/C/m^2/year$) but may reach 300 $g/C/m^2/year$ in upwelling regions (Jones & Stokes Associates 1981). Following blooms, phytoplankton biomass declines as nutrients become limiting and phytoplankton is eaten by zooplankton or other grazers.

The warmer, nutrient-poor oceanic water of the California Current supports less biomass and smaller phytoplankton species than those present during upwelling (Hood et al. 1990). During the stormy fall and winter season, primary production rates are low due to reduced solar radiation, reduced upwelling, increased mixing of surface waters below the euphotic (light-penetration) zone, and increased turbidity due to wave action and increased flow of sediment-laden river water. The northern-flowing Davidson Current occasionally influences phytoplankton composition offshore of Humboldt Bay during winter months by bringing warm-water phytoplankton species from central Pacific waters.

3.3.1.2 Zooplankton

Zooplankton are aquatic invertebrates that have limited mobility or passively drift with water currents. Zooplankton transfer some of the energy of primary producers (phytoplankton) to larger invertebrates, fish, birds, and marine mammals. Zooplankton are divided into two main groups: (1) holoplankton, which spend their entire life cycle in the water column; and (2) meroplankton, which consist mostly of the larvae of benthic macroinvertebrates that are temporary members of the pelagic zooplankton community. The larvae of polychaetes, bivalves, gastropods, and crustaceans are typical meroplanktonic organisms, while holoplanktonic organisms include copepods, opossum shrimp (*Mysidacea*), krill (*Euphausiacea*), and arrow worms (*Chaetognatha*).

Zooplankton populations are regulated by water temperature, food availability, and predation. Zooplankton are most abundant within the top 20 to 30 m (66 to 100 ft) of the water column (Peterson and Miller 1977) and closer to the shore over the continental shelf (Pearcy 1972, Colebrook 1977, Peterson and Miller 1977).

Zooplankton distribution tends to be extremely patchy, largely as a result of ocean currents (Wickett 1967). The vertical distribution of zooplankton is determined by light, phytoplankton density, food, and the biology of each species. Zooplanktonic species from the Subarctic, Transition, and Central Pacific faunal groups have been identified in the coastal upwelling regions offshore of Oregon (Peterson and Miller 1977). The oceanic currents that influence the zooplankton composition in the coastal waters of Oregon are similar to those that influence the area offshore of Humboldt Bay (Hickey 1979); therefore, the species composition of zooplankton found offshore of Humboldt Bay is comparable to that reported for the coast of Oregon.

Peak zooplankton abundance in the coastal waters of northern California occurs from May through July in response to increased food availability following upwelling. Zooplankton species characteristic of northern faunal groups dominate in the summer when the California Current flows to the south. The copepod *Pseudocalanus* spp. is an abundant component of the California Current zooplankton, with highest densities occurring within the nearshore zone (2.6 nmi off the coast). In general, the nearshore zone is an important habitat for many other species of zooplankton. *Acartia* spp. and *Centropages abdominalis* are restricted to this zone, while other important zooplankton, *Pseudocalanus* spp. and *Calanus marshallae*, move into the nearshore zone to reproduce. Many higher trophic level organisms (i.e., pelagic fishes, marine birds, and mammals) occur seasonally in the area in an apparent response to the increased abundance of zooplankton and other prey. During the winter, however, warm-water species are transported northward by the Davidson Current, and zooplankton species abundance is generally lower (Peterson and Miller 1977).

The predominant holoplanktonic organisms in the coastal waters of northern California are copepods such as *Calanus pacificus*, *Acartia* spp., and *Pseudocalanus* sp.; mysids such as *Neomysis kadiakensis* and *N. rayi*; and euphausiids, including *Thysanoessa spinifera* (Peterson and Miller 1977, Lockheed Center 1979, Pequegnat et al. 1990).

Of the meroplankton, the pelagic larval stages of many shallow-shelf benthic invertebrates (such as the Dungeness crab[1]) are an important seasonal component (Jones & Stokes Associates 1981). Following hatching, zoea stages of Dungeness crab larvae remain in the plankton off central California from mid-December to mid-March (Reilly 1983a). Considerable offshore movement of this larvae occurs during this time, and these larvae can be found at depths greater than 30 m (100 ft) (Reilly 1985). After upwelling begins in April and May, megalopae, the final pelagic stage of the Dungeness crab, appear near shore in large concentrations. The mechanism by which they move inshore is unclear (Pauley et al. 1989). Megalopae occur off Humboldt Bay from April to June, concentrating at the surface, especially at dawn and dusk (Toole 1989). They are frequently associated with floating materials, slicks, and upwelling fronts (Toole 1989). Dungeness crab larvae feed on zooplankton and are important prey items for plankton-feeding fish such as salmon (Reilly 1983b) and rockfish (Prince and Gotshall 1976).

No data are available describing the seasonal abundance and distribution of other meroplanktonic invertebrate larvae in the area offshore of Humboldt Bay. Oliver and Slattery (1976) reported that the reproductive patterns of the benthic invertebrate fauna correlated well with day length and phytoplankton blooms in the spring and fall in a study of a similar environment in Monterey Bay.

The zooplankton species that accompany the current regimes occurring offshore of Humboldt Bay are an essential link in the food web of the waters of the area but are not of direct economical or commercial importance.

3.3.2 The Benthic Algae Community

Attached plants are uncommon in open coastal waters with sandy bottoms because of a lack of nutrients, few attachment sites, and inhibition by waves and longshore currents. Some seaweed, mostly *Fucus distichus* and *Ulva* sp., is found along the intertidal and subtidal

[1] Scientific names for all species mentioned in text are presented in Appendix B.

portions of the north and south jetties. The lack of suitable substrate and the intensity of wave action prohibit the development of large kelp beds in the subtidal area off of Humboldt Bay.

3.3.3 The Benthic Invertebrate Community

Benthic macrofaunal invertebrates are those organisms (generally > 1 mm [0.04 inches]) that occur in bottom sediments. Several detailed studies of the benthic invertebrate communities offshore of Humboldt Bay have been performed (ERC 1976, Lockheed Center 1979, IEC 1981, Winzler and Kelly Consulting Engineers 1984, Pequegnat and Mondeel-Jarvis 1990, Pequegnat et al. 1990). However, only one study sampled the benthic macrofauna in water deeper than 30 m (100 ft) (Pequegnat et al. 1990). Benthic invertebrate communities have been surveyed more thoroughly at the shallower ocean alternative sites (the NDS and SF-3) than at the HOODS, which ranges in depth from 49 to 55 m (160 to 180 ft). A summary of the dominant benthic macrofaunal invertebrates reported near Humboldt Bay is provided in Table 3-3.

3.3.3.1 Benthic Infauna

Benthic infauna are invertebrates that burrow into the bottom sediments. The distribution, abundance, and species composition of benthic infauna communities in nearshore continental shelf sediments are related to sediment grain sizes (Gray 1974), organic content of sediments, production of organic matter in overlying waters, interactions among organisms, and environmental disturbances (such as storm waves and high sediment loads associated with episodic floods and drag fishing) (Pequegnat et al. 1990).

Pequegnat et al. (1990) conducted a study of benthic fauna in the area of study from 1989 to 1990. Polychaetes, mollusks, and crustaceans account for over 90% of the species and numbers of individuals of the benthic infauna in the area. The polychaete biomass is also greater in the finer sediments within the region. In general, the number of species and the abundance of benthic infaunal invertebrates increased with increasing depth in the benthic environment offshore of Humboldt Bay.

A total of 295 species of benthic invertebrates were identified by Pequegnat et al. (1990). Annelids, primarily polychaete worms, are the most abundant species group found in the benthic environment, accounting for over 70% of the individuals. The abundance of polychaetes, in general, increased with increasing depth. Mollusks, primarily gastropods and bivalves, were the next most abundant species group of the benthic infauna. The most abundant gastropod snail, *Olivella pycna*, occurred primarily in the shallower depths, while the most abundant bivalve was found in highest densities in the deeper areas. Crustaceans, especially amphipods, were the third largest species group contributing to benthic infaunal abundance.

Table 3-3. List of the Dominant Benthic Macrofaunal Invertebrates Reported near Humboldt Bay

Annelida
- Polychaeta
  - *Chaetazone setosa pugettensis*
  - *Decamastus gracilis*
  - *Glycera oxcephala*
  - *Heteromastus filobranchus*
  - *Lumbrineris luti*
  - *Mediomastus californiensis*
  - *Scoloplos armiger*
  - *Spiophanes bombyx*
  - *Tharyx* spp.

Arthropoda
- Crustacea
  - Malacostracans
    - Cumacea
      - *Diastylopsis dawsoni*
    - Amphipoda
      - *Ampelisca careyi*
      - *Anisogammarus pugettensis*
      - *Atylus tridens*
      - *Monoculodes spinipes*
      - *Protomedia prudens*
    - Isopoda
      - *Synidotea bicuspida*

Mollusca
- Gastropoda
  - *Olivella pycna*
  - *Mitrella* spp.
- Bivalvia
  - *Axinopsida sericata*
  - *Siliqua patula*

Source: Pequegnat et al. 1990.

Overall, the abundance of benthic infaunal invertebrates declines during the winter in the region. Total benthic infaunal abundances range from 2,400 organisms/m^2 in March 1990 to 3,450 organisms/m^2 in August 1989. Polychaetes are the most abundant infaunal species group in both summer and winter. Mollusks account for a greater percentage of the total number of individuals in the region during the winter than during the summer (Pequegnat et al. 1990).

Three zones of benthic infauna have been identified (Pequegnat et al. 1990): (1) the nearshore zone (< 35 m [115 ft] in depth), (2) the mid-depth zone (> 35 m [115 ft] but < 55 m [180 ft] in depth), and (3) the offshore zone (> 75 m [250 ft] in depth).

The nearshore benthic zone contains clean sand with little organic debris and is swept by waves. The infaunal diversity in the nearshore is low, and there are more suspension-feeders and fewer burrowing deposit-feeders than are found farther offshore. Small polychaetes, amphipods, cumaceans, and mollusks are the principal infauna in the nearshore zone (Lockheed Center 1979, IEC 1981, Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990). The abundance and diversity of infauna in the nearshore zone vary seasonally (Pequegnat et al. 1990, Winzler and Kelly Consulting Engineers 1984), probably because of seasonal wave action in the relatively shallow depths.

Two alternative ocean disposal sites, the NDS and SF-3, are located within this nearshore zone. Following disposal of dredged material, the abundance and numbers of infaunal species were lower than offshore and at nearby reference stations (Lockheed Center 1979, IEC 1981, Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990). The dredged material disposed at the sites was coarser than that of the adjacent habitat at similar depths, and the frequency of dumping inhibited benthic succession. Therefore, the benthic fauna at the site was characterized by opportunistic, small, mobile, surface-dwelling invertebrates. There has been no disposal at SF-3 since April 1990, or at the NDS since fall 1989. This period of respite from disposal disturbance is reportedly long enough to allow the benthic communities at these disposal sites to recolonize to an assemblage more similar to the adjacent benthic habitats (Bott and Diebel 1982, Tatem 1984).

The sandy sediments of the mid-depth zone contain more organic debris and so support a more diverse and abundant infauna than is found in the nearshore zone. The mid-depth zone also supports more burrowing deposit feeders, which have limited mobility and feed from burrows within the sediments. Sediments with high organic content provide better habitat for non-motile deposit-feeders than is found in the nearshore zone.

The break between the mid-depth and the offshore zones does not occur at a fixed depth but ranges from a depth of 55 to 75 m (180 to 250 ft) in response to wave energy and sediment supply. At water depths greater than 55 m (180 ft), the percentage of silt in the sediment increases, as does the amount of organic material. The boundary between the sands found in the nearshore and mid-depth zones and the muds found farther offshore (in waters greater than 75 m [250 ft] in depth) lies in this area. This transition area between the mid-depth and offshore zones is called the "mud-sand transition zone." The HOODS is located within the outer limit of the mid-depth zone and the inner limit of the mud-sand transition zone.

Higher diversity and greater abundances of infaunal species, including burrowing, deposit-feeding polychaetes and mollusks, are found in this transition zone than nearer to shore. The sediments in this zone are finer and contain more organic material, and so provide a more suitable habitat for burrowing infaunal organisms than the sand substrates characteristic of the nearshore and mid-depth zones. For example, the bivalve *Axinopsida serricata* has been found only in water > 49 m (161 ft) deep, probably because the finer-grained sediments found in deeper water are better for burrowing (Pequegnat et al. 1990). The stability of this environment is partly responsible for its relatively higher diversity and the increase in sedentary burrowing and tube-dwelling infauna (Oliver et al. 1980).

The offshore zone (> 75 m [250 ft] in depth) contains fine sands with silty clays and terrestrial organic debris. The area of study extends only a short distance into the offshore zone, so the offshore muds were not sampled. It is likely that even higher numbers of species and individuals would be found in samples from deeper locations.

The benthic invertebrate infauna of the region may be an important link in the food web supporting higher trophic level species, some of which are of commercial significance. Although the feeding preferences of demersal fish species and of Dungeness crab include benthic infaunal invertebrates, specific areas important for feeding have not been identified. These feeding habitats are likely to be widespread within similar depth zones and sediment types in the region.

3.3.3.2 Benthic Epifauna

Epifauna refers to animals that are associated with the surface of the sea floor rather than those that burrow into sediments. Most of the epibenthic species captured in trawls offshore of Humboldt Bay are carnivorous or omnivorous. These species affect the distribution and abundance of their infaunal prey (Woodin 1974, Virnstein 1977).

Decapods, particularly Dungeness crabs, and three species of shrimp (bay shrimp, sand shrimp, and coon-stripe shrimp), are numerically dominant organisms in the region. Pequegnat et al. (1990) report that these species are generally more abundant and found at greater depths in March than in August. Common echinoderms include sea stars, the short-spined star, the brown mud star, and the Pacific sand dollar. Large numbers of sand dollars are found in the nearshore and mid-depth zones.

The most economically important epifaunal invertebrate reported in this region is the Dungeness crab, which is fished commercially along the northern California coast. Most of these crabs are taken from water less than 55 m (180 ft) deep; however, this may be partly due to the depths to which fisherman are willing to lower their crabpots (Pequegnat et al. 1990). Adult crabs are found living over several substrate types, but they prefer sandy mud bottoms (Karpov 1983, Lawton and Elner 1985). Dungeness crabs are highly mobile and change depths in response to local conditions such as turbulence due to storms.

Adult male and female Dungeness crabs move into shallow sandy areas to mate between March and July; between September and November, egg-brooding females partially bury themselves in the sand in shallow subtidal and intertidal areas until their eggs hatch. The distribution of the planktonic life stages of the crab is discussed in Section 3.3.1.2. Juvenile Dungeness crabs remain at the bottom of estuaries or shallow nearshore areas for 11 to 15 months before moving offshore. Researchers are currently debating whether juvenile crabs need specific areas such as estuaries for nursery grounds for rearing (Toole 1989, Pauley et al. 1989, Pequegnat et al. 1990).

Dungeness crabs occupy successive trophic levels as they develop. Larvae eat zooplankton and are, in turn, preyed upon by fish. Adult Dungeness crabs are opportunistic feeders that eat mollusks, crustaceans, and fish, as well as serving as prey to numerous predators. According to Stevens et al. (1982), crabs eat bivalves during their first year, shrimp (*Crangon* spp.) in their second year, and juvenile fish in their third year. Cannibalism is common among these crabs and probably influences juvenile and adult abundance. Crabs move into shallower water at night and deeper water in the day; this response has been correlated with food availability (Stevens et al. 1984).

The field data obtained by Pequegnat et al. (1990) indicate that Dungeness crabs in the region are more abundant and found at greater depths in March in comparison to August. The greatest abundance of Dungeness crab has been found at and adjacent to the NDS (Lockheed Center 1979, IEC 1981, Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990), with the highest abundances in November at that site (Pequegnat et al. 1990).

Few or no crabs were reported from trawls made at the SF-3 site in April (IEC 1981), May (Winzler and Kelly Consulting Engineers 1984), or July (Winzler and Kelly Consulting Engineers 1984); or in the vicinity of the HOODS in April (IEC 1981) or August (Pequegnat et al. 1990). However, an increased abundance of Dungeness crabs was found at SF-3 in February (Lockheed Center 1979) and at the HOODS in March (Pequegnat et al. 1990). Lockheed Center (1979) found a greater abundance of Dungeness crabs in February in the areas adjacent to SF-3 compared to the trawls performed within the disposal site boundaries.

Caridean shrimp (bay and sand shrimp) found offshore of Humboldt Bay are important food items for demersal fish and crabs. The commercially fished pink ocean shrimp was not found in any of the trawl samples collected by Pequegnat et al. (1990). Pink shrimp are reportedly commercially fished in depths of over 70 m (230 ft) approximately 26.9 nmi north of the study areas at Patrick's Point.

The sea stars *Pisaster brevispinus* and *Luidia foliolata* are important predators of the benthic invertebrate community. They have been reported to prey heavily upon juvenile Dungeness crabs, olive snails, and clams. Sand dollars are found in extensive, densely-packed beds at depths of 0 to 100 m (0 to 330 ft) (Pearse 1975). Sand dollars migrate in response to sea conditions, moving into shallow water when seas are calm and moving offshore during storms. Sand dollars are found in narrow bands along the shore off of

Humboldt Bay throughout the year and are common at 12 m (40 ft) in September (Pequegnat and Mondeel-Jarvis 1990). They have been reported in large numbers at the NDS (Pequegnat et al. 1990).

3.3.3.3 Pelagic Macroinvertebrates

A few squid (*Loligo* sp.) were captured in trawls made by Pequegnat et al. (1990) offshore of Humboldt Bay at depths of 31 to 55 m (102 to 180 ft) in August and March. However, squid have not been reported in previous trawl samples from this vicinity (Lockheed Center 1979, IEC 1981, Winzler and Kelly Consulting Engineers 1984). The distribution of market squid is unclear, and environmental influences are largely unknown (Kaskiwada and Reckseik 1978). Squid egg sacks are occasionally found on crab pots off the Humboldt County coast and are an incidental catch by trawling shrimp fisherman in water 72 to 182 m (240 to 600 ft) deep. However, they apparently do not occur in adequate numbers to support a commercial fishery in this area.

3.3.4 The Fish Community

A total of 562 species of fish have been identified in California's coastal waters. In discussing the ecology of fishes, species are commonly grouped into assemblages based on broad similarities in biology or habitat (Miller and Lee 1972). Nearshore bottomfish, deep-water benthic fish, schooling marine fish, and anadromous fish are examples of major fish assemblages. Nearshore bottomfish and deep-water benthic fish are called demersal because they are associated with the sea floor, whereas schooling and anadromous fish are called pelagic because they live in open water. The following sections discuss the demersal and pelagic fish found within the region, as well as the occurrence of these fish in the vicinity of the alternative disposal sites.

3.3.4.1 Demersal Fish

Demersal fish are characterized as either nearshore species living at depths of 11 to 100 m (36 to 330 ft) or deep-water species occurring in shelf habitats at depths of 100 to 550 m (330 to 1,800 ft). Common demersal fish found near shore in the waters off of Humboldt Bay are English sole, Pacific sanddab, starry flounder, butter sole, sand sole, speckled sanddab, curlfin turbot, pricklebreast poacher, tubenose poacher, warty poacher, plainfin midshipman, staghorn sculpin, and showy snailfish (Table 3-4) (Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990). In addition, lingcod may occur near rocks off the Harbor entrance jetties, and California halibut may occur in nearshore waters outside the Bay (Monroe 1973). Of these species, the commercially important fish are English sole, Pacific sanddab, starry flounder, California halibut, and lingcod. Critical life history stages of these species are summarized in Table 3-5.

Table 3-4. Demersal Fish Known to Occur near Humboldt Bay

Common Name	Scientific Name
Class: Osteichthyes (Bony Fishes)	
Righteye flounders: Pleuronectidae	
English sole	*Parophrys vetulus*
starry flounder	*Platichthys stellus*
butter sole	*Isopsetta isolepsis*
sand sole	*Psettichthys melanostictus*
curlfin turbot	*Pleuronichthys decurrenss*
Dover sole	*Microstomus pacificus*
petrale sole	*Eopsetta jordani*
rex sole	*Glyptocephalus zachirus*
Lefteye flounders: Bothidae	
Pacific sanddab	*Citharichthys sordidus*
California halibut	*Paralichthys californicus*
speckled sanddab	*Citharichthys stigmaeus*
Poachers: Agonidae	
pricklebreast poacher	*Stellerina xyosterna*
tubenose poacher	*Pallasina barbata*
warty poacher	*Occella verrucosa*
Sculpins: Cottidae	
staghorn sculpin	*Leptocottus armatus*
Toadfishes: Batrachoididae	
plainfin midshipman	*Porichthys notatus*
Snailfishes: Cyclopteridae	
showy snailfish	*Liparis pulchellus*
blacktail snailfish	*Careproctus melanurus*
Greenlings: Hexagrammidae	
lingcod	*Ophiodon elongatus*
Rattails: Macrouridae	
roughscale rattail	*Coryphaenoides acrolepis*
black rattail	*C. acrolepis*
giant rattail	*C. pectoralis*

Table 3-4. Continued

Common Name	Scientific Name
Eelpouts: Zoarcidae	
twoline eelpout	*Bothrocara brunneum*
Sablefishes: Anoplopomatidae	
sablefish	*Anoplopoma fimbria*
Scorpionfishes: Scorpaenidae	
widow rockfish	*Sebastes entomelas*
canary rockfish	*S. pinniger*
bocaccio	*S. paucispinis*
darkblotched rockfish	*S. crameri*
chilipepper rockfish	*S. goodei*
Class: Chondrichthyes (Cartilaginous Fishes)	
Ratfishes: Chimaeridae	
ratfish	*Hydrolagus colliei*
Skates: Rajidae	
longnose skate	*Raja stellulata*
Dogfish sharks: Squalidae	
spiny dogfish	*Squalus acanthias*

Sources: Pequegnat et al. 1990, Winzler and Kelly Consulting Engineers 1977, Lockheed Center 1979.

Table 3-5. Summary of Critical Stages of Commercially Important Nearshore Demersal Fish Found near Humboldt Bay

Species	Spawning Habitat/Season	Egg Habitat	Larval Habitat	Juvenile Habitat/ Seasonal Feeding	Adult Seasonal Distribution/Habitat, Range, Feeding
English sole[a,b,c,d,e] *Parophrys vetulus*	spawn in sand and sand/mud bottoms at depths of 60 to 110 m; most abundant from December to February, but occur year-round	pelagic, November to March	pelagic; most larvae within 2 km of shore; December to May	larval juveniles settle to bottom from November to May into open coastal areas, mainly <16 m deep; nursery areas are mainly estuaries but also open coastline, April to October; juveniles emigrate to deeper waters, August to November Diet: amphipods, cumaceans, polychaetes, benthic invertebrates	summer depths of 20 to 70 m, winter depths of 40 to 130 m; offshore sand, sand/mud substrate; Baja, California to Bering Sea Diet: epifaunal, infaunal prey, including polychaetes, bivalves, small crustaceans, brittle stars
Pacific sanddab[b,f] *Citharichthys sordidus*	spawn in 30 to 90 m, sandy bottoms; July to September, with peak activity in August	pelagic	pelagic; inshore to 724 km offshore; July to August peak abundance in October to November	most occur in 66 to 92 m, spring to fall Diet: amphipods, copepods, cumaceans, mysids	commonly occur at depths of 35 to 90 m; deep sand to sand/mud areas; Baja, California to Bering Sea Diet: euphausiids and mysid crustaceans
Starry flounder[d] *Platichthys stellus*	spawn in shallow, coastal and bay areas, December to January	pelagic	pelagic	juveniles settle to bottom, probably in shallow waters	most abundant over soft sand, mainly in shallow water; Santa Barbara, California to Arctic Alaska Diet: crabs, shrimp, worms, clams
Lingcod[a,b,d,g] *Ophiocon elongatus*	spawn in rocky bottoms, from intertidal to 19 m; November to April with peak activity in late December to early February	demersal, rocks in tidepools from lower intertidal to 19 m depth	demersal, January to July; rocks and vegetation in lower intertidal, but older larvae are pelagic, near surface	pelagic, January to July; 1-yr juveniles may recruit to sandy, shallow bottoms, down to 60 m but usually in bays, estuaries	rocky habitat, mainly in waters less than 100 m deep; Baja, California to Shumagin Islands, Alaska
California halibut[a,d,h] *Paralichthys californicus*	spawn at depths of 6 to 20 m over sandy bottoms; February to August, peak in May	pelagic, concentrated in areas with depths of 6 to 20 m	pelagic, usually found between 12 and 45 m isobaths	March to May move to deeper, offshore waters with growth; juveniles recruit to sand and mud bottoms off coastal embayments/ estuaries in June Diet: copepods, mysids, cumaceans, amphipods	adults most common from surf (55 m) zone to 60 m; Baja, California to Quillayute River, Washington Diet: anchovies, croakers, flatfish, squid

Sources:

[a] MCP Applied Environmental Sciences 1987
[b] Toole 1989
[c] Toole et al. 1987
[d] Hart 1973
[e] Lassuy 1989
[f] Rackowski and Rikitch 1989
[g] Shaw and Hussler 1989
[h] Kucas and Hussler 1986

The most abundant demersal fish living in the deeper shelf environments are chimaeras, sharks, skates, flatfishes, and rockfishes (Winzler and Kelly Consulting Engineers 1977). The commercially important fish species in the deeper shelf areas are Dover sole, petrale sole, rex sole, black rattail, widow rockfish, canary rockfish, bocaccio rockfish, darkblotched rockfish, and chilipepper rockfish. Other fish species common to the deeper shelf areas include ratfish, roughscale rattail, giant rattail, blacktail snailfish, twoline eelpout, longnose skate, and spiny dogfish.

Many deepwater flatfishes and rockfishes move between deep and shallow water during their development (Pequegnat et al. 1990). Adult bottomfishes tend to move from deep to shallow water to aggregate and spawn; their eggs and larvae are pelagic and move with the currents. Juveniles settle to the bottom and move into nursery grounds in estuaries or shallow coastal areas. The juvenile stages of deepwater fish, in particular, are sensitive to conditions in nearshore habitats. The juvenile stages of many commercial deep-water bottomfish, including Dover sole, petrale sole, widow rockfish, canary rockfish, bocaccio rockfish, darkblotched rockfish, and chilipepper rockfish, occur in nearshore areas (Toole 1989). Critical life history stages of these species are summarized in Table 3-6.

3.3.4.2 Pelagic Fish

Pelagic fish are found in the epipelagic zone, which roughly encompasses the upper 200 m (660 ft) of the water column. The epipelagic zone extends over the continental shelf where upwelling occurs. The abundant phytoplankton and zooplankton in this area support vast schools of pelagic fish. Pelagic fish offshore of Humboldt Bay include anadromous fish and schooling marine species (Table 3-7).

Adult anadromous fish migrate through Humboldt Bay on their way to freshwater spawning grounds, and juveniles pass through the nearshore environment during their seaward migration. Anadromous fish species in Humboldt Bay include chinook salmon, coho salmon, steelhead trout, and coastal cutthroat trout (Monroe 1973).

Other species known to occur commonly in this open coastal area (the study area) include schooling fish such as blue rockfish, black rockfish, Pacific tomcod, Pacific herring, northern anchovy, night smelt, whitebait smelt, eulachon, shiner surfperch, spotfin surfperch, silver surfperch, walleye surfperch, white seaperch, and bay pipefish (Toole 1989, Pequegnat et al. 1990). Pacific cod, a year-round commercial and sport species, may also be found in this area (Dames and Moore 1981). The brown smoothhound shark also occurs in this area; it is a member of the family Triakididae, a group of schooling shark species (Eschmeyer et al. 1983). Critical life history stages of pelagic fishes found near Humboldt Bay are summarized in Table 3-8.

3.3.4.3 Occurrence of Pelagic and Demersal Fish at the Proposed Disposal Sites

The HOODS. Trawl surveys were conducted by Humboldt State University in August 1989 and March 1990 at depths of 49 and 55 m (160 and 180 ft) just south of the HOODS

Table 3-6. Summary of Critical Stages of Commercially Important Deep-Water Demersal Fish Found near Humboldt Bay

Species	Spawning Habitat/Season	Egg Habitat	Larval Habitat	Juvenile Habitat/ Seasonal Feeding	Adult Seasonal Distribution/Habitat, Range, Feeding
Dover sole[a,b,c,d] *Microstomus pacificus*	spawning aggregations in 80 to 732 m, November to March	pelagic eggs primarily in upper 50 m, from November to March	pelagic, primarily in upper 50 m	mud bottom, on shelf; February, 130 to 183 m depth, may move into shallows (10 to 183 m) in summer Diet: same as adults	mud bottoms, 18 to 915 m; Baja, California to Bering Sea Diet: polychaetes, bivalves, benthic crustaceans, brittle stars
Petrale sole[a,b,e] *Eopsetta jordani*	major spawning aggregations in 274 to 450 m, November to March; move offshore in winter and inshore in summer	pelagic eggs, float with current, sink before reaching nearshore areas	pelagic, in shallow waters	benthic in fall of first year (64 to 82 m depths), May to August found 18 to 90 m Diet: mysids, sculpins, juvenile flatfishes	sandy bottom; 18 to 547 m; Baja, California to Gulf of Alaska Diet: euphausiids, shrimp, pelagic fish, juvenile flatfish
Rex sole[d] *Glyptocephalus zachirus*	spawn at 100 to 300 m	pelagic	pelagic	become benthic in winter, 150 to 200 m, use this depth as nursery	sand or mud bottom; 18 to 614 m depth, but mainly below 61 m; San Diego to Bering Sea
Sablefish[a,b,e] *Anoplopoma fimbria*	deep water, January to February	pelagic	pelagic, upper 1 m, 5.6 to 370 km from shore, March to July	shallow waters; occur at depths of 100 to 200 m, occasionaly 30 m deep Diet: euphausiids, copepods, amphipods, larvaceans	mud/clay bottoms; bottoms at 305 to 1,829 m; Baja, California to Bering Sea Diet: squid, octopus, euphausiids, shrimp
Rockfish spp.	mid-November to mid-March	ovoviviparous	pelagic, found year-round, commonly at depths >100 m		
Widow rockfish[a,b,e] *Sebastes entomelas*	little known; spawning may be confined to restricted areas, January to March	ovoviviparous	pelagic, March	become benthic, small juveniles occur from surface to depths of 20 m; older juveniles at depths of 9 to 37 m, mainly June to August Diet: euphausiids, salps	rocky banks; 34 to 366 m; Baja, California to Kodiak, Alaska Diet: amphipods, euphausiids, shrimp, salps
Canary rockfish[b,e] *Sebastes pinniger*	spawning may be confined to specific areas, mid-winter	ovoviviparous	not in epipelagic, or shallow waters	become benthic, occur at depths less than 22 m; mainly May to August	rocky bottom; 91 to 274 m; Baja, California to Southeastern Alaska
Boccaccio rockfish[a,b,e] *Sebastes paucispinis*	two broods; spawning in mid-November and March	ovoviviparous	occur often far offshore in the upper 100 m, mid-December and April	some benthic juveniles occur in less than 22 m, but not common Diet: perches, jack mackerel, juvenile rockfishes	rocky reefs and open bottom; 27 to 320 m; Baja, California to Gulf of Alaska Diet: Pacific hake, northern anchovy

Table 3-6. Continued

Species	Spawning Habitat/Season	Egg Habitat	Larval Habitat	Juvenile Habitat/ Seasonal Feeding	Adult Seasonal Distribution/Habitat, Range, Feeding
Thornyhead rockfish[b,e] (shortspine and longspine) *Sebastolobus alascanus* and *S. altivelis*	little known	pelagic; eggs float at surface in gelatinous masses, January to May	pelagic	not restricted to shallow, nursery areas	
Darkblotched rockfish[b,e] *Sebastes crameri*	little known; spawning may be confined to restricted areas, February	ovoviviparous	pelagic, March	not restricted to shallow, nursery areas; 0-yr old found at 73 to 130 m	soft bottom, 29 to 549 m; southern California to Bering Sea
Chilipepper rockfish[a,e] *Sebasates goodei*	spawn in mid-November to mid-March	ovoviviparous	pelagic, occur near surface; December to April	age 0 found at surface to 8 m, around rocky reefs during summer; subadults and adults occur at depths of 50 to 350 m Diet: planktonic crustaceans	sand and mud bottom; 61 to 329 m; Baja, California to British Columbia Diet: euphausiids, anchovies, laternfish

References:

[a] MPC Applied Environmental Sciences 1987
[b] Toole 1989
[c] Horton 1989
[d] Miller and Lee 1972
[e] Hart 1973

Table 3-7. Pelagic Fish Known to Occur near Humboldt Bay

Common Name	Scientific Name
Class: Osteichthyes (Bony Fishes)	
Trouts: Salmonidae	
chinook salmon	*Oncorhynchus tshawytscha*
coho salmon	*O. kisutch*
steelhead trout	*O. mykiss*
coastal cutthroat trout	*O. clarki clarki*
Scorpionfishes: Scorpaenidae	
blue rockfish	*Sebasates mystinus*
black rockfish	*S. paucispinis*
Codfishes: Gadidae	
Pacific tomcod	*Microgaddus proximus*
Pacific cod	*Gadus macrocephalus*
Herrings: Culpeidae	
Pacific herring	*Culpea harengus pallasi*
Anchovies: Engraulidae	
northern anchovy	*Engraulis mordax*
Smelts: Osmeridae	
night smelt	*Spirinchus starkis*
whitebait smelt	*Allosmerus elongatus*
eulachon	*Thaleichthys pacificus*
Surfperches: Embiotocidae	
shiner surfperch	*Cymatogaster aggregata*
spotfin surfperch	*Hyperprosopon anale*
silver surfperch	*H. ellipticum*
walleye surfperch	*H. argenteum*
white surfperch	*Phanerodon furcatus*
Pipefishes: Syngnathidae	
bay pipefish	*Syngnathus leptorhynchus*

Table 3-7. Continued

Common Name	Scientific Name
Class: Chondrichthyes (Cartilaginous Fishes)	
Requiem sharks: Carcharhinidae	
brown smoothhound	*Mustelus henlei*

Source: Pequegnat et al. 1990, Winzler and Kelly Consulting Engineers 1977, Lockheed Center 1979.

Table 3-8. Summary of Critical Stages of Commercially Important Pelagic Fish Found near Humboldt Bay

Species	Spawning Habitat/Season	Egg Habitat	Larval Habitat	Juvenile Habitat/ Seasonal Feeding	Adult Seasonal Distribution/Habitat, Range, Feeding
Anadromous Fish					
Chinook salmon[a,b] *Oncorhynchus tshawytscha*	fish return to Humboldt County rivers and must hold in estuaries and nearshore areas until rains provide sufficient flows to move upstream; September to February	freshwater	freshwater	juveniles in nearshore waters, but little information on nearshore distribution in ocean; concentrate near canyon heads; May to October in some locations	ocean; San Diego to Bering Sea
Coho salmon[a,b] *Oncorhynchus kisutch*	fish return to Humboldt County rivers and must hold in estuaries and nearshore areas until rains provide sufficient flows to move upstream; September to February	freshwater	freshwater	juveniles in nearshore waters, in ocean off Oregon, most juveniles found within 4 m of surface; concentrate near canyon heads; March to June	ocean; Baja, California to Arctic Alaska
Steelhead trout[b,c,d] *Oncorhynchus mykiss*					
Summer run	return to Middle Fork Eel River; May to October	freshwater	freshwater	juveniles (1 to 4 yr olds) move through nearshore waters; March to April	ocean; Baja, California to Bering Sea
Winter run	return to Humboldt County rivers; November to April	freshwater	freshwater	juveniles (1 to 4 yr olds) move through nearshore waters; March to April	ocean; Baja, California to Bering Sea
Coastal cutthroat trout *Oncorhynchus clarki clarki*	spend summer in ocean and estuaries; spawn in January and February	freshwater	freshwater	seaward smolt migration peaks in May; fish remain close inshore	ocean; Eel River to southeast Alaska

Table 3-8. Continued

Species	Spawning Habitat/Season	Egg Habitat	Larval Habitat	Juvenile Habitat/ Seasonal Feeding	Adult Seasonal Distribution/Habitat, Range, Feeding
Rockfish					
Blue rockfish[b] *Sebastes mystinus*	spawn in mid-November to mid-April	pelagic	pelagic	become benthic in <25 m; late May to June	schooling rockfish; off bottom near reefs and pinnacles; surface to 550 m; Baja, California to Bering Sea
Black rockfish[e] *Sebastes melanops*	spawning area unknown; maybe offshore; January to April	pelagic	pelagic; April to June	restricted to benthic; 40 to 50 m depth; mainly in June; range is from April to October	primarily found in areas with depths of 54 m or less; mainly found in mid-waters; southern California to Aleutian Islands
Yellowtail rockfish[b] *Sebastes flavidus*	spawn in mid-November to mid-March	not applicable	pelagic	juveniles have been found in bay, nursery areas	mostly pelagic, 24 to 46 m; San Diego to Kodiak Island
Beach and Bay Fish					
Herring[a,f] *Clupea harengus pallasi*	spawn in protected embayments, especially Humboldt Bay; December to March	eggs restricted to embayments, especially Humboldt Bay; December to March	restricted to bays and shallow coastal areas near shore; spring and early summer	not restricted to shallow water nursery areas	when not spawning, typically offshore; Baja, California to Arctic Alaska
Surf, night smelt, whitebait smelt[a,b] *Hypomesus pretiosus, Spirinchus starksi, Allosmerus elongatus*	restricted to spawning in surf zone of sandy beaches; March to August; surf smelt spawns at day; night smelt spawn at night	eggs attached to sand grains in surf zone of sandy beaches; March to August	little known	little known	little known; generally, southern California to British Columbia or Alaska
surfperches[a,b] *Cymatogaster aggregata, Amphistus rhodoterus, Hyperprosopon ellipticum, H. argenteum, Phanerodon furcatus*	spawn in protected embayments and shallow coastal waters; spring and early summer	viviparous	viviparous	restricted to bays and shallow areas, especially Humboldt Bay; summer and fall	shallow surf, sheltered bays; generally, southern California to British Columbia or Alaska

References:

[a] Toole 1989
[b] Hart 1973
[c] Pauley et al. 1986
[d] Pauley et al. 1989
[e] Stein and Hussler 1989
[f] Lassuy 1989

(Pequegnat et al. 1990). In August 1989, the trawl catch in the HOODS was composed primarily of whitebait smelt and, in order of decreasing abundance, Pacific sanddab, rex sole, Dover sole, Pacific tomcod, and juvenile sanddab. More species were found during the March 1990 surveys; in order of decreasing abundance these were night smelt, whitebait smelt, Pacific tomcod, Pacific sanddab, shiner surfperch, black rockfish, English sole, speckled sanddab, Pacific sand sole, showy snailfish, curlfin turbot, eulachon, Pacific herring, juvenile sanddab, and larval smelt. Most of the catch (by weight) was made up of black rockfish, night smelt, English sole, Pacific sanddab, and Pacific tomcod.

These trawl surveys also showed that fish assemblages change with distance offshore. At the HOODS, two fish assemblages are likely to occur: an assemblage at mid-depth waters (40 to 49 m [130 to 160 ft] deep) composed mainly of Pacific sanddab, rex sole, and Dover sole; and another deep-water assemblage (greater than 55 m [180 ft] deep) with a species composition that is not clearly understood (Pequegnat et al. 1990). In comparison, fish communities captured in shallow waters at a depth similar to that of SF-3 (18 to 40 m [59 to 130 ft]) consisted mainly of smelt.

Commercially important bottomfish species occurring within the HOODS are English sole, Pacific sanddab, and probably lingcod and California halibut (Table 3-5 summarizes the life histories of these species). The English sole that use the HOODS are primarily adults and older juveniles. Adults live at depths of 20 to 70 m (66 to 230 ft) in the summer and 40 to 130 m (130 to 426 ft) in the winter; larger juveniles move from nearshore to deeper waters and may be found within the HOODS. Adult Pacific sanddab spawn at depths of 35 to 90 m (115 to 295 ft) between July and September, with most spawning activity in August. Juvenile lingcod could potentially use the HOODS since they are found in sandy bottoms from the intertidal zone to depths of 200 m (656 ft). Also, adult California halibut are found in waters as shallow as 55 m (180 ft), and older juvenile California halibut move from shallow bays to deeper offshore water such as the HOODS.

Of the deep-water bottomfish, Dover sole, petrale sole, and juvenile stages of widow rockfish, canary rockfish, bocaccio rockfish, and chilipepper rockfish are likely to occur in the vicinity of the HOODS (Table 3-6 summarizes the life stages of these bottomfish in relation to the importance of nearshore habitats). Juvenile Dover sole and petrale sole are likely to occur within the HOODS during the summer; adults may also occur in this area during their nonspawning period (April to October). Juvenile rockfish are commonly found in shallow waters (less than 37 m [121 ft] deep) in late spring and summer, but older juveniles gradually move offshore as they grow and may occur within the HOODS.

Many commercially important pelagic fish, including anadromous and schooling marine species, may occur in the HOODS (Table 3-7). Adult anadromous fish may pass through the HOODS as they migrate toward Humboldt Bay to spawn, and juveniles may pass through in their seaward migration. Of the schooling marine species, juvenile black rockfish, adult yellowtail rockfish, and juvenile and adult stages of whitebait smelt and night smelt may all occur in the vicinity of the HOODS (Pequegnat et al. 1990).

Results from Humboldt State University's trawl surveys showed a general tendency toward decreased fish abundance and total biomass in the deeper, offshore areas (Pequegnat et al. 1990). The number of fish caught at the HOODS in August (32) was lower than the number of fish caught at the SF-3 site (1,150) during the same survey period. There was also a correspondingly lower total biomass (weight) of fish caught at the HOODS (1,102 grams) compared to the shallower SF-3 site (3,503 grams) (Pequegnat et al. 1990). Similar trends were apparent during the surveys conducted in March.

Species diversity, however, did not decrease in all cases toward offshore sites. In August, the number of species appeared reduced at depths of 55 m (180 ft) and deeper, but in March surveys, species diversity seemed similar at most depths.

The SF-3 Site. SF-3 was surveyed by otter trawls on several occasions in the late 1970s and early 1980s (Lockheed Center 1979). The diversity of fish caught at SF-3 was characteristic of the fishes in the surrounding area. In February 1979, the trawl catches were dominated by Pacific tomcod, pricklebreast poacher, and showy snailfish. Trawl catches were composed primarily of night smelt in May 1983 and speckled sanddab in July 1983. These differences in catch were probably a function of season. In another survey, comparison of the SF-3 catches to catches at a nearby control site at similar depths indicated that fish species diversity and fish abundance were lower at SF-3 than at the control site. In February 1979, 55 individuals of 8 species were collected within the SF-3 site. Just outside SF-3, 178 individuals representing 18 different taxa were found. In the 1983 surveys, the assemblage of fish species was not significantly different between SF-3 and a nearby control site (outside the SF-3 disposal area). However, several species were more abundant at the control site, with a greater biomass than at SF-3. In May, Pacific tomcod were much more abundant at the control site than at SF-3; in July, English sole juveniles were the second most abundant species at the control site while only a few were found at SF-3. As with the benthic communities, differences in fish diversity and abundance were probably the result of the deposition of dredged material. (Winzler and Kelly Consulting Engineers 1984.)

Many nearshore bottomfish found at the SF-3 site are important to commercial and recreational fisheries. Pacific sanddab, English sole, starry flounder, lingcod, and California halibut are found year round (Table 3-5). During the summer, adult English sole are found at depths similar to that of the SF-3 site (average depth of 20 m [66 ft]). Juvenile English sole use shallow (16 m [52 ft] and shallower) sandy bottoms from November to May and may use the SF-3 site as a nursery. Several life stages of Pacific sanddab may use the SF-3 site: adults spawn in shallow (35 to 90 m [115 to 295 ft]) waters from July to September. Juvenile Pacific sanddab reside in the nearshore zone, and adults live in sandy to sand/mud shallow habitats. Adult starry flounder live and spawn in shallow, sandy areas, and juveniles probably reside in the nearshore habitat. The juvenile stages of lingcod and California halibut also may occur in the SF-3 site. Year-old lingcod move into sandy bottom habitats from the intertidal zone to 200 m deep, and juvenile California halibut use shallow, sandy bottoms as they gradually move to more offshore waters.

Commercially important deepwater bottomfish may use the SF-3 site as juveniles (Table 3-6). Dover sole, petrale sole, widow rockfish, canary rockfish, and bocaccio rockfish species all occur in waters with depths similar to those at the SF-3 site.

Commercially important anadromous fish, rockfish, and bay and beach fish may be found at the SF-3 site during all seasons. Adult and juvenile stages of anadromous fish species (chinook salmon, coho salmon, winter-run and summer-run steelhead trout, and coastal cutthroat trout) are found within the SF-3 site year round. Juvenile blue rockfish move to benthic habitats in waters less than 25 m (82 ft) deep from late May to June. Surfperches are also restricted to shallow coastal waters during spawning in spring and early summer. Juvenile surfperch use shallow waters in summer and fall. Night and surf smelt (adults and juveniles) are also common to this area.

Fish populations appeared to be higher at the SF-3 site than at other alternative disposal sites (Pequegnat et al. 1990). Trawl surveys conducted by Humboldt State University showed that fish abundance and biomass were generally higher in nearshore areas; in August samplings, abundance and biomass seemed to be higher in an area near the SF-3 disposal site than at the HOODS or the NDS.

The NDS. Otter trawl surveys were conducted at the NDS in August and November 1989 and March 1990 (Pequegnat et al. 1990). The most common fishes collected were night smelt, larval smelt, and whitebait smelt (93.9% total). Other species collected, in order of declining abundance, were Pacific sanddab, butter sole, Pacific tomcod, spotfin and shiner perch, Pacific sand sole, bay pipefish, larval flatfish, English sole, pricklebreast poacher, juvenile poacher, speckled sanddab, plainfin midshipman, and brown smoothhound. Surveys showed that species diversity and biomass increased by more than 60% between summer and late fall. The highest number of species and greatest biomass occurred in November, and the lowest occurred in August. Also notable was the presence of larval flatfish in the November trawl catch, suggesting that flatfishes use the nearshore zone as a nursery. The fish biomass at the NDS was low as compared to a nearby control site (Pequegnat and Mondeel-Jarvis 1990). An average of 740 grams per trawl was collected at this site, compared to catches in nearby control waters (adjacent to the Samoa Peninsula) of 6,100 grams per trawl and 1,500 grams per trawl in September 1988 and September 1989, respectively.

Since the NDS is similar in depth to SF-3, and because fish assemblages have been shown to vary with depth, the commercially and recreationally valuable fish using this site are probably very similar to those at the SF-3 site. Nearshore bottomfish include English sole, Pacific sanddab, starry flounder, lingcod, and California halibut. Adult English sole may reside within the NDS, and it is likely that juvenile English sole use the site since they are found in sandy, shallow bottoms in less than 16 m (52 ft) of water from November to May. Juvenile and adult stages of Pacific sanddab and starry flounder species prefer sandy, shallow areas nearshore and are also likely to use the NDS. Juveniles of both lingcod and California halibut occur in shallow bottoms and may occur at the NDS. Commercially important demersal fish living in deeper waters that may use this nearshore habitat include Dover sole, petrale sole, widow rockfish, canary rockfish, and bocaccio rockfish (Table 3-6). Juveniles of all of these species settle to the bottom in shallow nearshore waters during late spring and summer.

Pelagic species of commercial importance occurring in the NDS are anadromous species (chinook salmon, coho salmon, winter-run and summer-run steelhead trout, coastal cutthroat trout), blue rockfish, night and surf smelt, and surfperches. Anadromous fish may pass through the NDS throughout the year as adults and juveniles. Juvenile blue rockfish occur in shallow waters less than 25 m (82 ft) deep in late May and June. Smelt spawn in sandy areas near the surf zone; surveys off the Samoa Peninsula found adult smelt in nearshore waters (ERC 1976). Adult surfperches also are restricted to shallow surf areas and spawn in coastal waters; juveniles are found in shallow waters as well.

In August 1989, Humboldt State University's trawl surveys showed that fish abundance and biomass may be lower at the NDS than at the HOODS. However, in March 1990, fish abundance was higher at the NDS, with fish biomass similar to that of the HOODS.

3.3.5 Coastal and Sea Birds

The Humboldt Bay area provides habitat for a large number of migrant and resident bird species. The Bay and coastal area serve as both a stopover point in migration and as an over-wintering area for migratory shorebirds and waterfowl. Shorebirds and wading birds such as turnstones, plovers, and sandpipers are found only near shore and can occur along the shoreline within and outside of Humboldt Bay (see Table 3-9 for scientific names). Coastal species of seabirds and waterfowl such as alcids, loons, cormorants, California brown pelican, gulls, terns, and scoters and other sea ducks also occur throughout the Bay and nearshore waters of the area. Humboldt Bay is an important California breeding site for double-crested cormorants. Small numbers of western gulls breed within the Bay, and snowy plovers nest on the south spit of the Bay. The coastline of the region, including northern Humboldt and Del Norte Counties, provides critical habitat for 41% (13 species) of the state's breeding seabirds (Table 3-9) (Sowles et al. 1980).

The offshore waters of the Humboldt continental shelf provide habitat for seabirds that feed on fish and marine invertebrates at the surface or in the water column. The species likely to use the area for feeding and resting will be those regularly found in continental shelf waters. Common species include those listed above as well as phalaropes, shearwaters, and jaegers (ECI 1988).

Species of concern occurring in the region include the California brown pelican, the short-tailed albatross, the marbled murrelet, and the Aleutian Canada goose (discussed in Section 3.3.7).

3.3.6 Marine Mammals

3.3.6.1 Pinnipeds

Five species of pinnipeds (seals) occur in the Humboldt area. The northern (Steller) sea lion (see Section 3.3.7) and harbor seal breed in the area, and the California sea lion,

Table 3-9. Breeding Seabirds Found in Humboldt and Del Norte Counties

Common Name	Scientific Name
Fork-tailed storm petrel	*Oceanodroma furcata*
Leach's storm petrel	*O. leucorhoa*
Double-crested cormorant	*Phalacrocorax auritus*
Brandt's comorant	*P. penicillatus*
Pelagic comorant	*P. pelagicus*
Black oystercatcher	*Haematopus bachmani*
Western gull	*Larus occidentalis*
Common murre	*Uria aalge*
Pigeon guillemot	*Cepphus columba*
Marbled murrelet	*Brachyramphus marmoratus*
Cassin's auklet	*Ptychoramphus aleuticus*
Rhinoceros auklet	*Cerorhinca monocerata*
Tufted piffin	*Fratercula cirrhata*
Snowy plover	*Charadrins alexandrinus*

Source: Sowles et al. 1980.

northern elephant seal, and northern fur seal use the area for feeding and during migration (ECI 1988).

Humboldt Bay is one of California's most important pupping grounds for harbor seals. Peak numbers (on land) occur in May during the spring breeding season and in June when adults are on land to molt (ECI 1988). Harbor seals are usually found within 10.8 nmi from shore in waters less than 200 m (656 ft) deep (Bonnell et al. 1983).

The California sea lion is the most frequently sighted pinniped in the area. Sea lions migrate to and from breeding grounds in southern California and the Baja Peninsula. Major haul-out sites in the Humboldt region are to the north of Humboldt Bay at St. George Reef and Castle Rock (ECI 1988). The number of sea lions in the area peaks in September and October during the northward migration and again in May during their southward migration (ECI 1988).

Northern elephant seals occur regularly off Humboldt County in spring and summer after the winter breeding season (December-March) as pelagic, widely dispersed, solitary feeders. Northern fur seals occur seasonally in the region from December to June, mostly offshore along the continental shelf and shelf break. (ECI 1988.)

3.3.6.2 Cetaceans

At least 20 species of cetaceans (whales and dolphins) have been recorded in waters off of Humboldt Bay, and about half of these can be considered relatively common. The most common continental shelf species in the area are the harbor porpoise and the gray whale. Harbor porpoises are present throughout the year but are seen more frequently during fall, usually within 0.5 nmi of shore (ECI 1988) in waters 30 to 80 m (98 to 262 ft) deep.

The gray whale is the most common cetacean in the nearshore coastal waters and has recently been removed from the federal list of threatened or endangered species. Gray whales migrate south in December and January and north from March through May, usually passing within 0.8 to 4.3 nmi of the shore (ECI 1988). Gray whales pass closest to shore during spring migration when cows with calves stay close to the shoreline. Gray whales may feed during migration, particularly during the northward migration when females are with young. Their diet consists of soft-bottom benthic invertebrates found at depths of 9 to 40 m (30 to 131 ft) as well as dense swarms of shrimp and spawning squid (Jones et al. 1984). Dohl et al. (1983) noted that gray whales avoid very turbid water and change direction when approaching large river plumes such as the ones off the Klamath and Eel Rivers and San Francisco Bay during periods of heavy runoff.

Humpback whales are found in nearshore waters during their annual migrations between the southern winter breeding grounds and the feeding areas in Alaska. Minke whales also occur in nearshore waters. Other less common large migrant cetaceans in the area include the blue whale, finback whale, and sperm whale. These species generally occur in deeper waters, offshore from the HOODS.

Other common smaller cetaceans in waters off of Humboldt Bay are the Pacific white-sided dolphin, northern right-whale, Dall's porpoise, and Risso's dolphin. These species also occur primarily in deeper waters offshore from the HOODS. All but the northern right-whale also occur in smaller numbers in shelf waters (ECI 1988).

3.3.7 Threatened and Endangered Species

Four birds, four cetaceans, a pinniped, a marine turtle, and a fish that are federally and/or state listed as threatened or endangered may occur in the region: the California brown pelican, the marbled murrelet, the short-tailed albatross, and the Aleutian Canada goose; the humpback, blue, finback, and sperm whales; the northern (Steller) sea lion; the leatherback turtle; and the winter-run chinook salmon (Table 3-10).

The brown pelican is found in estuarine, coastal, and oceanic waters along the California coast. In northern California, pelicans are common from June through November and rare to uncommon from December to May (ECI 1988). In other areas of California, they breed from March to July on the Channel Islands at Anacapa Island and near Santa Barbara Island. Breeding also occurs on islands off the Pacific Baja California coast of Mexico and in the Gulf of California (Sowles et al. 1980). Pelicans feed during daylight hours, mostly on small schooling fish. They are plunge divers and prefer clear waters for easy prey detection. Because their feathers are wettable, pelicans usually forage within 8 nmi of shore and return to specific coastal roosts for the evening, usually arriving by late afternoon (Schrieber and Clapp 1987). Within the area of study, pelicans use the south spit of Humboldt Bay for roosting.

Marbled murrelet populations have been reduced by logging of old-growth forests where these birds nest. In California, the marbled murrelet is found from the Oregon border south to Santa Cruz. During the summer breeding season, murrelets concentrate nearshore closer to their nests. Marbled murrelets feed on fish they catch by surface diving within 1 nmi of shore in depths of 30 m (98 ft) (Ehrlich et al. 1988).

The short-tailed albatross was once abundant in the northwest Pacific and off northern California but was thought to be extinct by the late 1940s. By 1954, a few birds had returned to nest on Torishima, an island south of Japan. The present worldwide population is estimated at 250. North American sightings in recent years have been mainly from Alaska, although two have been recorded in California. Prior to their population decline, short-tailed albatrosses flew in large flocks offshore (Harrison 1983, Stallcup 1990). Their diet consists of fish, shrimp, and squid.

The Aleutian Canada goose is a subspecies of the Canada goose and prefers lacustrine, fresh emergent wetlands, moist grasslands, croplands, pastures, and meadow habitats. It feeds on green shoots, seeds, wild grasses, forbs, and aquatic plants. In northeastern California, it nests mainly from March to June and prefers to nest near water on a dry, slightly elevated site, with good visibility from the nest. It will also use man-made structures such as platforms, baskets, and artificial rock islands. Approximately 12,000 geese

Table 3-10. Federally Listed Threatened or Endangered Marine Species Occurring in the Project Region

Common Name	Scientific Name	Status
Cetaceans		
Blue whale	*Balenoptera musculus*	Endangered
Fin whale	*B. physalus*	Endangered
Humpback whale	*Megaptera novengliae*	Endangered
Sperm whale	*Physter catodon*	Endangered
Pennipeds		
Northern (Steller) sea lion	*Eumetopias jubatus*	Endangered
Sea Turtles		
Leatherback sea turtle	*Dermochelys coriacea*	Endangered
Sea Birds		
California brown pelican	*Pelicanus occidentalis*	Endangered
Short-tailed albatross	*Diomedea albatrus*	Endangered
Marbled murrelet	*Brachyramphus marmoratus*	Endangered
Aleutian Canada goose	*Branta canadensis leucopareia*	Endangered
Fish		
Winter-run chinook salmon	*Onchorhynchus tshawytscha*	Endangered

were counted in a 1993 USFWS survey in Crescent City (Shoulak and Kay 1994). Historically, Humboldt County has been used as an important staging area during spring and fall migration; however, since their population levels are low, use of the project area by the Aleutian Canada goose is unpredictable (USFWS 1994).

The humpback whale has a worldwide range. The summer feeding grounds range from the coasts of Japan and southern California north to the Chukchi Sea. Humpback whales typically can be found off the California coastline from approximately March through January, with the greatest concentrations occurring from mid-August through October (Dohl et al. 1983). According to recent National Marine Fisheries Service (NMFS) surveys conducted in 1991 and 1993, approximately 600 humpbacks were counted off the California coast (Shoulak and Kay 1994).

Summer feeding occurs from the Aleutian Islands to the Farallon Islands off central California. Humpback whales feed on baitfish, euphausiids, pelagic crabs, and a variety of other prey in the summer and early fall.

Similar to humpback whales, blue whales are pelagic and may occur offshore from Humboldt Bay in summer and early fall. Blue whales are usually found in continental slope and deeper waters. Because their primary food is euphausiids, they almost always occur within 200 nmi of the continental shelf. Off northern and central California, Dohl et al. (1983) noted blue whales in waters from 80 to 3,600 m (262 to 11,800 ft) deep, and recent NMFS surveys have counted approximately 2,200 blue whales off the California coast (Shoulak and Kay 1994).

The finback whale ranges in the Pacific from the Bering Sea to Cabo San Lucas, Baja California. They are most abundant off northern and central California during summer and autumn; approximately 985 were recorded in recent NMFS surveys. The finback whale feeds on small fish, pelagic crustaceans, and squid.

The sperm whale occurs in deep oceanic waters and is rarely reported over the shelf. Sperm whales range in the Pacific from the Bering Sea to the equator. They are deep divers and prey mostly upon large squid, skate, and bottomfish.

The northern (Steller) sea lion was recently listed as threatened because of a worldwide decline in populations. The cause for their decline in California is unclear; several factors may be acting synergistically, including infertility due to pollutants and disease, interspecific competition with California sea lions, and a depleted food source. Northern sea lion populations have been declining throughout their range over the past two decades. Recent counts in Alaska indicate that northern sea lion populations have declined by 70% since 1979 (Sease et al. 1993). Waters off Humboldt Bay are not identified as critical habitat for this species.

The endangered leatherback turtle is the only marine turtle that commonly occurs in the offshore waters of northern California; however, it is unlikely to occur in nearshore waters in this region due to its pelagic habits (Dames and Moore 1981).

Winter-run chinook salmon, an anadromous species, reside as adults off the Pacific coast, including areas off Humboldt Bay (USFWS 1994). Adult chinook salmon tend to be opportunistic feeders, their diet consisting primarily of krill, larval crabs, and fish. Waters off Humboldt Bay have not been identified as critical habitat for this species.

The NMFS is reviewing petitions to list coastwide populations of coho salmon and steelhead trout. The NMFS is expecting to publish their determination for listing (warranted, not warranted, or warranted but precluded from listing actions for other higher priority species) soon (previous deadlines have expired). Like chinook salmon, coho salmon and steelhead trout may reside as adults off the Pacific coast, including areas off Humboldt County.

3.3.8 Potential for Development of Nuisance Species

Dredged material that is high in organic content or contaminants may promote conditions favorable to the growth of nuisance species. Opportunistic or pollution-tolerant species can dominate disturbed or contaminated substrates and prevent recolonization by the surrounding benthic fauna (SAIC 1986). Examples of nuisance species previously reported in organically enriched contaminated sediments include the polychaetes *Capitella capitata* and *Streblospio benedicti* (Pearson and Rosenberg 1978).

Opportunistic and generalist species commonly occur in the benthic fauna offshore of Humboldt Bay, especially in the nearshore zone. These species respond to the availability of uncolonized substrate and not to the presence of organically enriched or contaminated sediments. Winzler and Kelly Consulting Engineers (1984) observed the changes in benthic fauna following the disposal of dredged material offshore of Humboldt Bay and found that opportunistic fauna were composed of small, surface-dwelling crustaceans, gastropods, and polychaetes.

Pequegnat et al. (1990) reported the polychaete *Ophelia assimilis* in the sediments at the NDS following disposal of dredged material. This organism has been reported in high densities in the channels in Humboldt Bay and is a generalist with regard to substrate. Pequegnat et al. (1990) did not find *O. assimilis* at sufficient densities to consider it a nuisance species.

Since the sediment dredged from Humboldt Bay has a high sand content and is low in organics and contaminants, disposal of the material at any of the alternative sites should not promote the development of nuisance species over the long term. Previous examinations of the benthic fauna present at the SF-3 site and at the NDS support this prediction (Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990).

3.4 SOCIOECONOMIC ENVIRONMENT

3.4.1 Commercial Fishing

Humboldt County has a long history of commercial fishing and ranks as one of the most productive areas on the west coast. A variety of fish and shellfish are caught year round in waters adjacent to the County. About 500 vessels fish primarily out of Eureka, Field's Landing, Trinidad, King Salmon, and Shelter Cove, and land seafood with a dockside value of $10 to 20 million annually (Corps/HBHRCD 1994). Seafood processors in Eureka and Field's Landing fillet, pack seafood, and ship Humboldt County products throughout the United States and overseas.

There are 45 marine species that contribute to the commercial fishing effort. Oyster culture is the largest commercial fishing activity within Humboldt Bay itself and is limited to the North Bay, where a small amount of sea perch and clam are also taken. In other areas, the primary fishes caught commercially are groundfish (flatfish and rockfish), albacore tuna, Dungeness crab, and salmon. Flatfishes averaged 31% to 42% of the total annual landings for Humboldt Bay region from 1981 to 1985 (Barnhart et al. 1989), with Dover sole and English sole being the most important of these. Rockfish are caught by commercial fishermen outside the Bay and comprised 25% to 31% of the commercial landings from 1981 to 1985. Salmon is the most valuable finfish on a per pound basis, but landings in recent years have been greatly reduced due to declines in salmon runs and a restricted commercial season.

During the 1981 to 1985 period, commercial fishermen annually landed an average of nearly 1.6 million pounds of Dungeness crab, worth over $1.4 million, at Eureka (Corps/HBHRCD 1994). The Bay supports a minor commercial fishery for sevengill and leopard sharks, which are caught by hook and line and drift gill nets. There is a commercial gill net fishery each winter in Arcata Bay for adult herring, primarily to obtain herring roe, which is exported to Japan, and there is a live anchovy bait fishery by albacore fishermen in the fall. A minor commercial fishery for surfperch exists, primarily for redtail, which are captured by beach seine and hook and line.

3.4.2 Commercial Shipping

Humboldt Bay is the only harbor between San Francisco, California, and Coos Bay, Oregon, with channels deep enough to permit passage of large, commercial ocean-going vessels. In 1988, 120 deep-draft vessel trips accounted for 1,145,922 tons of commerce, consisting of woodchips, pulp, logs, lumber, petroleum, and particle and fiber board. Historically, annual deep-draft tonnage accounts for approximately 70% of the total annual tonnage passing through the Harbor, with all but petroleum representing exports (Corps/HBHRCD 1994).

3.4.3 Recreational Activities

Humboldt Bay provides a multitude of outdoor recreational opportunities associated with its biological resources. The unique combination of redwood forests, rocky headlands, sandy beaches, and estuaries makes the Humboldt County coastline particularly attractive. The number of visitors to the area is increasing, and their importance to the local economy is high. Cold air and water temperatures limit the use of the area for swimming, waterskiing, and other such water contact sports. The greatest use is, therefore, closely tied to fish, wildlife, and aesthetic values. Use of these resources can be divided into two types: appropriative and nonappropriative uses. Appropriative uses involve the actual removal of individual units such as fish or game. Nonappropriative uses involve the same resources but without any removal -- activities such as nature study, photography, or wildlife observations. Both of these are important and each has its place in the overall recreational picture.

3.4.4 Hunting

The most significant appropriative use in the immediate area of the Bay is waterfowl hunting, which is estimated to supply over 25,000 hunter-days of recreation annually (Monroe 1973). Most hunting is done from temporary or permanent blinds along the shorelines of the Bay, marshes, sloughs, and agricultural lands. Another popular waterfowl hunting style here, which is rarely seen in other parts of the state, is known as sculling. This is accomplished by approaching rafted birds on open water in a uniquely designed low-profile boat. These vessels are highly efficient when in the hands of a skilled operator.

The regular waterfowl season usually opens in October and extends into January. The black brant season opens in November and ends in late February. Humboldt Bay is the most important brant hunting area in California, contributing up to 75% of the total state kill. Wilson's snipe is a bird found in salt marshes, freshwater marshes, and wet pasturelands adjacent to the Bay, and these are also hunted on a limited scale over a season that coincides with the waterfowl season. There are many private hunting clubs in operation, and many private landowners permit hunting on their farmlands. Upland game hunting species include pheasant, quail, dove, bandtailed pigeon, grouse, squirrel, and rabbit. Deer hunting is the major appropriative use of big game. (Corps/HBHRCD 1994.)

3.4.5 Sportfishing

Humboldt Bay is one of the primary sportfishing areas in California. Anglers fishing in the Bay catch at least 41 species of fish as well as collecting oysters, 10 species of clams, and 3 species of crabs. Animals such as shore crabs and ghost shrimp are collected by fishermen for bait, thereby indirectly contributing to sport fishing activities. Seven of California's 12 shellfish reserves are within Humboldt Bay. These areas are state lands that have been set aside for clam digging and native oyster taking by the public, as authorized by the State Fish and Game Code.

Sport clam diggers operate mostly in the South Bay due to the easier access to and greater abundance of the more desirable clams. The most popular areas are the northern end of Clam Island and Buhne Point. The clamming that takes place in Arcata Bay is focused on Indian Island, Bird Island, San Island, and along the Mad River Channel. Of the 25 species of clam found, only 10 are harvested to any extent. These include two species of gaper clams, two species of Washington clams, the littleneck clam, basket cockle, softshell clam, bentnose clam, geoduck, and rough piddock. Mussels and native oysters are also taken in Arcata Bay, the greatest abundance of these being north of Woodley Island and within the Arcata Channel. Sport crabbers usually operate in the winter months and catch market, red, and rock crabs.

The fishing effort can be separated into shore, pier, skiff, and skindiving categories. Shore fishing is the most popular type of sport fishing effort and takes the form of surf-casting, surf-netting, and rocky shore fishing. Shore anglers operate predominantly on the South Jetty and Buhne Point Jetty and catch the widest variety of species, approximately 27 different kinds. These include surfperches, night and surf smelt, blennies, greenlings, rockfish, flatfish, and salmon. Salmonids are caught during the summer at the entrance, particularly from the jetties or in a boat between the jetties, but most are caught in the nearshore waters outside the Bay.

Some 10,000 to 15,000 anglers operate from 500 boats out of Humboldt Bay annually. The Pacific Fishery Management Council reported that for the years from 1971 to 1975, recreational salmon anglers fished an average of 40,000 angler days out of the Bay and averaged about 10,000 chinook salmon. Salmon anglers took 26,000 chinook in 1985 from ports on the Bay. Several licensed party boats operate from Humboldt Bay, predominantly from June through September. Salmon and crabs have been the target species.

Pier anglers catch the most sport-caught fish in terms of tonnage. Given the general area in which these structures are located, this type of fishing is limited to surf-frequenting species, bottom-dwellers, and surface-feeders. Smelt dipping is popular and makes up a large portion of the angling catch taken from piers. Greenling and lingcod are usually taken from the jetties and other rocky areas but also occur in waters of mud flats and channels. Rockfish as well as surfperch are commonly caught by anglers fishing from the jetties.

Humboldt Bay supports a very active marine skiff fishing center and is the most important area in Northern California for this effort. Most skiff fishing occurs during the summer and fall, and the fishery is showing a growing trend. Harvest by skindivers is increasing in popularity, and target species include lingcod, seaperch, rockfish, kelp greenling, and cabezon. Divers are also in search of abalone, sea urchins, shells, coral, and clams.

3.4.6 Nature Study

Nonappropriative uses of the Bay constitute by far the heaviest recreational use. These include nature study, wildlife observation, and photography, and are enjoyed by residents and visitors in excess of 135,000 user days annually. The Humboldt Bay National Wildlife Refuge is a location for many of these uses, and the number of people engaging in these activities is increasing. The Audubon Society and the Sierra Club are among the environmental organizations with local chapters in the Humboldt area.

3.4.7 Scientific and Educational Use

Humboldt Bay, with its wealth of natural resources and physical features, is highly attractive for educational and scientific purposes. It offers almost unlimited possibilities for the study of natural history, ecology, and marine sciences. The College of the Redwoods and Humboldt State University are located close to the Bay, and these institutions provide research results on the many facets of the Bay environment. High school and grammar school classes also use the Bay and its resources for field trips and classroom work, both of which have become a regular part of many school conservation programs. Scientific use of the Bay is also made by many governmental agencies, independent foundations, and private industry, as is evidenced by the hundreds of publications on record concerning the Bay and its resources. These uses are expected to increase.

3.4.8 Cultural Resources

The ocean waters in the vicinity of Humboldt Bay have been the site of numerous vessel accidents and sinkings. Coordination with the California Office of Historic Preservation and the State Lands Commission has indicated that several ships have been reported as sinking in the vicinity of the HOODS. No shipwrecks are recorded as situated within the disposal site.

To assist in identifying the possible presence of marine archaeological properties at the HOODS, an archaeological survey (magnetometer and side-scan sonar) was completed in 1990, under contract to the Corps. A report entitled Historic Shipwreck Survey of the Humboldt Bay Dredged Material Disposal Site (Land and Sea Surveys/BioSystems - copy available from the Corps) was issued in 1991. This project was coordinated with the State Historic Preservation Officer and the National Park Service, including submittal of review copies of the report. Numerous magnetic and sonar anomalies were identified within the HOODS. Three of the identified seafloor features were interpreted as potential shipwreck locations. No further investigation of the suspected wrecks was conducted, but such study was recommended should disposal possibly affect these locations. Subsequent to the marine survey, these potential locations were avoided during disposal of dredged materials from maintenance dredging projects.

3.4.9 Public Health and Welfare

Ensuring that public health and welfare are not adversely affected by ocean disposal of dredged materials is a primary concern. Here only two issues, health and safety, are discussed.

Health hazards may arise if the chemical nature of the dredged materials has the potential to cause bioaccumulation of toxic substances in organisms. Potential impacts on human health can be inferred from bioassay and bioaccumulation tests performed on marine mammals. Since marine waters, including those at the HOODS and at other alternative sites, provide a large amount of fish and invertebrates for human consumption, the public health issue gains added importance. Green Book testing requirements for proposed dredged materials are intended to minimize these risks.

The disposal of dredged material could present safety hazards to navigation either as a result of mounding within the disposal site or as a result of the disposal barges interfering with shipping traffic. Mounding effects on wave height which would affect navigation would only occur if sediments accumulating at the disposal site were shallow enough to interact with waves. This has occurred at the NDS and the SF-3 site. Potential mounding effects on waves at the HOODS site are discussed under Section 4.2.1.2.

Section 4

Environmental Consequences

Section 4. Environmental Consequences

4.1 INTRODUCTION

The purpose of this section is to provide a detailed discussion of the potential impacts of the proposed and alternative actions on the physical, biological, and socioeconomic environment. This DEIS has been prepared in accordance with the National Environmental Policy Act (NEPA) guidelines. Potential impacts identified in this section are classified according to the following scheme (modeled after EPA 1988):

- **Significant adverse impacts that cannot be mitigated to insignificance.** No measures can be taken to avoid or reduce the adverse impacts to insignificant or negligible levels.

- **Significant adverse impacts that can be mitigated to insignificance.** These impacts potentially are similar in magnitude to nonmitigatable impacts, but the severity can be reduced or avoided by implementation of specific mitigation measures.

- **Adverse but insignificant impacts or no effects anticipated.** No mitigation measures are necessary to reduce the magnitude or severity of these impacts.

- **Beneficial effects.** These effects could improve conditions relative to existing or preproject conditions. These can be classified further as significant or insignificant beneficial effects.

The definition of "significant" under the NEPA guidelines (40 CFR 1508.27) requires the consideration of both the context and intensity of the impact. The context of an impact refers to analyzing the impact in relation to society (human, national), the affected region (localized or regional), the affected interests, and the locality. Both short-term and long-term effects are relevant.

Intensity of an impact refers to the severity of the impact. The following factors need to be considered in the evaluation of the intensity of an impact:

- Impacts may be either beneficial or adverse. A significant effect may exist even if the federal agency believes that on balance the effect will be beneficial.

- The degree to which the proposed action affects public health or safety.

- Unique characteristics of the geographical area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

- The degree to which the effects on the quality of the human or ecological environment are likely to be highly controversial.

- The degree to which the possible effects on the human or ecological environment are highly uncertain or involve unique or unknown risks.

- The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

- The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.

- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

- Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.

Based on these broad definitions, significance criteria were developed and applied to the environmental impact assessment for each of the resource areas evaluated in this DEIS. Specific significance criteria for physical, biological, and socioeconomic resources are presented at the beginning of each section.

The following sections identify potential impacts associated with the designation of the HOODS or the alternative sites. Additional mitigation sections are included where significant impacts are identified.

4.2 THE HOODS - THE PREFERRED ALTERNATIVE

4.2.1 Physical Environment

4.2.1.1 Air Quality

Project Significance Criteria. Significance criteria for air quality impacts are based on federal, state, and local air pollution standards and regulations. An impact was considered significant if project emissions are projected to:

- increase ambient pollutant levels from below to above federal or state air quality standards; or
- substantially contribute to an existing or projected air quality standard violation.

Project Impacts. No significant impacts to regional air quality are expected as a result of the proposed designation of the HOODS as the regional ODMDS (Corps/HBHRCD 1994). Although combined regional emissions sometimes result in exceedance of regional air quality criteria (PM_{10}), exhaust emissions from annual maintenance dredging and disposal operations are not expected to increase from present levels. Emissions associated with the transport and disposal of dredged materials at the HOODS are not expected to adversely impact any sensitive receptors.

Potential air quality impacts associated with the proposed Harbor and Bay Deepening Project are discussed in the draft EIR/EIS for that project, and will not be discussed in detail in this DEIS. Briefly, as a worst case, the deepening project is expected to result in exceedance of NCUAQMD criteria for NO_x and PM_{10}. However, disposal of dredged materials at the HOODS would not cause emissions significantly different than those generated by disposal at any of the alternative sites.

Mitigation. The Corps will operate equipment in a manner which minimizes emissions, including avoidance of unnecessarily idling construction equipment. Additional mitigation measures that would reduce potential air quality problems include obtaining and complying with all required AQMD and NCUAQMD permits and applicable rules and regulations.

4.2.1.2 Physical Oceanography

Project Significance Criteria. Impacts of the proposed and alternative actions on physical oceanography were considered significant if the project would:

- produce any measurable effect on regional or site-specific physical oceanographic conditions (i.e., waves or currents); or

- substantially change the character of sediments at the disposal site.

Project Impacts. Disposal of dredged material at the HOODS is expected to result in accumulation of dredged material over the seafloor, changes in the bathymetry, and slight changes in sediment characteristics within the site. Over the 50-year life of the site (a site capacity of 50,000,000 yd^3), accumulations of material and changes in bathymetry could be substantial. Assuming the dredged material is distributed evenly across the site and there is no transport of material outside of the site, the depth of the site would be reduced by 11 m (36 ft) over the 50-year life of the site.

Numerical modeling of sediment dispersion indicated that, due to the relatively weak bottom currents, the HOODS is a non-dispersive site (Scheffner 1990). Accumulations at other sites (site SF-3 and the NDS) have resulted in the creation of adverse sea surface conditions by waves shoaling on the accumulated mounds of dredged material. The HOODS site is located in much deeper water (49 to 55 m [160 to 180 ft]) than the SF-3 site and the NDS (less than 18 m [60 ft]). Therefore, the potential for adverse sea surface conditions or wave refraction caused by mounding of sediments at the HOODS is much lower than at the shallower sites.

Disposal of dredged material which is dissimilar in character to bottom sediments can potentially adversely affect the recolonization of the site by benthic fauna. The HOODS is located between the 49 and 55 m (160 to 180 ft) depth contours, which is generally described as the mud-sand transition zone. General physical impacts to the character of the seafloor within the site can be minimized by disposing of sandy materials at sandy areas within the HOODS, and disposing of finer materials at locations within the HOODS with siltier bottom conditions.

Mitigation. Although significant impacts to sediment characteristics are not anticipated under the proposed action, accumulations of dredged material are unavoidable. To minimize the significance of disposal impacts on the site, several mitigation measures have been included in the site management and monitoring plan including:

- Periodic surveys of the entire site will be conducted to determine changes in bathymetry.

- Accurate positioning of the hopper dredge will used to ensure that dredged material is deposited over seafloor areas within the site with similar sediment character.

- A Dredge Data Logging System (DDLS) will be used as a monitoring and surveillance tool on contract hopper dredges. Disposal logs will be maintained and spot inspection will be performed during disposal operations.

- Hopper dredges will not be overloaded to minimize the potential for accidental spillage of materials outside the HOODS.

4.2.1.3 Water Quality

Project Significance Criteria. Significance criteria for water quality impacts are based on federal, state, and local water quality criteria and regulations, and the potential for long-term degradation or endangerment to the environment.

Project Impacts. No significant, long-term water quality impacts are anticipated to occur as a result of designation of the HOODS as the regional ODMDS. Dredged material disposal typically has a short-term (several hours to days) localized impact on the water column. Water quality variables which could be temporarily affected by disposal of dredged material from Humboldt Bay include: total suspended solids, light transmittance through the water column, dissolved oxygen, and nutrients. Materials dredged from Humboldt Bay during routine dredging operations have not been found to contain significant concentrations of potentially toxic substances. Any materials proposed for disposal at the site will be tested and approved in accordance with EPA Ocean Dumping Regulations (40 CFR 227) and EPA/Corps testing guidelines (EPA/Corps 1991 "Greenbook") prior to disposal at the HOODS.

The disposal of dredged material in the marine environment occurs through three major phases (convective descent, dynamic collapse, and passive dispersion) which affect the behavior of the material in the water column and the nature of the deposit on the bottom. The convective descent phase occurs as the majority of the dredged material falls to the bottom as a concentrated cloud under the influence of gravity. Dynamic collapse occurs as the downward momentum of the cloud is converted to horizontal dispersion of the material as it contacts the bottom. Passive diffusion occurs following the loss of momentum when ambient currents and turbulence act as the major forces of dispersion.

Dredged materials to be disposed of at the HOODS during maintenance dredging operations are primarily coarse sand, with a smaller volume of sediment characterized as sand/silt. Coarser materials fall relatively rapidly to the bottom. Finer materials can remain in the water column for longer periods of time. Numerical models can provide reasonable estimates of the transport and fate of coarser materials (Koh and Chang 1973). The fate and transport of finer material are difficult to model because some fraction of the finer material descends as relatively large aggregates. However, some fraction of the finer materials remains in suspension in the water column following disposal operations. The ultimate fate of this suspended material depends primarily on its settling rate and the ambient currents and water column conditions at the disposal site at the time of disposal.

Mitigation. Short-term water quality (primarily turbidity) impacts during disposal operations are unavoidable. To minimize potentially significant impacts to water quality, sediments will be chemically analyzed in order to determine suitability for disposal at the HOODS. A chemical characterization study of sediments dredged during annual maintenance dredging of federal channels in Humboldt Bay is currently being performed. Based on the results of this study, a schedule of sediment quality studies for these channels will be established and become a part of the site management and monitoring program.

Sediments dredged as part of the proposed Harbor and Bay Deepening Project have been tested (Corps/HBHRCD 1994). The Corps proposes to dispose of the materials acceptable for unconfined ocean disposal at the HOODS. The Corps proposes to dispose of unacceptable materials at a confined upland site.

Any dredged materials from non-federal projects would also require testing in order to determine suitability for ocean disposal at the HOODS.

4.2.2 Biological Environment

4.2.2.1 Project Significance Criteria

A biological impact was considered significant if it:

- is expected to affect the population status of a state or federally listed, proposed, or candidate threatened or endangered species or is expected to affect the breeding or foraging habitat of such species so as to result in increased mortality or reduced reproductive success;
- causes the loss or long-term degradation of any environmentally sensitive species;
- interferes substantially with the movement of any resident or migratory fish or wildlife species; or
- causes a measurable change in species composition or abundance of a sensitive community or causes a substantial, long-term change to marine habitats.

4.2.2.2 Phytoplankton

Project Impacts. The disposal of dredged material at the preferred site may cause mortality to phytoplankton due to entrainment in the sediment plume and may temporarily reduce phytoplankton production by increasing turbidity, consequently reducing light available to algae. However, the increased turbidity produced during disposal of dredge spoils is localized and temporary, and the impacts are expected to be insignificant compared to natural fluctuations in primary production (Copeland and Dickens 1974, Hirsch et al. 1978). The pelagic environment offshore of Humboldt Bay is seasonally subjected to large amounts of suspended sediments discharging from the Eel River and Humboldt Bay. The impact from the disposal of the projected amounts of maintenance dredged materials at the HOODS is not expected to have any significant long-term adverse effects on the phytoplankton offshore of Humboldt Bay.

4.2.2.3 Zooplankton

Project Impacts. Impacts on zooplankton, including planktonic larvae of fish and invertebrates, as a result of dredged material disposal may include mortality due to entrainment in the sediment plume and interference with filter feeding caused by a temporary increase in suspended sediments. These impacts are expected to be short-term and localized and not significantly affect planktonic conditions over the nearshore waters in the region.

4.2.2.4 Benthic Algae

Project Impacts. Disposal of dredged material at the preferred site would not have any significant short-term or long-term effects on the benthic algae communities in the area. The only significant benthic algae communities in the study area are along the intertidal and subtidal portions of the jetties. Disposal operations are not expected to affect the limited algal communities along the jetties because those communities are about 3 nmi from the HOODS.

4.2.2.5 Benthic Infauna

Project Impacts. Survival of organisms varies according to species and their ability to burrow through the sediments; it also depends on the thickness of disposed materials (Hirsch et al. 1978). Direct mortality due to burial of organisms and reductions in the number of species and the abundance of infaunal organisms is expected to be restricted to the immediate disposal area (Oliver and Slattery 1976, Scott et al. 1987, Hirsch et al. 1978). Recolonization by opportunistic species occurs within 3 to 6 months (Bingham 1977, Scott et al. 1987).

The most permanent impact of dredged material disposal is a change in substrate (Tatem 1984). Although the grain size of the substrate at the HOODS ranges from approximately 50% sand in the easterly cells to approximately 10% sand in the westerly cells (Pequegnat et al. 1990), the sediments dredged from Humboldt Bay are predominantly sand (approximately 85% to 90%). Many benthic invertebrates will be unable to move through the spoils, and the lateral migration of adults from the adjacent benthic community will be hindered because those individuals are adapted to finer-grained sediments (Hirsch et al. 1978). In addition, the planktonic larvae of many benthic invertebrates respond to specific cues, including grain size of the substrate, for settlement and metamorphosis (Meadows and Campbell 1972). Dexter et al. (1984) found that although the sediments at a dredged material disposal site in Elliott Bay, Washington, were sandier than ambient sediments, 3 years after disposal there was a greater abundance and biomass of benthic invertebrates in the dredged spoils mound than in the surrounding area. However, this may have been the result of organisms introduced by currents around the mound (Tatem 1984).

From previous observations of macrobenthic recolonization at dredged material disposal sites, it is expected that after the dredged material is deposited, the initial recolonization will be by motile, short-lived, shallow-burrowing, opportunistic species, probably small crustaceans (e.g., amphipods and cumaceans) and polychaetes (Oliver and Slattery 1976, Winzler and Kelly Consulting Engineers 1984). Deposit-feeding fauna will have a more difficult time recolonizing because the low organic content and coarseness of the dredged spoils are not conducive to burrowing infauna. The rate at which the benthic community at the HOODS recovers will depend on the length of time between disposal operations. Recolonization of a diverse and stable benthic assemblage at the HOODS would probably be complete for 1 to 3 years after the cessation of all disposal operations (Dillon 1984, Scott et al. 1987). Hence, impacts of dredged material disposal on the benthic infauna community within the disposal area are expected to be significant but localized.

Mitigation. Several operational procedures are designed to minimize potential impacts to benthic infauna. The selection of the HOODS was based in part on the sediment characteristics of the site. The HOODS lies within a mud-sand transition zone with fine sand to sandy silt substrates in the eastern portion of the site, and silty sands and clay in the western portion of the site. The variability in substrate composition allows the disposal of dredged materials on bottom substrates of similar character.

Significant accumulations of dredged materials and associated burial of infaunal organisms is an unavoidable significant impact within the site. Numerical modeling conducted by the Corps and a sediment dispersion analysis performed by Scheffner (1990) for the HOODS concluded that the site is non-dispersive. To ensure that impacts to benthos are isolated to the site, the Corps is conducting post-disposal bathymetric surveys to verify the non-dispersive nature of the site. The Corps requires that accurate positioning is used during disposal events and that performance data (position, time, draft, disposal area) be collected via DDLS to verify dredged material disposal within the site. The Corps will also be required by EPA to conduct periodic monitoring to verify the nontoxic nature of disposed sediments, and that significant quantities of sediments have not been transported out of the HOODS.

4.2.2.6 Benthic Epifauna

Project Impacts. Of particular concern is the potential impact of disposal operations on Dungeness crab. The impacts on planktonic larval stages (zooplankton) were discussed above. Dredged material disposal operations offshore of Humboldt Bay generally occur during April and May, when Dungeness crabs are mating in shallow, sandy areas; and in September and October, when egg-brooding females partially bury themselves in the sand in the shallow subtidal areas. Juvenile Dungeness crabs settle in shallow offshore areas from April to July. During these critical life stages, Dungeness crabs caught beneath the disposal plume would be smothered. With regard to the alteration in sediment type following disposal, however, Dungeness crabs are found in association with a range of substrates, so this change should not have a detrimental effect on colonization of the site by crabs.

Because the HOODS is located in waters deeper than those usually associated with Dungeness crabs at their critical life stages, few Dungeness crabs are expected to be affected. The HOODS has not been identified as a critical habitat for any life stages of Dungeness crab or any other epifaunal species reported in this area. Since the impacts will be short-term and restricted to the area within the disposal site boundaries, significant long-term impacts on Dungeness crabs and other epifauna populations in the study area are not expected.

4.2.2.7 Pelagic Invertebrates

Project Impacts. The HOODS is not known to provide critical spawning habitat for the market squid *Loligo opalescens*. In addition, this species is highly mobile and would be able to avoid the disposal plume. Although this species has been reported to be a component of the biological community offshore of Humboldt Bay, there is no evidence that this species would be adversely affected by dredged material disposal at the preferred site.

4.2.2.8 Demersal Fishes

Project Impacts. Disposal of dredged material at the HOODS is likely to adversely affect the demersal fishes. The immediate local effect of dredged material disposal would be the burial of adult and juvenile bottomfish as well as their epifaunal and infaunal food resources. After dredged material is dumped, much of the fine-grained sediment would remain suspended near the ocean floor (Hirsch et al. 1978). This may physically stress fish by clogging their gills and reducing the absorption of dissolved oxygen. Adults can avoid suspended material by moving out of the area, but juvenile fish may be more vulnerable and susceptible to stress (SAIC 1986). Sediments can remain suspended for weeks or months, and areas outside of the immediate disposal area might be affected if bottom currents transport suspended sediments. The HOODS, however, is far enough offshore (3 to 4 nmi) that, except during storms, bottom current velocities are small, and suspended sediments are not expected to move beyond the disposal area (Scheffner 1990).

Over the long term, dredged material disposal at the HOODS may result in a localized decrease in species diversity and abundance. Previous studies at the NDS and SF-3 indicate that past disposal actions have adversely affected demersal fish fauna (ERC 1976, Lockheed Center 1979, Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990). These reductions could be caused, in part, by reduced food availability. Benthic infauna and epifauna populations, which are the main food source for demersal fish, decline when disposal occurs frequently because the benthic fauna are unable to reestablish themselves (SAIC 1986). Some recovery of the benthic community occurs within months, but complete recovery of the original benthic communities requires about 1 to 3 years (Dillon 1984, Scott et al. 1987). When dumping occurs more than once a year, it is likely that the benthic community will be reduced and so support a more limited demersal fish community. However, dredged material disposed at the HOODS might have a smaller effect on fish populations than would disposal at nearshore areas (such as SF-3 and the NDS) since, in general, fish abundance and biomass decrease toward offshore areas.

To reduce the effects of suspended sediments on fish, very fine-grained sediments should be deposited in the smallest area possible so that the least amount of benthic habitat is affected (Hirsch et al. 1978). However, sandy sediment deposited in an area with similar indigenous sediments should be dispersed over a large area. The similar-grained sediment should minimally modify the disposal area, and a thin layer of sediment would allow bottomfish a better chance of surviving burial (Hirsch et al. 1978).

Mitigation. Mitigation for potential impacts to demersal fish communities is the same as that discussed for benthic infauna (Section 4.2.2.5). The effects of disposal could be further minimized by scheduling activities during seasons that would least affect fish reproduction. Recovery from physical impacts is most rapid when disposal operations are completed shortly before seasonal peaks in spawning or larval abundance (Hirsch et al. 1978). Peak spawning activity of many benthic fish occurs from December to February, and usually eggs and larvae are pelagic by spring. Disposal of dredged material in November, just before the peak in spawning activity, might allow a rapid recovery. Preservation of nursery areas is also critical. Juveniles of many species usually occur in the shallow, sandy bottoms from May through August. Older juvenile English sole might use the area from August to November as they move from protected areas to deeper waters off the open coast (Lassuy and Moran 1989).

4.2.2.9 Pelagic Fishes

Project Impacts. Disposal activities at the HOODS are expected to minimally affect pelagic marine and anadromous fishes. Pelagic fish passing through the immediate area might be forced to change their route during discharge operations. Adult fish within and immediately adjacent to the disposal area may experience short-term clogging of their gills by suspended materials, as well as a slight decrease in available oxygen due to the biological oxygen demand of the dredged material. Adult fish may also experience stress from avoidance reactions. However, these impacts are expected to be short-term and localized, and the effects on pelagic adults in the water column are not expected to be significant.

Juveniles may be more susceptible to the effects of released dredged material. Juveniles passing through a turbidity plume may be subject to gill clogging, interference with oxygen exchange, and slightly lowered oxygen availability due to the biological oxygen demand of the suspended sediments. Juvenile anadromous fish generally move seaward between March and October, and juvenile black rockfish usually move to benthic habitats in June. Release of dredged material is expected to be least likely to affect juvenile anadromous and marine fish during the late fall and winter.

4.2.2.10 Coastal and Sea Birds

Project Impacts. Disposal of dredged material at the HOODS would have little direct effect on seabird breeding colonies in the area because the site is located offshore, away from known colonies. Indirect impacts on seabirds from dredged material disposal at the HOODS could result from temporary turbidity, which would displace and obscure prey items in the water column. This would affect surface-diving seabirds (such as alcids) and lunge divers (such as brown pelicans) that feed in clear water. Turbidity from disposal would be both localized and temporary; consequently, birds that feed in clear water and in the mid-water column will likely avoid plumes and feed elsewhere. Benthic fish and invertebrates at the preferred site are not generally used as food by seabirds. Only a few deep-diving species (e.g., common murres, cormorants, and loons) dive to depths of more than 35 m (115 ft), and studies indicate that bottomfish compose only a small portion of their diet (Ainley and Boekelheide 1990). Disposal of dredged material might actually provide a brief supply of food for surface-feeding seabirds such as shearwaters, storm petrels, fulmars, and gulls, depending on the abundance of marine organisms present within the spoils. This food source, however, would be temporary and incidental to the total diet of these birds.

Use of the HOODS would have no direct effect on the marbled murrelet, snowy plover, or double-crested cormorant breeding populations because these species usually occur closer to the coastline.

4.2.2.11 Marine Mammals

Project Impacts. Use of the HOODS will have no direct impact on populations of marine mammals in the Humboldt Bay area. Many marine mammals occur in offshore waters deeper than those found at the preferred site. It is possible that the plume or disposal ship traffic would cause gray and humpback whales to slightly alter migratory routes. Gray whales might move offshore to avoid ship traffic and turbid water (Dohl et al. 1983). Disposal at this site would probably have little direct effect on marine mammal foraging, since most marine mammals in the area forage on mobile organisms that would likely avoid the disposal area during disposal operations.

Use of the HOODS will have no direct effect on pinniped breeding or haul-out sites because the site is located offshore of known breeding colonies and haul-out sites.

4.2.2.12 Threatened or Endangered Species

Project Impacts. No significant impacts to threatened or endangered species are expected to occur as a result of the proposed designation of the HOODS as the regional ODMDS. Potential impacts are expected to be temporary in nature, and confined to the disposal site. Therefore, no loss of critical foraging habitat, increases in mortality, or reductions in reproductive success for these species are expected to occur relative to the entire region as a result of the proposed action.

Brown pelicans are plunge divers and thus require relatively clear waters in which to feed (Ashmore 1971). Therefore, depending on the amount and duration of disposal, dumping at the HOODS would temporarily exclude brown pelicans from foraging in the local area. Pelicans may be indirectly affected if reproduction and abundance of favored prey are reduced by dumping activities. However, as noted above, pelagic fish species (pelican prey) are expected to be only minimally affected by disposal operations at the HOODS. There would be no direct effects on the brown pelican roosts on the south spit of Humboldt Bay.

The short-tailed albatross is rarely sighted in California (Stallcup 1990). Therefore, it is highly unlikely that dredged material disposal at the HOODS would affect this species.

The marbled murrelet nest in the coastal forests of the Humboldt Bay area and can be observed feeding in waters near the Bay entrance. Because murrelets generally feed in waters closer to shore, this species is not expected to be affected by disposal operations at the HOODS.

Winter-run chinook salmon may occasionally pass through the site during disposal operations. However, any impact of turbidity to this species would be short-term and localized. No significant impact to this stock of chinook salmon is anticipated.

4.2.3 Socioeconomic Environment

4.2.3.1 Project Impacts

Impacts to commercial fishing and shipping, recreation, hunting, sport fishing, nature study, or science and education are not anticipated as a result of designation of the HOODS site. The site is situated 3 to 4 nmi offshore and does not lie within any established shipping routes or at a commercially important fishing ground.

Several magnetic and sonar anomalies were identified within the HOODS. Three of these anomalies were identified as potential shipwreck locations; however, no positive identification of these sites has been made.

4.2.3.2 Mitigation

The Corps will avoid disposal of dredged materials at potential shipwreck sites within the HOODS to protect their cultural value.

4.3 SF-3

4.3.1 Physical Environment

Disposal of dredged material at the SF-3 site has resulted in significant impacts to the oceanic conditions near the Bay entrance. Waves shoaling on the accumulated mound of previously disposed dredged materials are reported to have resulted in breaking waves within the site. This condition affects safe navigation when entering the Bay from the south.

If SF-3 is designated as the regional ODMDS, continued disposal of materials would result in continuation and magnification of navigation hazards. No mitigation has been identified which would reduce this significantly adverse impact to less than significant levels.

Potential impacts to water quality would be similar to those discussed for the HOODS. However, higher current and more intense wave action at the SF-3 site would likely resuspend and disperse suspended sediment over a greater area.

4.3.2 Biological Environment

4.3.2.1 Phytoplankton

The impacts of dredged material disposal on phytoplankton at SF-3 are expected to be similar to those discussed for the preferred alternative.

4.3.2.2 Zooplankton

The impacts of dredged material disposal on zooplankton at SF-3 are expected to be similar to those discussed for the preferred alternative.

4.3.2.3 Benthic Algae

Although SF-3 is closer than the other sites to the intertidal and subtidal algal communities on the jetties, dredged material disposed at this site is not expected to be transported from SF-3 to the jetties in significant quantities. No significant adverse effects on the benthic algae are anticipated.

4.3.2.4 Benthic Infauna

The benthic communities in the shallow nearshore zone are better adapted for surviving physical disturbances than the more stable offshore communities. Initially, dredged material disposal would smother the resident infauna. Although the grain size of dredged spoils from Humboldt Bay is more like that of the nearshore zone sediments than that of the mid-depth and offshore zones, previous studies have shown that disposal at SF-3 clearly affected the infaunal community (Winzler and Kelly Consulting Engineers 1984). Coarse-grained sediments do not provide a suitable habitat for most infaunal burrowing species. Species diversity at the SF-3 disposal site was low while the site was active; the benthic community consisted mainly of small surface-dwelling, surface-deposit feeders. This indicates that disposal disrupted the ecology of the area and provided newly deposited sediments for recolonization by generalist and opportunistic species. Because of substrate type, wave action, and the annual disturbance resulting from disposal activities, the benthic community observed at SF-3 remained unstable during its use as a disposal site. Long-term use of SF-3 for dredged material disposal would cause biological impacts on the benthic infauna that would be significant and would adversely affect this community. Oliver and Slattery (1976) reported that 1 to 3 undisturbed years would have to pass before the benthic communities recovered to a state similar to the unaffected adjacent areas.

No mitigation has been identified which would reduce this significantly adverse impact to less than significant levels.

4.3.2.5 Benthic Epifauna

The dredged material disposal operations offshore of Humboldt Bay generally occur during periods of Dungeness crab breeding and spawning. The SF-3 site is located within the shallow subtidal area that serves as habitat for critical life stages of Dungeness crabs. Brooding females partially bury themselves in shallow subtidal areas from September to November offshore of Humboldt Bay. Dungeness crabs mate in shallow, sandy areas from March to July; the process can take up to 9 days as the male waits for the female to molt. During these critical life stages, individuals in the immediate disposal area would be adversely affected by burial under dredged material. These impacts would be limited to the boundaries of the disposal site and are not expected to have significant long-term adverse impacts on Dungeness crab populations offshore of Humboldt Bay. If the disposal of dredged material offshore of Humboldt Bay became more frequent, as might occur if a channel widening and deepening project in Humboldt Bay were undertaken, the magnitude of these impacts would increase.

4.3.2.6 Pelagic Invertebrates

The impacts of dredged material disposal on the market squid *Loligo opalescens* at SF-3 are expected to be similar to those discussed for the preferred alternative.

4.3.2.7 Demersal Fishes

Disposal of material at the SF-3 site is expected to adversely affect resident demersal species at the site. The immediate effects of dredged material disposal are similar to those discussed for the HOODS. Disposal at SF-3 has already modified the fish community and lowered the density of fish species (Lockheed Center 1979, Winzler and Kelly Consulting Engineers 1984). Resumption of disposal at this site would reduce the epifaunal and infaunal food resources, as in the past, limiting the number of fish that the area can support. Species diversity would also continue to be depressed. However, previous studies at SF-3 did not definitively determine that certain species previously occurring in the area became excluded as a result of disposal activities. Also, nuisance fish species did not become established.

No mitigation has been identified which would reduce this significantly adverse impact to less than significant levels.

4.3.2.8 Pelagic Fishes

Disposal operations are expected to minimally affect pelagic species. Migrating fishes might temporarily avoid SF-3 during disposal activities but would not be blocked from the entrance channel to Humboldt Bay and could pass around the disposal site. Pelagic fishes present inside or immediately adjacent to the disposal site during operations might experience physiological stresses similar to those discussed for the preferred alternative.

4.3.2.9 Coastal and Sea Birds

Selection of SF-3 as a disposal area is expected to have little direct effect on breeding colonies of seabirds because the site is located approximately 16.5 nmi from the nearest coastal seabird colonies. The only impacts would be the short-term loss of prey and foraging habitat that would result from increased turbidity. This would apply especially to diving seabirds such as common murres, rhinoceros auklets, and cormorants. The degree of seabird displacement from foraging areas depends upon the duration and size of sediment plumes and the volume of dredge spoils. The effect on seabirds could be significant if the reproduction and abundance of favored prey are affected in nearshore waters. The loss of the benthic community at SF-3 would result in a loss of localized feeding habitat for seabirds that feed on benthic organisms; however, seabirds would likely find food elsewhere in the area. Disposal at this site might briefly provide food for seabirds such as gulls, depending on the number of marine organisms in the dredged sediments. This food source, though, would be temporary and incidental to the main diet of these birds.

4.3.2.10 Marine Mammals

The impacts of dredged material disposal on marine mammals at the SF-3 site would be similar to those discussed for the preferred alternative. Pinniped breeding and haul-out sites are not expected to be affected by the use of SF-3. All breeding and haul-out sites, except for harbor seal rookeries, are located more than 8 nmi from the SF-3 disposal site, and the nearest harbor seal rookery is located approximately 0.9 nmi away, inside Humboldt Bay.

The SF-3 site may provide some foraging habitat for marine mammals because of its relatively shallower depths and proximity to shore. However, loss of this habitat in relation to the foraging range of marine mammals would be less than significant.

4.3.2.11 Threatened or Endangered Species

The impacts of dredged material disposal at SF-3 on threatened or endangered species would be similar to those discussed for the preferred alternative site, but with the exceptions discussed below.

The SF-3 site lies within potential foraging range of both marbled murrelets and Steller sea lions. However, the foraging habitat at the SF-3 site is small in relation to the foraging range of these species, and use of the site is not expected to cause significant impacts to threatened and endangered species.

4.3.3 Socioeconomic Environment

4.3.3.1 Project Impacts

Designation and dredged material disposal will result in accumulations of sediments at the SF-3 site. These accumulations will likely intensify the present navigation hazards at the site. Additionally, the site is not large enough to adequately contain disposed dredge materials, given the anticipated quantity of 50,000,000 yd^3 over the 50-year life of the site.

4.3.3.2 Mitigation

Enlargement of the SF-3 site is the only potential mitigation to reduce impacts to navigation. However, the environmental impacts associated with enlarging the site enough to contain 50,000,000 yd^3 without impacts to surface navigation would likely preclude this mitigation alternative.

4.4 THE NDS

4.4.1 Physical Environment

Potential impacts of designating the NDS as the regional ODMDS are similar to those discussed for the SF-3 site.

4.4.2 Biological Environment

4.4.2.1 Phytoplankton

The impacts of dredged material disposal on phytoplankton at the NDS are expected to be similar to those discussed for the preferred alternative.

4.4.2.2 Zooplankton

The impacts of dredged material disposal on zooplankton at the NDS are expected to be similar to those discussed for the preferred alternative.

4.4.2.3 Benthic Algae

Although the NDS disposal site would be closer to benthic algal communities than the HOODS or SF-3, these communities are still located at a safe distance from the site. Dredged material disposal at the NDS is not expected to have any significant adverse effects on the benthic algae in the study area.

4.4.2.4 Benthic Infauna

A month after the disposal of dredged material at the NDS, benthic invertebrate species diversity and abundance were observed to be reduced (Pequegnat et al. 1990). However, benthic communities tend to be unstable in shallow water due to wave action. Since the NDS has not been used for dredged material disposal since the fall of 1989, the benthic community has most likely recolonized, with the fauna more like that of the adjacent environment.

The impacts of dredged material disposal on the benthic infauna at the NDS are expected to be similar to those discussed for the SF-3 site alternative. The number of species and individuals decreased by more than 60% between the August and November 1989 samplings conducted by Pequegnat et al. (1990). Although this might have been related to the disposal of dredged material at this site prior to the November sampling, it is also probable that this is a seasonal trend (Pequegnat et al. 1990).

No mitigation has been identified which would reduce this significantly adverse impact to less than significant levels.

4.4.2.5 Benthic Epifauna

The potential impacts of dredged material disposal on the benthic epifauna at the NDS might be greater than at either of the other two alternative disposal sites because of the relatively high seasonal abundance of Dungeness crab reported there. The highest abundances of Dungeness crab were recorded in the vicinity of the NDS, with the greatest numbers observed in November following the disposal of dredged material in the fall. Both the April-May and September-October disposal periods offshore of Humboldt Bay occur when Dungeness crabs can be found at the shallow depths.

4.4.2.6 Pelagic Invertebrates

The impacts of dredged material disposal on the pelagic invertebrates at the NDS are expected to be similar to those discussed for the SF-3 site alternative.

4.4.2.7 Demersal Fishes

Project Impacts. Dredged material disposal activities are expected to adversely affect bottomfish species at the NDS and in areas adjacent to the site. Such disposal operations have only occurred twice at this site, but trawl catches indicated that species diversity and biomass were reduced as compared to catches in control areas. The immediate effect of disposal is expected to be similar to that described for the SF-3 site alternative. The long-term effects of disposal would include reduced food resources and modified sedimentation patterns. Disposal material would be composed of fine-grained sediment (fine sand to silt and clay) in the spring and of coarse-grained materials in the fall (Scheffner 1990). Fine-grained material differs from the indigenous sediment at the NDS and is not suitable for nearshore disposal. When disposed sediments differ from bottom sediments, recolonization of dredged material by epifauna and infauna might be slow, and food resources for fish might be limited (Hirsch et al. 1978).

Mitigation. The effects of dredged material disposal could be reduced by conducting disposal operations before peak spawning periods and when juveniles are unlikely to use the area, and by using material with similar grain size. Recovery from physical impacts is most rapid when dredged material disposal occurs just prior to peak spawning periods, which for bottomfish are typically from December to February. Also, juveniles are most likely to be in nearshore areas such as the NDS from April to August, except for juvenile English sole, which might be found as late as November.

4.4.2.8 Pelagic Fishes

The impacts of dredged material disposal on pelagic species at the NDS are expected to be similar to those discussed for the preferred alternative.

4.4.2.9 Coastal and Sea Birds

The impacts of dredged material disposal on coastal and sea birds at the NDS are expected to be similar to those discussed for the SF-3 alternative.

4.4.2.10 Marine Mammals

The impacts of dredged material disposal on marine mammals at the NDS are expected to be similar to those discussed for the preferred and SF-3 alternatives. Pinniped rookeries and haul-out sites would probably not be affected by disposal at the NDS because all rookery and haul-out sites, except for harbor seal rookeries, are located more than 8 nmi from this alternative site. Harbor seal haul-out sites are about 0.65 nmi away, inside Humboldt Bay.

4.4.2.11 Threatened or Endangered Species

The impacts of dredged material disposal on threatened or endangered species at the NDS are expected to be similar to those discussed for the SF-3 site alternative.

4.4.3 Socioeconomic Environment

4.4.3.1 Project Impacts

Designation and dredged material disposal will result in accumulations of sediments at the NDS. These accumulations will likely intensify the present navigation hazards at the site. Additionally, the NDS is not large enough to contain disposed dredged materials, given the anticipated quantity of 50,000,000 yd^3 over the 50-year life of the site.

4.4.3.2 Mitigation

Enlargement of the NDS is the only potential mitigation to reduce impacts to navigation. However, the environmental impacts associated with enlarging the site enough to contain 50,000,000 yd^3 without impacts to surface navigation would likely preclude this mitigation alternative.

4.5 LONG-TERM IMPACTS AS A RESULT OF THE PROJECT

Long-term significant impacts on the biological community are expected to be localized within the boundaries of the preferred alternative site. Impacts may include a decrease in benthic infaunal and epifaunal populations and lowered fish diversity. Benthic infaunal communities at the preferred alternative site are expected to be affected as long as disposal is taking place. Benthic infauna would be buried during disposal and, depending on the volumes dumped, the thickness of deposited material on the bottom, and the length of time between disposal operations, might not have sufficient time to recolonize. Benthic epifauna, including Dungeness crabs, might also be affected to some extent; however, few, if any, of the critical life stages of this crab species are found at the HOODS.

The long-term effect of dredged material disposal on demersal fish at the preferred site may be a decrease in species diversity and abundance. This effect has been documented offshore of Humboldt Bay at the NDS and at SF-3 (ERC 1976, Lockheed Center 1979, Winzler and Kelly Consulting Engineers 1984, Pequegnat et al. 1990) and at other coastal disposal sites (EPA 1987). These reductions are partially caused by reduced populations of benthic infauna and epifauna populations, a main food source for fish.

Overall, disposal of dredged material at the preferred alternative site is not expected to affect any geographically limited species or affect any unique habitats, breeding areas, or critical areas that are essential to commercially important species and to rare or endangered species.

4.6 RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM RESOURCE USES

The proposed designation of any of the alternative sites as an ODMDS is not expected to produce significant, long-term, adverse impacts to resources, including the physical, biological, and socioeconomic environments, within the Humboldt Bay region. Impacts to benthic invertebrates within the site are expected to persist as long as the site is used for disposal. However, cessation of disposal should result in gradual recovery over time. Recolonization of a diverse and stable benthic community would probably be complete 1 to 3 years after cessation of disposal operations (Dillon 1984, Scott et al. 1987).

Use of the proposed ODMDS is not expected to interfere with uses of resources outside of the boundaries of the alternative sites. These resources include commercial and sport fishing, marine bird and mammal observation, and use of the regional by commercial and recreational vessels. No significant mineral or oil and gas resources occur within any of the alternative sites. Therefore, use of the ODMDS does not represent a potential conflict with the long-term use of resources.

Any impacts or restricted uses of resources within the site boundaries would represent a very small percentage of these resources within the Humboldt Bay study region. This marginal loss of some resources is balanced by the significant benefit that would be derived from the proposed action. In contrast, lack of a designated ocean disposal site capable of receiving large quantities of dredged material could have a significant adverse effect on the economic productivity associated with Humboldt Bay.

4.7 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

Irreversible or irretrievable resources that would be committed if an ocean disposal site is designated will include:

- energy resources used as fuel for dredges, pumps, and disposal vessels, and for research vessels involved in monitoring studies;
- economic resources associated with ocean disposal including monitoring and surveillance;
- unavailability of sediments disposed at the ODMDS for potential beach restoration or other beneficial use projects; and

- some loss or degradation of the benthic habitat and associated benthic communities at the site for at least the duration of site use.

The commitment of energy and economic resources will increase with increased distance of a site from dredging areas. However, the three alternative sites are similar distances from Humboldt Bay, and no significant differences in the resources contained within the alternative sites are evident. Therefore, the magnitude of any long-term commitment of irreversible or irretrievable resources that can be determined from the existing information is essentially the same for each of the three alternative sites.

Section 5

Coordination

Section 5. Coordination

This section contains information on public involvement and interagency activities related to the DEIS for designation of the ODMDS off Humboldt Bay, California. Several scoping meetings occurred between January 1989 and January 1991. Initial field studies were conducted by the Corps in 1990. During preparation of the DEIS, EPA initiated coordination with agencies regarding the potential impacts of the proposed site designation to threatened or endangered species that may occur in the area of the alternative sites. Although some of these agencies have responded with lists of these species, they have reserved formal determination until after the release of the DEIS (see following letters).

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213
TEL (310) 980-4000; FAX (310) 980-4018

JAN 17 1995 F/SW03:SHK

Mr. Jeff Rosenbloom
Chief, Wetlands and Sediment Section
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Dear Mr. Rosenbloom:

Thank you for requesting information regarding the presence of Federally listed threatened or endangered species or critical habitat that may be affected by the designation of an ocean dredged material disposal site off Humboldt Bay, California.

Available information indicates that the endangered Sacramento River winter-run chinook salmon and the threatened Steller sea lion may occur at the proposed project site. No critical habitat occurs for either species at the proposed project site. The National Marine Fisheries Service is also conducting status reviews of coho salmon and steelhead trout on the west coast, and these reviews may result in proposals to list either or both species. Both of these species may also occur in the area of your proposed project.

The U.S. Fish and Wildlife Service (USFWS) may also have listed species or critical habitat under its jurisdiction in the project area. Please contact Mr. Joel Medlin, Field Supervisor, USFWS, at 2800 Cottage Way, Room E-1803, Sacramento, California 95925, or (916) 978-4613, regarding the presence of listed species or critical habitat under USFWS jurisdiction that may be affected by your project.

If you have questions concerning these comments, please contact Mr. Gary Stern at (707) 578-7513.

Sincerely,

Hilda Diaz-Soltero
Regional Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Sacramento Field Office
2800 Cottage Way, Room E-1803
Sacramento, California 95825-1846

In Reply Refer To:
1-1-95-SP-277

January 18, 1995

Mr. Jeff Rosenblum
Chief, Wetlands and Sediment Management
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, California 94105-3901

Subject: Species List for Proposed Ocean Dredged Material Disposal Site Off Humboldt Bay, Humboldt County, California

Dear Mr. Rosenblum:

As requested by letter from your agency dated December 12, 1994, you will find enclosed a list of listed, proposed and candidate species that may be present in the subject project area (see Enclosure A). This list fulfills the requirement of the Fish and Wildlife Service to provide a species list pursuant to Section 7(c) of the Endangered Species Act, as amended, (Act).

Pertinent information concerning the distribution, life history, habitat requirements, and published references for the listed species is available upon request. This information may be helpful in preparing the biological assessment for this project, if one is required. Please see Enclosure B for a discussion of the responsibilities Federal agencies have under Section 7(c) of the Act and the conditions under which a biological assessment must be prepared by the lead Federal agency or its designated non-Federal representative.

Formal consultation, pursuant to 50 CFR § 402.14, should be initiated if you determine that a listed species may be affected by the proposed project. If you determine that a proposed species may be adversely affected, you should consider requesting a conference with our office pursuant to 50 CFR § 402.10. Informal consultation may be utilized prior to a written request for formal consultation to exchange information and resolve conflicts with respect to a listed species. If a biological assessment is required, and it is not initiated within 90 days of your receipt of this letter, you should informally verify the accuracy of this list with our office.

We have included the candidate species that may be present in the project area (see Enclosure A). These species are currently being reviewed by our service and are under consideration for possible listing as endangered or threatened. Candidate species have no protection under the Endangered Species Act, but are included for your consideration as it is possible that one or more of these candidates could be proposed and listed before the subject project is completed. Should the biological assessment reveal that candidate species may be adversely affected, you may wish to contact our office for technical assistance. One of the potential benefits from such technical assistance is that by exploring alternatives early in the planning process, it may be possible to avoid conflicts that could otherwise develop, should a candidate species become listed before the project is completed.

We appreciate your concern for endangered species. If you have further questions, please call Laurie Stuart Simons of this office at (916) 979-2725 If you have any questions regarding wetlands, contact Mark Littlefield at (916) 979-2113.

Sincerely,

Joel A. Medlin
Field Supervisor

Enclosures

ENCLOSURE A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES THAT MAY OCCUR IN THE AREA OR MAY BE AFFECTED BY THE PROPOSED OCEAN DREDGED MATERIAL DISPOSAL SITE OFF HUMBOLDT BAY
HUMBOLDT COUNTY, CALIFORNIA
(1-1-95-SP-277, JANUARY 18, 1995)

Listed Species

Fish
tidewater goby, *Eucyclogobius newberryi* (E)

Birds
marbled murrelet, *Brachyramphus marmoratus* (T)

Proposed Species

None

Candidate Species

Fish
green sturgeon, *Acipenser medirostris* (2R)

(E)--Endangered (T)--Threatened (P)--Proposed (CH)--Critical Habitat
(1)--Category 1: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.
(2)--Category 2: Taxa for which existing information indicated may warrant listing, but for which substantial biological information to support a proposed rule is lacking.
(1R)-Recommended for Category 1 status.
(2R)-Recommended for Category 2 status.
(■)--Listing petitioned.
(*)--Possibly extinct.

ENCLOSURE B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) and (c) OF THE ENDANGERED SPECIES ACT

SECTION 7(a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species; 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7(c) Biological Assessment--Major Construction Activity[1]

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action[2] on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative actions may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

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[1] A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

[2] "Effects of the action" refers to the direct and indirect effects on an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

Section 6

Preparers and Contributors

Section 6. Preparers and Contributors

Agency and Name	Expertise	Experience	Responsibility
EPA Allan Ota/M.S.	Biological Oceanography	13 years conducting research and preparation and review of technical reports.	Work Assignment Manager and EIS review
Corps Dave Hodges/B.S.	Geology	4 years experience in preparation and review of dredging projects.	Project Manager
Jones & Stokes Associates Richard Oestman/M.S.	Fisheries, Marine Biology, Dredged Material Disposal Analysis, NEPA Document Preparation	Over 8 years experience in managing and conducting environmental studies and impact assessments in the marine environment, and EIS management and preparation.	Project Manager, preparation of EIS, EIS review
Jones & Stokes Associates Grant Bailey/B.S.	Marine Biology, Regulatory Compliance, NEPA EIS Preparation	Over 20 years experience in managing and conducting environmental studies and impact assessments in marine environment, and EIS management and preparation.	EIS review
Jones & Stokes Associates Larry Larsen/Ph.D.	Physical Oceanography, Numerical Modeling	Over 25 years experience in conducting research in physical oceanography and pollutant transport.	Preparation of EIS sections: Affected Environment and Environmental Consequences
Jones & Stokes Associates Andrew Wones/M.S.	Marine Biology	Over 5 years experience in conducting research and preparing technical reports and EIS sections.	Preparation of EIS sections: Affected Environment and Environmental Consequences
Jones & Stokes Associates Sara Noland/B.S.	Technical Editing	Over 3 years experience in performing editing and production of NEPA documents and technical reports.	Editing and production of EIS

Section 7

Glossary

Section 7. Glossary

advected - horizontally or vertically transported, as by a current

ambient - the existing level of air pollutants or other environmental factors

amphipods - an order of crustaceans with laterally compressed bodies, including sand fleas and beach fleas

amplitude - for a wave, the vertical distance from sea level to crest, or sea level to trough, or one-half the wave height

anadromous - migrating from the sea up rivers to breed in fresh water; salmon are anadromous

annelids - members of the phylum annelidea; includes segmented worms such as polychaetes

bathymetric - pertaining to seafloor elevations and variations of water depth

benthic - of the seafloor, or pertaining to organisms living on or in the seafloor

bioaccumulation - the uptake of substances, such as heavy metals, leading to elevated concentrations of those substances within plant or animal tissues

biomass - the weight of living organisms in a given area or volume at a given time

biota - the plants and animals living in a given area

bivalves - marine shellfish with two shells, such as oysters and clams

bloom - an explosive growth of algae that can contribute to reduced clarity of the water

box core - a device used to collect sediment samples from the ocean floor

carbon monoxide (CO) - a colorless, odorless gas resulting from incomplete combustion; high concentrations can cause sickness and death in humans

carnivorous - having a diet consisting of the flesh of other animals

chlorophyll - a pigment found in plants that converts sunlight, water, and carbon dioxide into sugars needed for plant growth; gives green plants their color chlorophyll _a_ - a specific chlorophyll pigment characteristic of higher plants and algae, frequently used as a measure of phytoplankton biomass

copepods - a large diverse group of small planktonic crustaceans representing an important link in oceanic food chains

cosmopolitan species - species with world-wide distribution

crustaceans - a class of animals with jointed legs and hard external skeletons; includes crabs, barnacles, shrimp, and lobsters

decapods - crustaceans such as crabs, lobsters, and shrimp having 10 legs

demersal - living at or near the bottom of the sea

deposit-feeder - an animal which feeds on organic material in and on the seafloor

diatoms - microscopic phytoplankton with a cell wall made of overlapping silica plates

dinoflagellates - a large, diverse group of phytoplankton with flagella (whip-like appendages used for locomotion); some dinoflagellates are responsible for toxic red tides

dissolved oxygen (DO) - the quantity of oxygen dissolved in a unit volume of water

diversity - a statistical measurement which generally combines a measure of the total number of species in a given environment with the number of individuals of each species; species diversity is high when there are many species with a similar number of individuals, and low when there are fewer species and when one or two species dominate

echinoderms - a group of marine invertebrates that includes sea urchins, sea cucumbers, sea stars, and sand dollars

epifauna - animals that live on bottom sediments or hard surfaces

epipelagic zone - the upper portion of the pelagic zone, including surface waters

estuary - a partially enclosed coastal body of water where fresh water (such as a river) and salt water mix

euphasiids - planktonic, shrimp-like crustaceans

faunal group - a group of biologically or ecologically related animals

flagellates - one-celled animals with flagella (whip-like appendages used for locomotion) food web - the complex of feeding relationships within a community of organisms including production, consumption, decomposition, and the flow of energy within the community and the environment

gastropods - mollusks that have a distinct head, a flat foot, and usually a spiral shell, such as snails

hopper dredge - a self-propelled vessel with capabilities to dredge, store, transport, and dispose of dredged materials

hydrocarbons (HC) - organic compounds containing only hydrogen and carbon, occurring in petroleum, natural gas, and coal

hydrographic - related to the physical conditions of waters

infauna - animals that live in the bottom sediment

insolation - exposure to sunlight

invertebrates - a group of animals lacking backbones; includes many marine species such as worms, jellyfish, snails, and clams

jetty - a structure located to influence currents or protect the entrance to a harbor or river from waves

littoral - of or pertaining to the seashore, especially the area between tide lines

macrofaunal - pertaining to animals large enough to see with the unaided eye

macroinvertebrates - animals lacking backbones (invertebrates) that are large enough to be visible to the unaided eye

mollusk - a group of animals lacking body segments and usually having a shell made of calcium; examples are snails, clams, and octopus

multiple-port diffuser - the terminus of an outfall pipe fitted with several holes or ports to enhance the mixing of effluent in receiving waters

nitrogen oxides (NO_x) - a group of compounds containing varying proportions of nitrogen and oxygen; one of these, nitrogen dioxide, is a primary component of smog

omnivorous - having a diet consisting of both plants and animals

otter trawl - a large conical net dragged along the seafloor to catch fish and other marine life

pelagic - pertaining to near surface waters of the ocean phytoplankton - that portion of the plankton that consists of microscopic plants

plankton - the passively floating or weakly swimming, usually microscopic plant and animal life in a body of water

particulate matter (PM) - particulates suspended in the air that contribute to air pollution

PM_{10} - particulate matter smaller than or equal to 10 microns in diameter; PM_{10} is of health concern because particles this size are small enough to reach the lungs when inhaled

polychaetes - a type of marine worms

primary production - the amount of organic matter (such as starches) produced by plants from inorganic substances per unit time and volume of water

reactive organic gases (ROG) - the components of organic gases which react with nitrogen oxides to form ozone

salinity - a measure of the salt content of water

seabed drifter (SBD) - an umbrella-shaped device which is used to determine the direction of transport along the seafloor

sulfur dioxide (SO_2) - an air pollutant that reacts with sunlight and other pollutants to contribute to atmospheric haze

suspension-feeder - an animal that feeds on nutrients and other animals suspended in the water column

synergistic effect - an effect caused by two or more interacting factors

tectonic - relating to the movement of the earth's crust and production of earthquakes

Tertiary - a geologic period of time between 65 and 2 million years ago

topography - the description of the physical features of a place or region

transmittance - a measure of light passing through a specific distance in water, used as a measure of light penetration or water clarity

trophic level - the position of an organism in a food chain or food web such as primary producers, secondary producers, consumers, and detritivores

turbidity - the measure of sediment suspended in a volume of water

upwelling - the rising of nutrient-rich bottom waters to the surface; usually the result of divergent surface currents wave period - time required for two successive wave crests or troughs to pass a fixed point

zoea stage - a stage in the development of certain crustaceans such as crabs

zooplankton - that portion of the plankton that consists of microscopic animals

Section 8

References

Section 8. References

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Appendix A

Site Management and Monitoring Plan for HOODS ODMDS

APPENDIX A

SITE MANAGEMENT AND MONITORING PLAN (SMMP) FOR HUMBOLDT BAY (HOODS) OCEAN DREDGED MATERIAL DISPOSAL SITE

I. INTRODUCTION

The Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972 (33 USC Section 1401 et seq.) is the primary legislative authority regulating the disposal of dredged material into ocean waters. The MPRSA prohibits disposal activities that would unreasonably degrade or endanger human health or the marine environment. Under the act, the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) have joint authority for regulating ocean disposal of dredged material and for managing ocean disposal sites. Management of an ocean disposal site consists of: (a) regulating the quantities, types of material, times, rates, and methods of disposing dredged material at an ocean disposal site; (b) development and maintenance of an effective monitoring program for the site; (c) recommending changes to site use, disposal amounts, or designation for a limited time based on periodic evaluation of site monitoring results; and (d) enforcement of permit conditions.

Section 506 of the Water Resources Development Act (WRDA) amends Section 102(c) of the MPRSA. These amendments require, in part, that a site management plan be developed for each designated ocean disposal site. This site management plan is required to include:

- a baseline assessment of conditions at the site;
- a program for monitoring the site;
- special management practices necessary for protection of the site;
- consideration of the quantity and contaminant levels of material to be disposed at the site;
- consideration of the active life of the site and management requirements after site closure; and
- a schedule for review and revision of the site management plan.

Section 506 of the WRDA further requires that, after January 1, 1995, a site management plan must be developed and approved before final designation is issued. After January 1, 1997, no permit for dumping may be issued under Section 103 of the MPRSA for a site unless the site has received final designation.

In the case of this proposed action, the final designation is scheduled for fall 1995. Thus, a site management plan is required to be developed and approved, pursuant to the WRDA, before the final designation may be issued.

Two key parts of an effective management plan are the flexibility to accommodate unforeseen needs, and the ability to revise the plan as changes are identified. The primary goal of site management is to ensure adequate environmental protection and regulatory compliance. To this end, the SMMP (see Exhibit A) for the ocean dredged material disposal site (ODMDS) off Humboldt Bay (HOODS) will be reviewed periodically by EPA Region IX and the Corps' San Francisco District. Agency representatives will meet to review site operations, to discuss potential problems with the condition at the HOODS or monitoring activities, and to address public concerns about disposal at the HOODS. Any changes must meet the approval of both agencies. Resolution of management and monitoring issues and public concerns will be worked out cooperatively.

A. Purpose of the SMMP

The SMMP for the HOODS has been developed jointly by EPA Region IX and the Corps' San Francisco District. It is designed to identify possible unacceptable adverse environmental impacts that may occur beyond the site boundary, and to ensure that disposal operations comply with established permit conditions. This document provides guidance to EPA Region IX and the Corps' San Francisco District staff on available management options and the proper times when management decisions may be required.

The HOODS is located in water depths between 49 and 55 meters (160 and 180 feet) and is positioned within the coordinates 40° 48 25N, 124° 16 22W; 40°49'3"N, 124°17'22"W; 40°47'38"N, 124°17'22"W; 40°48'17" N, 124°18'12"W (Figure 1). The site is one square nautical mile (nm^2; 850 acres) in area and is divided into 4 quadrants (1-4), each containing 9 cells (Figure 2). Management decisions must reflect local characteristics of the disposal site such as: (1) geographic location; (b) oceanographic conditions; (c) physical, chemical, and biological characteristics and composition of the proposed dredged material; and (d) adjacent amenities and resources that might be adversely affected by disposal operations.

As an integral part of the SMMP, a site monitoring program has been designed for the HOODS to provide necessary data for site management. These data will address potential and actual impacts to the marine environment and biological resources at the HOODS or in areas adjacent to the site boundaries. The program design facilitates monitoring of both short-term and long-term impacts, enabling EPA Region IX and the Corps' San Francisco District to make management decisions in a timely manner should potential or actual unacceptable adverse impacts be detected. Specific portions of the SMMP will also help EPA Region IX and Corps' San Francisco District staff to verify whether disposal operations are carried out in compliance with permitting requirements and other environmental laws.

The SMMP addresses the options available to the federal agencies for modification of activities at the site to avoid significant environmental impacts, or options to mitigate

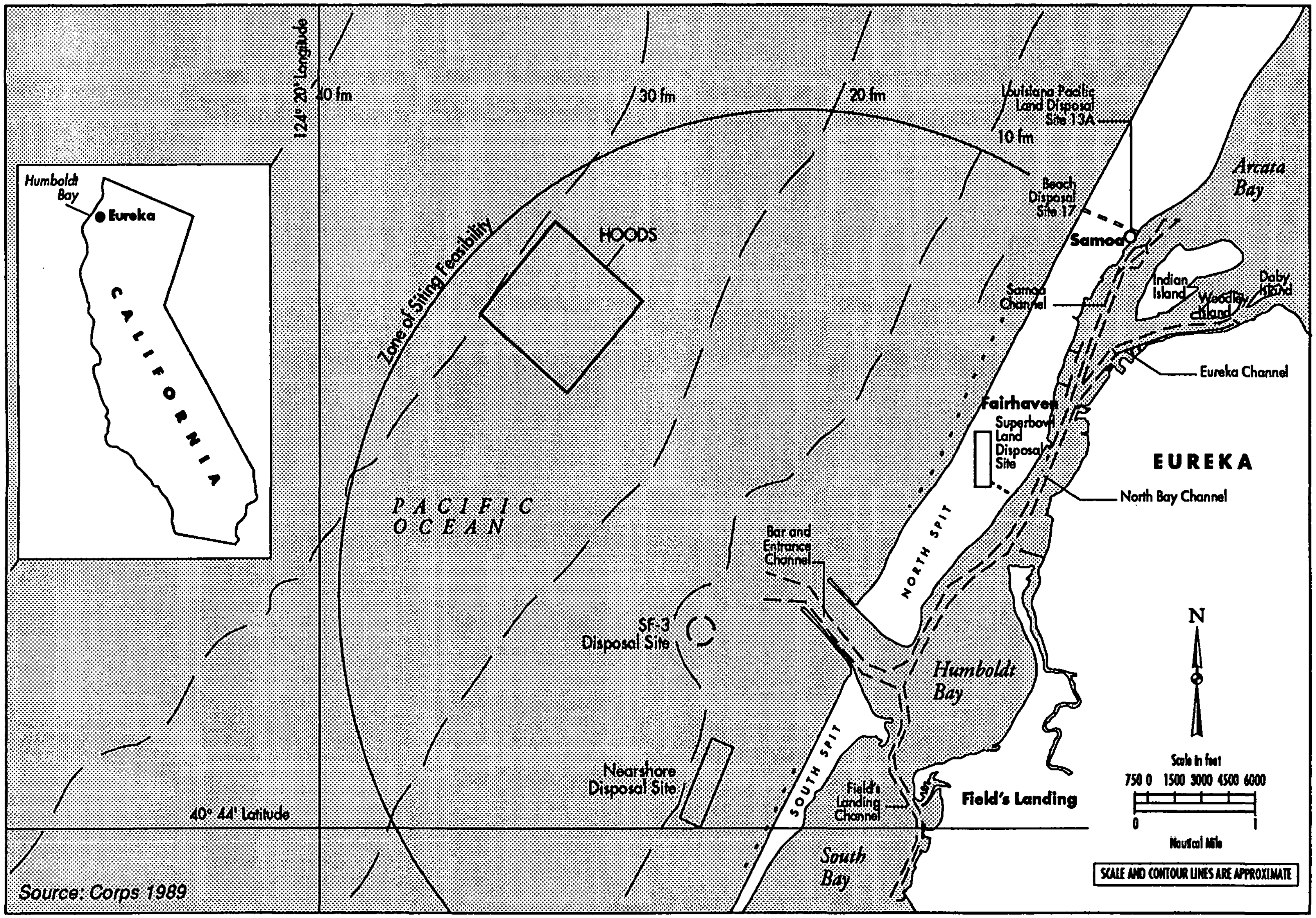
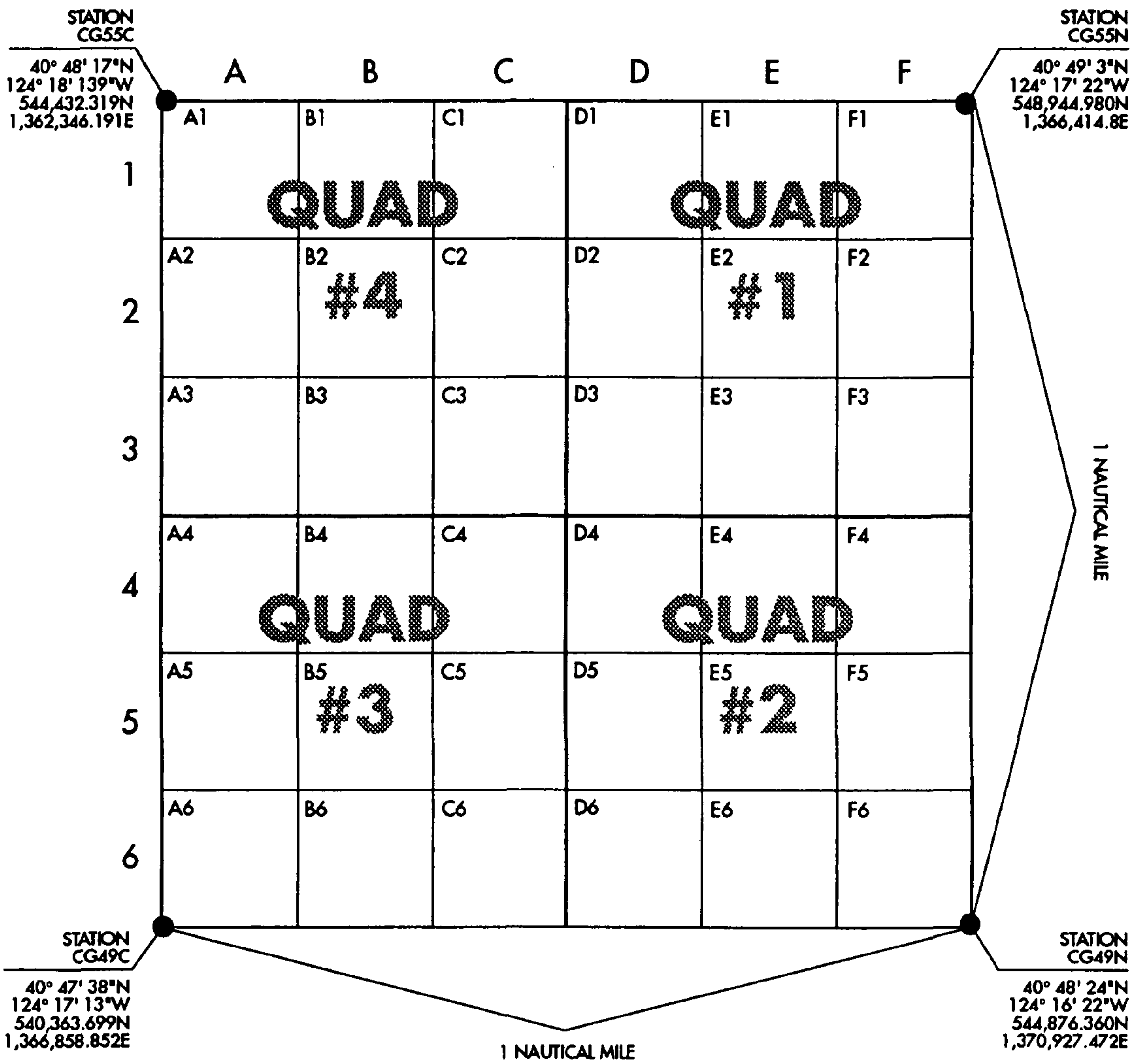


Figure 1. Location of Past and Present Ocean and Land Dredged Material Disposal Sites Near Humboldt Bay, California



Source: Corps 1994b

Figure 2. Humboldt Open Ocean Disposal Site

The SMMP addresses the options available to the federal agencies for modification of activities at the site to avoid significant environmental impacts, or options to mitigate potentially adverse impacts. Management actions may include: (a) adjustment of permitting and monitoring procedures, (b) adequate enforcement of permit conditions, or (c) modification of disposal activities, either temporarily or permanently. Specific considerations may include a change in dredging or disposal practices, restrictions on amounts of dredged material disposal, revision of site size, use of the site for a limited time, or designation of a new site.

B. SMMP Objectives

1. The following specific objectives are included in the SMMP to ensure acceptable long-term use of the HOODS as the designated site. These objectives may be used to revise the configuration or location of the disposal site, and will accommodate disposal of acceptable dredged material without causing adverse impacts outside site boundaries:

    a. Define the overall strategy and rules for site use.

    b. Establish specific site use requirements to ensure compliance with the EPA's Ocean Dumping Regulations.

    c. Publish sediment testing and reporting requirements jointly agreed to by EPA Region IX and the Corps' San Francisco District to complement national guidance on sediment testing. This will be accomplished by publishing a San Francisco District Public Notice defining the proposed testing and reporting procedures to obtain comments from other agencies, prospective permit applicants, and contractors.

    d. Identify biological resources of concern based on the HOODS Final Environmental Impact Statement (U.S. Environmental Protection Agency, Region IX, 1995).

    e. Facilitate assessment of any potential problems which may be identified as a result of routine site monitoring, and implement changes to avoid such problems.

    f. Provide an instrument of agreement for site management between the EPA Region IX, the Corps' San Francisco District, the U.S. Coast Guard, and other concerned regulatory and resource agencies responsible for successful site operation or enforcement.

2. The suitability of any dredged material proposed for disposal will be determined before disposal at the HOODS. This involves appropriate physical, chemical and biological testing of the proposed dredged sediments based on requirements and procedures defined in EPA's Ocean Dumping Regulations at 40 CFR Parts 220,

225, 227 and 228. The following information will be supplied by the permit applicant to EPA Region IX and the Corps' San Francisco District as part of the permit application process (33 CFR Parts 335 to 338):

a. Written documentation of the need to dispose the dredged material in the ocean, including a disposal alternatives analysis. This will be used to decide the proper disposal alternative for the sediments proposed for dredging.

b. A description of historical dredging and activities at or adjacent to the proposed dredging site that may have contaminated the sediments. The historical analysis will give the federal agencies information on potential sources of contamination at the site. Additional chemicals of concern may be identified by this report.

c. The quantity of dredged material proposed for disposal, including overdredge (tolerance) material. EPA Region IX and the Corps' San Francisco District will use this information to determine whether the HOODS can accommodate the amount of sediment proposed for disposal.

d. A recent condition survey of the proposed dredging area showing present hydrographic data at the proposed dredging site, including proposed dredging depths, overdredge depths, side slopes, and depths adjacent to the boundary of the proposed dredging area. This survey is required before field sampling occurs to locate the sampling stations at the proposed dredging site.

e. Characteristics and composition of the proposed dredged material, including physical, chemical, and biological tests. These data will be used by the federal agencies to determine whether the proposed dredged materials are suitable for disposal at the HOODS.

f. An estimate of the starting and ending dates for the dredging project. This information will be used to plan inspections at the dredging site or during disposal operations at the HOODS.

g. A debris management plan and the most likely types of equipment to be used in the project. This plan will address the disposal of materials other than approved sediment (such as piling, tires, metal debris, etc.) to assure that these other materials are not disposed of at the HOODS.

II. SITE MANAGEMENT

Site management consists of three major activities jointly administered by EPA Region IX and the Corps' San Francisco District. These activities are:

- ocean dumping permit requirements,

- site monitoring program requirements, and
- evaluation of permit compliance and monitoring results.

A. MPRSA Section 103 Permitting

Management decisions about the suitability of dredged material for ocean disposal will be guided by criteria set out in MPRSA and EPA's Ocean Dumping Regulations. MPRSA Section 103 authorizes the Corps to administer the permit program. This section provides for EPA review of Corps' Public Notices and permits. Initial opportunities for management decisions begin with the MPRSA Section 103 permitting process. Guidance on specific aspects of these regulations is provided in the Evaluation of Dredged Material Proposed for Ocean Disposal (the Green Book, U.S. Environmental Protection Agency and U.S. Army Corps of Engineers 1991). EPA Region IX and the Corps are developing regional guidance for sediment testing which should be used in addition to the 1991 Green Book. The current regional guidance is EPA (1991).

An adequate sampling plan must be developed by the permittee to characterize sediment quality. The sampling plan should address information listed in EPA Region IX's 1991 sediment testing requirements. This plan and the information listed in Section I.B.2. above are submitted to the Corps' San Francisco District and interested federal and state regulatory agencies. Early consultation with concerned federal and state regulatory and resource agencies is highly recommended to prevent delays in sampling, sediment testing and agency review. This consultation is normally conducted with the Corps' San Francisco District Permit and Regulatory Branch; however, it is advisable that the permit applicant or the Corps' Civil Works planner coordinate with EPA Region IX on the sampling before any sampling is conducted.

A reference site will be identified prior to the designation of the HOODS. Proposed dredging site sediment characterization test results are compared to similar information from the HOODS reference site to determine whether the sediment is suitable for ocean disposal. Management decisions related to the proposed dredged material and the disposal operations at the HOODS will be based on:

1. compliance with applicable criteria defined in the EPA's Ocean Dumping Regulations at 40 CFR Part 227,

2. the requirements imposed on the permittee under the Corps' Permitting Regulations at 33 CFR Parts 320-330 and 335-338, and

3. the potential for significant adverse environmental impacts at the HOODS from the disposal of the proposed dredged material.

For any environmental impact to be considered significant and, therefore, a basis for a management decision at the permitting stage, such an impact or change must be shown to be statistically significant and to pose an unacceptable risk to the marine environment or human health. These determinations will be based on appropriate statistical methods to evaluate differences between the proposed dredged material and reference site conditions for the chemicals of concern, acute toxicity of the proposed dredged material, the magnitude of bioaccumulation, and potential ecological impacts. The main concerns are: (1) disposal of sediments that may cause significant mortality or bioaccumulation of contaminants at the disposal site or adjacent to the site boundaries, and (2) adverse ecological changes to the HOODS and the surrounding ocean floor. Changes in the benthic community inside the HOODS site could occur because coarser or finer grain sizes in dredged material are expected to allow different benthic species to colonize the site. If material is found moving off the disposal site, benthic community changes adjacent to the site may be evaluated to determine whether these changes are acceptable.

Management decisions will be implemented to reduce or mitigate any significant adverse environmental impacts. Management options for the permitting process may include: full or partial approval of dredged material proposed for ocean disposal, prohibition of sediments proposed for ocean disposal, or special management restrictions for ocean disposal of the proposed material such as limits on disposal quantities or disposal at specific areas within the HOODS site.

Existing regulatory information, such as the Federal Water Quality Criteria and the State of California Water Quality Objectives, may also be management decision triggers in some cases. Such mathematically precise tests cannot be applied to all proposed dredged material disposal projects. Most permit reviews will require the agencies' best professional judgment to manage the MPRSA Section 103 permitting process properly. The Corps' San Francisco District staff will prepare the Public Notice and EPA Region IX will participate in its review. EPA Region IX will only approve, disapprove, or propose conditions on the draft of the MPRSA Section 103 permit, because EPA must review the MPRSA Section 103 permit as specified in 40 CFR Section 220.4(c). The possible management options for the draft permit will be concurrence or denial.

B. Conditions at the HOODS

Conditions at the HOODS were documented in EPA Region IX's Draft EIS for the proposed designation action (U.S. Environmental Protection Agency, Region IX, 1995). These two documents will be used, with reference site data, to evaluate future changes at the site. As part of the three-tiered site monitoring program, EPA Region IX and the Corps' San Francisco District can evaluate the physical, chemical, and biological parameters:

1. inside the HOODS site boundaries,
2. over an area adjacent to the HOODS site boundaries that may be found to be affected by dredged material disposal, and/or
3. at the reference site.

Both agencies are particularly concerned with effects at the HOODS site boundary and the adjacent area. When evaluations of biological resources of concern are made, the reference site will be used as the point of comparison for data obtained from the areas adjacent to the HOODS and stations within the HOODS.

C. Surveillance and Enforcement of Permits

Once dredging and disposal activities have begun, management responsibilities, including surveillance and inspection of dredging and disposal operations, will be initiated to ensure compliance with permit conditions. Surveillance of the disposal operations will be carried out by the U.S. Coast Guard with the assistance of EPA Region IX and the Corps' San Francisco District. EPA Region IX has the authority to enforce against illegal dumping activities, including non-compliance with permit conditions. Section 105 of MPRSA defines EPA's enforcement authority over these permits. Management options by the Corps' San Francisco District could involve the temporary or permanent withdrawal of a permit by the Corps' San Francisco District.

Surveillance and inspection may consist of one or more of the following activities:

1. On-board inspection by EPA Region IX or the Corps' San Francisco District staff to ensure that transportation and disposal of the sediment occur within the designated dump zone, and that the permittee complies with all the permit terms and special conditions.

2. On-board inspection by a certified inspector hired by the permittee or a regulatory agency to ensure that transportation and disposal of the sediment occur within the designated dump zone, and that the permittee complies with all the permit terms and special conditions.

3. Plots of barge navigation course while inside the confines of the disposal site. Permittees may be required to provide a record of the barge navigation course, annotated with the coordinates at the beginning and end of the disposal operation. For example, dumping contractors will be required to navigate using an electronic positioning system or other approved navigation system with sufficient accuracy to dispose of dredged material at specific locations within the disposal site.

4. The permittee will be required to prepare a detailed postdredging hydrographic survey of the dredging site to determine the quantity of dredged material disposed at the HOODS and to confirm that only permitted dredged material was disposed at the site. This survey will be compared to the predredging survey. An estimate of the total amount of dredged material disposed at the HOODS site should be provided based on pay yardage and any non-pay overdredged sediment.

III. SITE MONITORING

A. Overview

The site monitoring activities were designed specifically for the HOODS. They are an integral part of the SMMP framework. The major concerns and hypotheses are explained in Exhibit A. Implementation of site monitoring is a shared responsibility of EPA Region IX and the Corps' San Francisco District. The primary purpose of the site monitoring activities is to evaluate the impact of the disposal on the marine environment at the HOODS.

Monitoring activities will ensure that the area of acceptable impact is primarily restricted to the disposal site and that unacceptable environmental impacts do not occur beyond the site boundaries. To accomplish this, the site monitoring activities have been designed to:

- Identify the physical extent of dredged material disposal at the HOODS and to see whether material is moving outside the site boundaries.

- Identify what effects sediment moving outside the disposal site are having on sensitive benthic resources identified by EPA Region IX and the Corps' San Francisco District compared to similar benthic resources at a reference site.

- Determine whether body burdens of chemicals of concern exist in benthic resources that show significant adverse impacts at the HOODS compared to the reference site, and determine whether any potentially adverse impacts on resident fisheries resources or other amenities are possible, if significant body burden impacts are found.

The site monitoring activities are designed as a three-tiered hypothesis testing framework. Management decisions at each tier are defined for sediment fate and effects, body burdens of chemicals of concern or benthic biological community effects. Each tier will require a management decision based on the information gathered. If the null hypothesis for a particular tier is rejected, then a more complex set of tests are invoked at the next higher tier to determine the extent of impacts. Sequential-tiered testing is used to facilitate rapid, accurate and economical collection of information for use by the EPA Region IX and the Corps' San Francisco District in the management process. If monitoring results show that significantly adverse environmental impacts are predicted to occur or have occurred, then management actions may be necessary to avert or minimize such impacts.

B. Reference Site(s)

Because the HOODS site has been used as an interim disposal site, pre-dumping conditions cannot be used as a reference for site monitoring. A reference site, or sites, as appropriate, shall be used to document background conditions for comparison in site monitoring activities at Tiers 2 and 3, and to evaluate the suitability of sediment for ocean disposal as part of the sediment testing program. A reference site will serve as a basis for determining natural variability in the future at a site not affected by dredged material disposal.

IV. TIERED MONITORING AND MANAGEMENT DECISION OPTIONS

Appropriate management responses will be decided by EPA Region IX and the Corps' San Francisco District on a case-by-case basis. This SMMP does not attempt to specify particular responses to any predicted or actual adverse impact resulting from disposal activities. It does address possible management options, including those defined within the Ocean Dumping Regulations. The timing of monitoring surveys and other activities will be governed by agency funding resources, the frequency of disposal at the HOODS and acceptance or rejection of null hypotheses. The following information provides examples of actions to be considered for each tier.

A. Tier 1 - Sediment Transport Evaluation

The concerns for the sediment deposition and transport are: identifiable progressive movement or accumulation of disposed dredged materials that may affect any shoreline, marine sanctuary or critical biological area; and consistent detection of significant amounts of dredged material outside the disposal site using side-scan sonar, bathymetric surveys, sub-bottom profiling, sediment profile camera surveys, or other appropriate oceanographic survey methods. It is expected that Tier 1 (target) mapping surveys of the deposits within the disposal site would be conducted annually. If the null hypothesis for Tier 1 is rejected, then management decisions could include:

1. Revise size or location of the dump zone, or move dump zone to the upcurrent portion of the HOODS based on current data.

2. Enforce permit conditions on navigation and placement of barges.

3. Limit the amount of dredged material disposed at the site each year.

4. Reconfigure the disposal site boundaries.

5. Specify dredged material density or modify the consistency (i.e., percent clumping) of disposal material.

6. Evaluate the effect of sediment movement outside the HOODS site on sensitive benthic communities under Tier 2 or 3.

7. Implement other feasible and responsible management options that are developed as the monitoring program progresses.

8. Limit designation of the HOODS to a finite time and initiate environmental studies for a new disposal site.

9. Designate a new disposal site.

B. Tier 2 - Physical Impacts on Biological Resources of Concern

If dredged material moving out of the HOODS site is affecting sensitive biological resources identified by EPA Region IX and the Corps San Francisco District, then identification of these impacts will occur in Tier 2. An assessment of the sensitive benthic resource will be made by comparing the specific resources of concern at the HOODS to the same type of resources at a reference site or sites. Resources of concern could be benthic infauna, benthic epifauna, recreational fisheries or commercial fisheries resources.

Possible responses to rejection of the Tier 2 null hypothesis could include:

1. Restrict disposal to specific locations within the dump site to allow portions of the disposal site to recolonize.

2. Restrict disposal to upcurrent portions of the disposal site based on seasonal current patterns to prevent material from moving outside the site boundaries.

3. Enforce permit conditions on navigation and placement of barges.

4. Determine extent of adverse impacts on commercial and recreational fisheries resources or human health.

5. Evaluate body burden impacts on bioaccumulation effects in Tier 3.

6. Reconfigure the disposal site boundaries.

7. Implement other feasible and responsible management options that are developed as the monitoring program progresses.

8. Initiate environmental studies for a new disposal site.

9. Designate a new disposal site.

C. Tier 3 - Body Burden Analysis of Biological Resources

During the permitting process, proposed sediment is tested to determine whether there is a potential for the sediment to cause test species to bioaccumulate contaminants at a higher level than those animals exposed to the reference sediment. Proposed dredged material that shows the potential to cause significant bioaccumulation cannot be permitted for ocean disposal without the District Engineer seeking a waiver from the EPA Ocean Dumping Regulations.

If sensitive benthic resources outside the HOODS boundaries are significantly affected by disposal, then monitoring of body burdens of resident species will occur in Tier 3. EPA Region IX will conduct Tier 3 monitoring as part of its oversight responsibilities for site designation. Body burdens of chemicals of concern will be assessed by comparing tissues of specific resources of concern at the HOODS to the same resources at a reference site. These tests should not be confused with testing of proposed dredged materials that must be conducted for each permit application. The resources of concern would be the same as those identified in Tier 2 or higher trophic levels that feed on the benthic resources.

Possible responses to rejection of the Tier 3 null hypothesis could include:

1. Re-evaluate bioaccumulation testing and analytical procedures before issuing disposal permits.

2. Define the levels of contaminants in dredged material that would be suitable for ocean disposal, or restrict the quality of material to be dredged.

3. Determine extent of adverse impacts on commercial and recreational fisheries resources or human health.

4. Implement other feasible and responsible management options that are developed as the monitoring program progresses.

5. Initiate environmental studies for a new disposal site.

6. Designate a new disposal site.

D. Periodic Confirmatory Monitoring

The EPA may require confirmatory monitoring activities periodically on an other than annual basis. This monitoring may include but not be limited to periodic sediment chemistry, studies of sediment transport, bathymetric surveys, mound stability evaluations, or additional water current studies if it is determined that the dredged material is accumulating or moving more than expected. Confirmatory monitoring may also include conducting bioassays of sediments taken from the disposed dredged material footprint using one or more appropriate sensitive marine species consistent with applicable ocean disposal testing guidance ("Green Book" or related Regional Implementation Agreements), as determined by the Regional Administrator, to confirm whether contaminated sediments are being deposited at the HOODS despite pre-disposal testing of sediments. Other confirmatory activities may include testing for bioaccumulation by placement of near-surface arrays of appropriate filter-feeding organisms (mussels) in and around the disposal site for at least one month during active site use, to confirm whether substantial bioaccumulation of contaminants may be associated with exposure to suspended sediment plumes from multiple disposal events.

If a concern for water column impacts develops, EPA Region IX and the Corps' San Francisco District may require the permittees to monitor their discharge plumes as a special condition of the MPRSA Section 103 permit. The agencies would require the permittee to comply with the Limiting Permissible Concentration of the disposed dredged material and prevent unacceptable impacts on pelagic fisheries resources or coastal areas from the disposal plumes. If required, plume tracking would occur on a limited basis only, unless a management decision is made to continue these measurements.

E. Cancellation of the Designated Site

An overall management decision to cease all disposal activities at the site, either on a temporary or permanent basis, is also an option if other corrective actions are ineffective in preventing adverse environmental impacts beyond the site boundary. Temporary halts will allow the opportunity for further study to investigate means of preventing further impacts. If EPA Region IX and the Corps' San Francisco District determine that the HOODS has caused unacceptable environmental impacts, permanent cessation of disposal operations could be required. Closing the disposal site may be preceded by identification of an acceptable alternative ocean disposal site. Monitoring of the closed site may continue to ensure that adverse effects do not worsen and to allow remedial actions to proceed in a timely manner.

V. REFERENCES

U.S. Environmental Protection Agency, Region IX. 1995. Draft environmental impact statement (DEIS) for the designation of an ocean dredged material disposal site off Humboldt Bay, CA.

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EXHIBIT A

HUMBOLDT BAY (HOODS) OCEAN DREDGED MATERIAL DISPOSAL SITE SITE MONITORING PROGRAM

I. INTRODUCTION

Disposal of dredged material is expected to change benthic conditions inside the HOODS boundary because the variation of grain sizes in dredged material disposed at the HOODS is expected to allow different species to colonize the area. Site monitoring activities are necessary to assure that long-term unacceptable adverse environmental impacts do not occur within the HOODS site or beyond the site boundaries. A three-tiered monitoring program has been designed to evaluate conditions at the HOODS. Tier 1 consists of periodic physical surveys of the disposal site to determine the areal extent of disposed dredged material and whether material is being deposited outside of the disposal site boundaries. If significant adverse impacts on selected biological resources are suspected based on the Tier 1 survey, data on physical impacts (Tier 2) and body burdens of chemicals of concern (Tier 3) at the HOODS site and adjacent areas will be compared to a reference site.

The HOODS site monitoring activities are a part of the overall HOODS SMMP. The site monitoring program is based on testing specific hypotheses at three sequential tiers. Several aspects of the site monitoring program were developed in direct response to concerns identified in the HOODS Draft Environmental Impact Statement (DEIS). These concerns include questions on the movement of dredged material disposed at the HOODS and possible associated impacts on resident marine resources or fisheries resources if the disposed sediments move outside the site boundaries. Procedures defined in the site monitoring program should provide data required to make management decisions; however, the site monitoring program will be managed with the flexibility to modify, delete or substitute new monitoring procedures as other needs are identified.

II. OBJECTIVES

One of the major objectives of the HOODS site monitoring activities is to detect potentially adverse impacts beyond the HOODS site boundaries. Adjustments in site use will be selected to prevent adverse impacts from occurring in areas adjacent to the HOODS. Scientific analysis of the fate of the disposed dredged material is essential to meet this objective. With regard to physical sedimentation impacts, the objective is to determine whether benthic biological resources of concern have been adversely affected by sediment movement out of the site. The objective of biological monitoring is: (1) to determine if the ODMDS is causing detrimental bioaccumulation in resident infauna, epifauna or fisheries resources, (2) to provide early detection of potential threats to marine community structure, and (3) to evaluate whether potential impacts on biological resources will adversely affect higher trophic levels.

III. SITE MONITORING OVERVIEW

The site monitoring activities designed for the HOODS involve sequential collection of physical and biological data to help achieve the objectives outlined above. These objectives are defined to ensure compliance with state and federal laws, to provide guidance for EPA Region IX and Corps' San Francisco District staff for site management, and to address the concerns raised by other interested parties. The following concerns are addressed:

A. Sediment Impacts at the HOODS and Outside the Site Boundary

- Adverse physical environmental impacts on benthic communities near the ODMDS boundary.
- Habitat alterations displacing resident benthic communities near the ODMDS.

B. Water Column Impacts Outside the HOODS Site Boundaries

- Potential violation of established criteria at or beyond the site boundary at any time, or violation of criteria within the site boundary 4 hours after disposal.

C. Biological Impacts at the HOODS and Outside the Site Boundary

- Bioaccumulation of contaminants.
- Significant alteration in benthic communities based on bioaccumulation of contaminants.
- Significant changes in the resident epifauna or fish communities.

Each of these concerns is addressed in the site monitoring activities summarized in Table 1. Monitoring in a particular tier is based upon a testable hypothesis. If the null hypothesis for a specific tier is accepted, advancement to the next tier is not necessary. If the null hypothesis is rejected, an appropriate management action can be considered, or the prescribed monitoring from the next tier may be required. Information on management actions is provided in the HOODS SMMP.

Table 1. Tiered Monitoring at the HOODS Ocean Dredged Material Disposal Site

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TIER 1

- Periodic bathymetric, side-scan sonar and/or sub-bottom surveys of the HOODS funded by the Corps' San Francisco District based on site use.

TIER 2

- Assessment of sedimentation impacts on biological resources of concern as identified by EPA Region IX and the Corps' San Francisco District. This tier is triggered if dredged material moving out of the disposal site is determined by Tier 1 analysis to be a potential adverse impact to benthic resources.

TIER 3

- Body burden analyses of chemicals of concern in identified biological resources based on EPA Region IX's site designation and management oversight responsibilities. This tier is triggered if dredged material deposited outside of the disposal site is found to contain contaminants which could potentially cause adverse impacts to benthic resources.

CONFIRMATORY MONITORING

- Additional monitoring requirements imposed as needed by EPA Region IX or the Corps' San Francisco District to confirm sediment dispersion and quality.

Tier 1 bathymetric, side-scan sonar and/or sub-bottom surveys are expected to be scheduled on an annual basis, although this schedule may be modified based on the frequency of disposal, the amount of dredged material disposed at the HOODS, and the results of the monitoring activities. EPA Region IX and the Corps' San Francisco District will evaluate the survey data to test the Tier 1 hypothesis. We will determine whether movement of material out of the HOODS may cause adverse impacts on biological resources of concern adjacent to the site. If management options require additional monitoring, then physical (Tier 2) or biological impact (Tier 3) evaluations will be conducted as needed.

Monitoring actions described in Tiers 2 and 3 involve analyses of data from the HOODS in relation to a reference site described in Section II.A of the SMMP. The characteristics of the reference site or sites will represent the conditions of the HOODS before disposal of dredged material occurred. Thus, meaningful comparisons can be made between the sites to determine the impacts of dredged material disposal operations at the HOODS. Future reference site measurements will provide information on natural variability and periods of any unusual conditions in the region.

IV. DETAILS OF TIERED MONITORING

A. Tier 1 - Bathymetric Survey of the Site

Hypothesis: Dredged material accumulation outside of the HOODS boundary averages less than 0.5 inches (1.3 centimeters) relative to the bottom sediment surface defined at the time of site designation.

Monitoring at Tier 1 is designed to determine whether significant amounts of dredged material move beyond the HOODS boundary, thus providing an indication of potentially adverse impacts to nearby benthic resources of concern. Tier 1 monitoring is designed to evaluate the accumulation of dredged material outside of the disposal area, relative to baseline conditions at the time of site designation. Equipment such as precision bathymetry, side-scan sonar, sub-bottom profiling, or other similar oceanographic survey techniques will be used to detect accumulation of dredged material greater than 4 inches (10 centimeters) relative to the bottom sediment surface at the time of site designation. These data will be used to estimate the 0.5 inch contour as a test of the Tier 1 hypothesis. If Tier 1 analyses show sediment movement outside the site boundary and the null hypothesis is rejected, then management options will be evaluated to mitigate the impacts, or monitoring in Tier 2 can be scheduled.

B. Tier 2 - Sediment Impacts on Biological Resources of Concern

Hypothesis: Dredged material accumulation at or beyond the HOODS boundary does not show significant adverse impacts on biological resources of concern based on sediment physical properties compared to similar biological communities at a reference site or sites.

Tier 2 monitoring activities are designed to detect significant changes in biological resources of concern as a result of dredged material movement outside the HOODS. Biological resources of concern will be identified by EPA Region IX and the Corps' San Francisco District based on information contained in the HOODS EIS, the survey of the HOODS and information on fisheries resources in the area.

If benthic infauna are identified as a resource of concern, then analysis of this community can be accomplished by examining sediment profiles using techniques including but not limited to sediment profiling camera surveys taken in areas where dredged material has accumulated significantly. This type of information can be compared to other locations within the HOODS, zones outside the HOODS that have not been affected by dredged material disposal, or a reference site(s). The sediment profiling camera method has the advantage of providing in situ estimates of grain size distribution and infaunal community structure (Rhoads and Germano 1982). In addition, depending on the characteristics of previously deposited materials, newly deposited material can be differentiated by the photographs to indicate the rate of deposition at the site boundary for accumulation depths of from 2-8 inches (5-20 centimeters). Publications on this photographic profiling technique indicate that oxidized surface layer of previously deposited dredged material can be identified photographically when covered by similar material for up to a year (Germano and Rhoads 1984).

If resident benthic epifauna (invertebrates or fish) are identified as biological resources of concern, then bottom trawls can be used to sample areas where dredged material has accumulated. Samples can be compared to locations within the HOODS, zones outside the HOODS, or a reference site(s). The Tier 2 sampling is limited to assessment of physical impacts, such as the loss of a biological resource based on sediment movement, grain size changes or other effects from direct contact with disposed dredged material. Disposal of dredged material with a different grain size than the ambient sediments at the disposal site will change the biological community characteristics of the HOODS. Different species may colonize the disposal area because they can live in the finer or coarser grained dredged material. Simple changes in community structure in response to grain size changes are not considered significant impacts at the HOODS. If Tier 2 analyses show significant adverse impacts to biological resources of concern and the null hypothesis is rejected, then management options will be evaluated to mitigate the impacts, or monitoring in Tier 3 can be scheduled.

C. Tier 3 - Analyses of Body Burdens in Biological Resources

Hypothesis: Contaminant body burdens in biological resources of concern at stations where dredged material has moved out of the HOODS and within the HOODS are not significantly greater than body burdens detected in similar biological communities at a reference site or sites.

Analysis of contaminant body burdens will be conducted as part of EPA Region IX's site designation and management oversight responsibilities. If chemicals of concern (listed in EPA Region IX's August 1989 sediment testing guidance) bioaccumulate to a higher degree at the HOODS compared to a reference site(s), significant adverse impacts could affect resident biological communities at the HOODS or the adjacent areas where dredged material has moved out of the site. Tier 3 monitoring is designed to determine whether the HOODS is a site of significant bioaccumulation and to provide early detection of the potential for adverse impacts on nearby biological resources or human health.

Tier 3 monitoring will assess the concentration of chemical contaminants in resident infaunal or epifaunal organisms at the HOODS or other areas where dredged material has moved outside the site. The body burdens of organisms collected at or adjacent to the HOODS will be compared to similar organisms at a reference site(s). Collection of resident organisms for this analysis does not need to be quantitative. However, a large enough sample of the target species should be collected to provide adequate tissue for analysis. Sampling devices such as box cores, grabs or benthic sleds may be used. Selection of target species for this portion of the monitoring program should follow the protocols outlined in U.S. Environmental Protection Agency (1987) guidance.

If the Tier 3 hypothesis is rejected, management decisions will be evaluated to mitigate any impacts, or EPA Region IX and the Corps' San Francisco District will consider closing the HOODS and initiating the designation process for another suitable site.

V. REFERENCES

Germano, J. D. and D. C. Rhoads. 1984. REMOTS sediment profiling at the Field Verification Program (FVP) disposal site. Dredging '84: Proceedings of the conference, ASCE, November 14-16, Clearwater, FL, pp. 536-544.

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U.S. Environmental Protection Agency, Region IX. 1991. EPA Region IX general requirements for sediment testing of dredged material proposed for ocean dumping, effective date: August 1989, 8 pages.

Appendix B

Common and Scientific Names of Species Mentioned in Text

Appendix B. Common and Scientific Names of Species Mentioned in Text

Common Name	Scientific Name
Fish	
Butter sole	*Isopsetta isolepsis*
Dover sole	*Microstomus pacificus*
English sole	*Parophrys vetulus*
Petrale sole	*Eopsetta jordani*
Rex sole	*Glyptocephalus zachirus*
Sand sole	*Psettichthys melanostictus*
Starry flounder	*Platichthys stellus*
Pacific sanddab	*Citharichthys sordidus*
Speckled sanddab	*Citharichthys stigmaeus*
Rockfish	*Sebastes* sp.
Black rockfish	*Sebastes melanops*
Blue rockfish	*Sebastes mystinus*
Bocaccio rockfish	*Sebastes paucispinis*
Canary rockfish	*Sebastes pinniger*
Chilipepper rockfish	*Sebastes goodei*
Darkblotched rockfish	*Sebastes crameri*
Widow rockfish	*Sebastes entomelas*
Yellowtail rockfish	*Sebastes flavidus*
Salmon	*Oncorhynchus* sp.
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*Oncorhynchus kisutch*
Coastal cutthroat trout	*Oncorhynchus clarki clarki*
Steelhead trout	*Oncorhynchus mykiss*
Curlfin turbot	*Pleuronichthys decurrens*
Pricklebreast poacher	*Stellerina xyosterna*
Tubenose poacher	*Pallasina barbata*
Warty poacher	*Occella verrucosa*
Plainfin midshipman	*Porichthys notatus*
Staghorn sculpin	*Leptocottus armatus*
Showy snailfish	*Liparis pulchellus*
California halibut	*Paralichthys californicus*
Lingcod	*Ophiodon elongatus*
Brown smoothhound shark	*Mustelus henlei*
Longnose skate	*Raja rhina*
Black rattail	*Coryphaenoides acrolepis*
Giant rattail	*Coryphaenoides pectoralis*
Roughscale rattail	*Coryphaenoides acrolepis*
Blacktail snailfish	*Careproctus melanurus*

Appendix B. Continued

Common Name	Scientific Name
Twoline eelpout	*Bothrocara brunneum*
Spiny dogfish	*Squalus acanthias*
Pacific tomcod	*Microgadus proximus*
Pacific herring	*Clupea harengus pallasi*
Northern anchovy	*Engraulis mordax*
Night smelt	*Spirinchus starkis*
Whitebait smelt	*Allosmerus elongatus*
Eulachon	*Thaleichthys pacificus*
Shiner surfperch	*Cymatogaster aggregata*
Spotfin surfperch	*Hyperprosopon anale*
Silver surfperch	*Hyperprosopon ellipticum*
Walleye surfperch	*Hyperprosopon argenteum*
White seaperch	*Phanerodon furcatus*
Bay pipefish	*Syngnatus leptorhynchus*
Pacific cod	*Gadus macrocephalus*
Crustaceans	
Dungeness crab	*Cancer magister*
Bay shrimp	*Crangon franciscorum*
Coon-stripe shrimp	*Pandalus danae*
Pink ocean shrimp	*Pandalus jordani*
Sand shrimp	*Crangon nigricauda*
Market squid	*Logigo opalescens*
Echinoderms	
Brown mud star	*Luidia foliolata*
Short-spined star	*Pisaster brevispinus*
Pacific sand dollar	*Dendraster excentricus*
Molluscs	
Olive snail	*Olivella pycna*
Coastal and Sea Birds	
Turnstone	*Arenaria* sp.
Snowy plover	*Charadrius alexandrinus*
Loon	*Gavia* sp.
Cormorant	*Phalacrocorax* sp.
Double-crested cormorant	*Phalacrocorax auritus*
California brown pelican	*Pelecanus occidentalis*

Appendix B. Continued

Common Name	Scientific Name
Western gull	*Larus occidentalis*
Tern	*Sterna* sp.
Phalarope	*Phalaropus* sp.
Shearwater	*Puffinus* sp.
Jaeger	*Stercorarius* sp.
Short-tailed albatross	*Diomedea albatrus*
Marbled murrelet	*Brachyramphus marmoratus*
Aleutian Canada goose	*Branta canadensis leucopareia*
Marine Mammals	
Northern (Stellar) sea lion	*Eumetopias jubatus*
Harbor seal	*Phoca vitulina richardi*
California sea lion	*Zalophus californianus*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus usinus*
Dall's porpoise	*Phocoenoides dallii*
Harbor porpoise	*Phocoena phocoena*
Gray whale	*Eschrichtius robustus*
Humpback whale	*Megaptera novaeangliae*
Minke whale	*Balaenoptera acutorostrata*
Blue whale	*Balaenoptera musculus*
Finback whale	*Balaenoptera physalus*
Sperm whale	*Physeter catodon*
Northern right-whale	*Lissodelphis borealis*
Risso's dolphin	*Grampus griseus*
White-sided dolphin	*Lagenorhynchus obliquidens*
Reptiles	
Leatherback turtle	*Dermochelys coriacea*