Kikiaola Light Draft Harbor
Navigation Imp.

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July 13, 1998

OFC. OF QUALITY ... BOR-E 0025.99

Mr. Gary Gill, Director
Office of Environmental Quality Control
235 South Beretania Street, Suite 702
Honolulu, Hawaii 96813

Dear Mr. Gill:

SUBJECT: *Navigation Improvements, Kikiaola Light Draft Harbor, Kekaha, Kauai, Hawaii*

Enclosed is the supplemental information, prepared by the U.S. Army Corps of Engineers, in compliance with the existing requirements of the Hawaii Administrative Rules for submission of a State Environmental Assessment. We have reviewed this supplemental information and concur with these findings.

Accordingly, we request that you initiate action for subsequent project notice issuance into "The Environmental Notice" bulletin as a joint Federal/State Environmental Assessment for the subject navigation improvement project.

We have reviewed the Final Environmental Assessment, prepared by the U.S. Army Corps of Engineers, and hereby issue a finding of no significant impact.

Should you have any questions, please call me at 587-1966, or contact Manuel Emiliano of our Boating Engineering Branch at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

Enclosure

cc: Tim Young, COE
BOR-K

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1998-07-23-KA-FEA-KiKiaola Light

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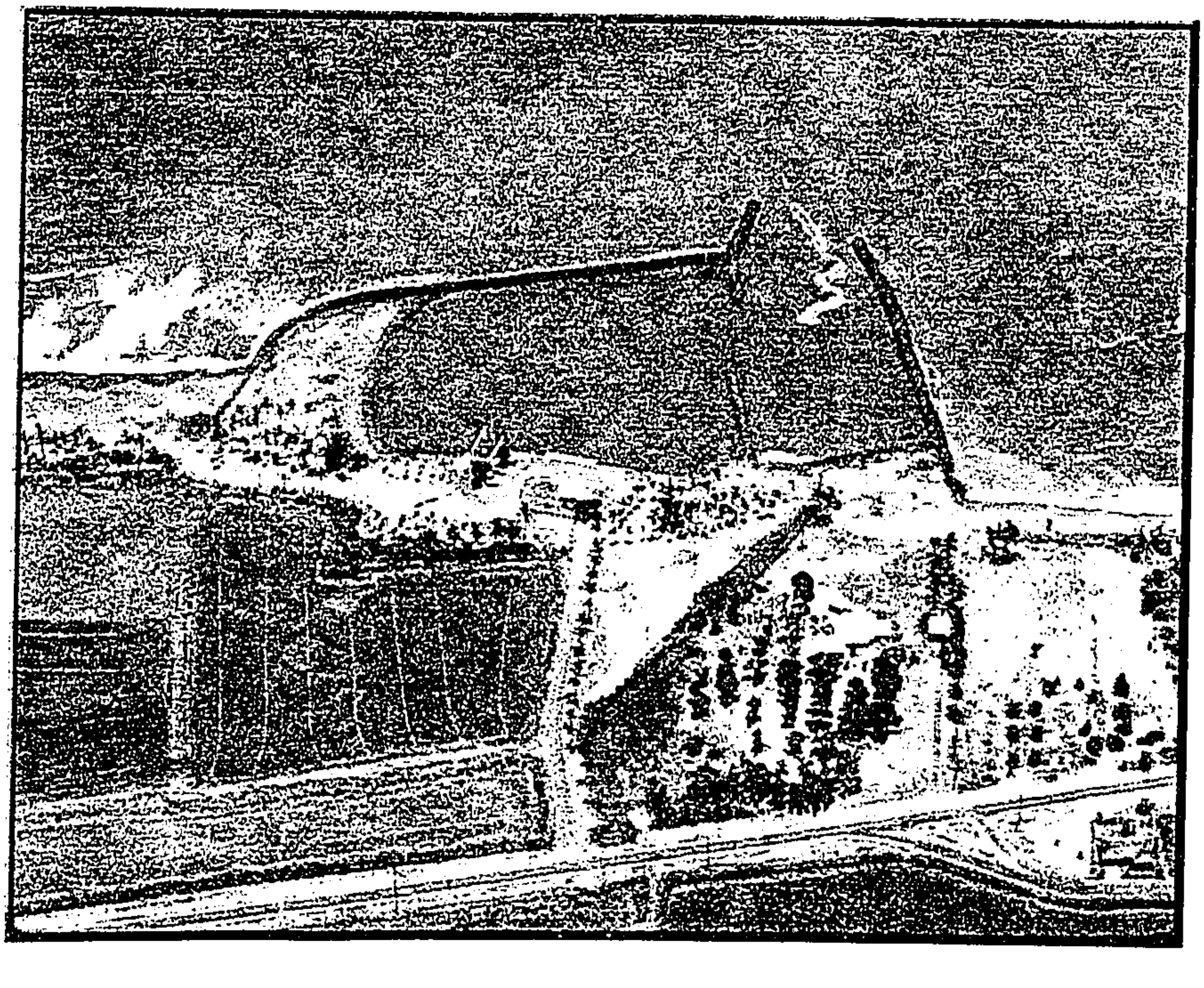
Draft Harbor Navigation Improvements

U.S. ARMY CORPS
OF ENGINEERS
Honolulu Engineer District

GENERAL REEVALUATION REPORT AND
ENVIRONMENTAL ASSESSMENT
JUNE 1998

NAVIGATION IMPROVEMENTS
KIKIAOLA LIGHT DRAFT HARBOR
Kekaha, Island of Kauai, Hawaii



NAVIGATION IMPROVEMENTS
AT
KIKIAOLA
LIGHT DRAFT HARBOR

Kekaha, Kauai, Hawaii

GENERAL REEVALUATION REPORT
AND
ENVIRONMENTAL ASSESSMENT

JUNE 1998

EXECUTIVE SUMMARY

NAVIGATION IMPROVEMENTS AT KIKIAOLA LIGHT DRAFT HARBOR

1. **Authority.** This study was accomplished under the authority of Section 101 of the River and Harbor Act of August 13, 1968 (Public Law 90-483).

2. **Background.** A General Design Memorandum (GDM) and Final Environmental Impact Statement (EIS) was completed in September 1980 and approved by the Director of Civil Works in September 1981. Subsequently, construction priorities set forth by the State of Hawaii had been revised and Kikiaola Harbor was placed third on the State's scheduled list of projects. This project was put on hold for several years until June 1991 when a formal request was received from the State of Hawaii to initiate Preconstruction Engineering and Design (PED). Federal funding for the PED phase was appropriated for Fiscal Year 1994.

3. **Purpose.** This General Reevaluation Report (GRR) was prepared to determine whether continued Federal interest in harbor modifications is warranted based on a re-evaluation of existing and new alternative plans.

4. **Project Sponsor.** The project sponsor for this project is the State of Hawaii, Department of Land and Natural Resources (DLNR).

5. **Study Location.** Kikiaola Harbor is located along the southwest coast of the Island of Kauai. The harbor is approximately 1-mile southeast of Kekaha, 1.5 miles west of Waimea, and 8 miles northwest of Port Allen, the nearest light-draft vessel harbor.

6. **Problem Identification.** Boaters and fishermen utilizing the existing State built harbor continue to experience hazardous navigation conditions. The shallow depths in the harbor basin and the entrance channel contribute directly to the navigational problems. As a result of the shallow depths in the entrance channel, steep wave fronts and breaking wave conditions are encountered by boaters several times a year. There have been numerous documented cases of vessels sustaining minor damages during transit within the harbor basin and channel.

7. **Recommended Plan.** Based on the economic, social and environmental impacts and needs and desires of the boating community and local sponsor, Plan 1 was selected as the recommended plan of improvement. Plan 1 is the National Economic Development (NED) Plan which maximizes net benefits and is the original authorized plan. The recommended plan of improvement includes the modification and removal of existing breakwaters, dredging of an entrance and access channel and provides a berthing area for 45 boats.

8. **Environmental Impacts**. Based on existing boring logs, no blasting will be required during dredging operations. The dredging of the entrance and access channel and berthing area will consist mostly of loose silty sand and some basalt and coral limestone sand at the outer portion of the entrance channel. Since the basic harbor configuration and footprint of protective

structures are essentially identical to the existing facility, only minimal impacts to the marine environment is anticipated. Dredging operations are expected to cause a temporary increase in turbidity, however, the contractor will be required to implement construction controls such as movable silt barriers around the dredging plant. The proposed disposal site for the initial dredged material will be on property adjacent to the existing harbor belonging to the Kikiaola Land Company.

9. **Sand Bypass Program.** A sand bypass program will be implemented by the project sponsor upon completion of this project. In an effort to minimize future maintenance harbor dredging requirements and address existing shoreline erosion, a mitigation plan which incorporates the physical relocation of sand (Sand Bypassing) will be implemented. Sand bypassing would be accomplished *mechanically* by removing material along the eastern shoreline (Accreted Shoreline) and placing it along the western shoreline (Eroded Shoreline) by dump truck and loader. It is estimated that approximately 16,000 CY of material will need to be moved every 4.5 years.

10. **Physical Data.**

Existing Outer East Stub Breakwater:
- Remove 150 feet

Existing East Breakwater:
- Raise crest elevation by four feet from Station 8+70 to Station 9+85 & three feet from Station 2+50 to Station 8+20.
- Flatten seaward slope to one vertical on two horizontal from Station 8+70 to Station 9+85.

Existing/New Inner East Breakwater:
- Remove 85-foot existing breakwater.
- Construct new 85-foot breakwater.

Existing West Breakwater:
- Modify 220 feet of the existing west breakwater by resetting the armor stone so that it is keyed and fitted from Station 3+80 to Station 6+00.

New Entrance Channel:
- Dredge 700-foot long, 105 to 205-foot wide entrance channel to a depth of 11 feet.

New Access Channel:
- Dredge 320-foot long channel to depth of seven feet & varying in width from 70 to 105 feet.

11. **Benefit to Cost Ratio.**

Average Annual Cost	$529,000
Average Annual Benefits	$643,000
Benefit / Cost Ratio	1.22
Net NED Benefits	$114,000

Note: Benefits & cost based on October 1997 price level & the amortization of cost over a 50-year economic life at an interest rate of 7-3/8 percent.

12. **Total Project First Costs (Recommended Plan).**

ITEM	FEDERAL	NON-FEDERAL
General Navigation Features (GNF):	$4,543,000	$1,009,000
LERR&D	0	$101,000
ULTIMATE COST	**$4,543,000**	**$1,110,000**
Inner Harbor Facilities:		
U.S. Coast Guard Navigation Aids	$35,000	0
Floating Dock System	0	$420,000
Berthing Area Dredging	0	$137,000
TOTAL PROJECT FIRST COSTS 1/	**$4,578,000**	**$1,667,000**

1/ April 2001 price level (Estimated midpoint of construction)

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NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

MAIN REPORT

GENERAL REEVALUATION REPORT
AND
ENVIRONMENTAL ASSESSMENT
FOR
NAVIGATION IMPROVEMENTS AT
KIKIAOLA LIGHT DRAFT HARBOR

KEKAHA, KAUAI, HAWAII

JUNE 1998

1. INTRODUCTION

1.1 STUDY AUTHORITY

The General Reevaluation Report (GRR) and Environmental Assessment for Navigation Improvements at the Kikiaola Light Draft Harbor, Kekaha, Kauai, Hawaii, was prepared under the authority of Section 101 of the River and Harbor Act of August 13, 1968 (Public Law 90-483) in accordance with House Document No. 353, 90th Congress, 2nd Session. House Document No. 353 contained the Chief of Engineers' report dated July 8, 1968 on Coasts of the Hawaiian Islands, Harbors for Light Draft Vessels. Applicable portions of this section are as follows:

> "Section 101. That the following works of improvement of rivers and harbors and other waterways for navigation, flood control, and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of the Army and supervision of the Chief of Engineers, in accordance with the plans and subject to conditions recommended by the Chief of Engineers in the respective reports hereinafter designated. The provisions of section 1 of the River and Harbor Act approved March 2, 1945 (Public Law Numbered 14, Seventy-Ninth Congress, First Session), shall govern with respect to projects authorized in this title; and the procedures therein set forth with respect to plans, proposals, or reports for works of improvement for navigation or flood control and for irrigation and purposes incidental thereto, shall apply as if herein set forth in full.

NAVIGATION

Coasts of Hawaiian Islands, Harbors for Light Draft Vessels".

1.2 STUDY BACKGROUND

The Kikiaola Harbor project for navigation improvements was originally initiated and investigated under the "Report on Survey of the Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels", authorized by Section 110 of the River and Harbor Act of May 17, 1950. The report was completed in June 1967 and forwarded to the Division Engineer and Board of Engineers for River and Harbors for review and approval. The Board of Engineers for River and Harbors concurred with the findings of the reporting officers and recommended construction of the improvements at Kikiaola Harbor. Subsequently, the final report, was signed by the Chief of Engineers on April 11, 1968 and forwarded to the Secretary of the Army for approval. In response to authorizations contained in the River and Harbor Act of May 17, 1950, a favorable report was recommended to be submitted to the Congress. The Bureau of Budget stated in June 1968 that no commitment could be made as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Post authorization studies were initiated in 1978 to reaffirm the basic planning decisions made during the preauthorization studies. Because of the long interval between project authorization in 1968 and post authorization studies, the General Design Memorandum (GDM) studies included reevaluation of problems and needs, public attitude towards the plan of improvement, possible alternative plans, oceanographic analysis, navigation requirements, social and economic evaluations, and desires of the project sponsor. The GDM and Final Environmental Impact Statement (EIS) was completed in September 1980 and approved by the Director of Civil Works in September 1981.

Subsequently, construction priorities set forth by the State of Hawaii were revised and Kikiaola Harbor was placed third on the State's scheduled list of projects. In addition, cost sharing issues raised by the Water Resource Development Act of 1986 (WRDA 86) further delayed State activity on the project. This project was put on hold for several years until June 1991 when a formal request was received from the State of Hawaii to initiate Preconstruction Engineering and Design (PED). Federal funding for the PED phase was appropriated for Fiscal Year 1994.

1.3 STUDY PURPOSE AND SCOPE

The purpose of this GRR is to reaffirm the basic planning decisions made during post authorization studies. A reevaluation of the alternative plans presented in the 1980 GDM Report and an evaluation of the new alternative plan were completed under this study. Based on criteria changes to the Civil Works Planning Guidance and consideration of a new alternative plan, this GRR includes a reevaluation of problems and needs, public attitude towards the plan of improvement, new alternative plans, numerical model testing, sediment transport study, navigation requirements, social and economic evaluations, and desires of the project sponsor to determine if continued Federal interest in harbor modifications to the existing Kikiaola Harbor is warranted.

The preparation of the GRR follows the basic criteria for a Feasibility Report. This GRR reviewed and reevaluated the identified problems, needs and extent to which federal government should participate in implementing navigation improvements. The alternative plans presented in this report were assessed and evaluated and a recommended plan of improvement was selected. The evaluation process was based on a plans overall compatibility, acceptability and compliance with technical, economic, social, and environmental criteria.

1.4 STUDY AREA

Kikiaola Harbor is located on the southwest coast of Kauai. Kauai is the northernmost of the eight major Hawaiian Islands and is 103 statute miles west and slightly north of Honolulu. The roughly circular island is the fourth largest in the chain with a land area of 549 square miles. The harbor is approximately 1-mile southeast of Kekaha, 1.5 miles west of Waimea, and 8 miles northwest of Port Allen, the nearest light-draft vessel harbor. Lihue, the county seat and center of commerce and business activity, is located approximately 23 miles east of Kikiaola Harbor.

1.5 STUDY PARTICIPANTS AND COORDINATION

The Honolulu Engineer District (HED) has the overall responsibility for conducting and coordinating the study and preparing this report. The lead local agency involved in the study is the State of Hawaii, Department of Land and Natural Resources, Division of Boating and Ocean Recreation. The preparation of this report has also been coordinated with other State, County and Federal agencies such as the U.S. Fish and Wildlife Service, National Marine Fisheries Service, State Historic Preservation Officer, County of Kauai Department of Public Works ,the State Coastal Zone Management and the local boating community.

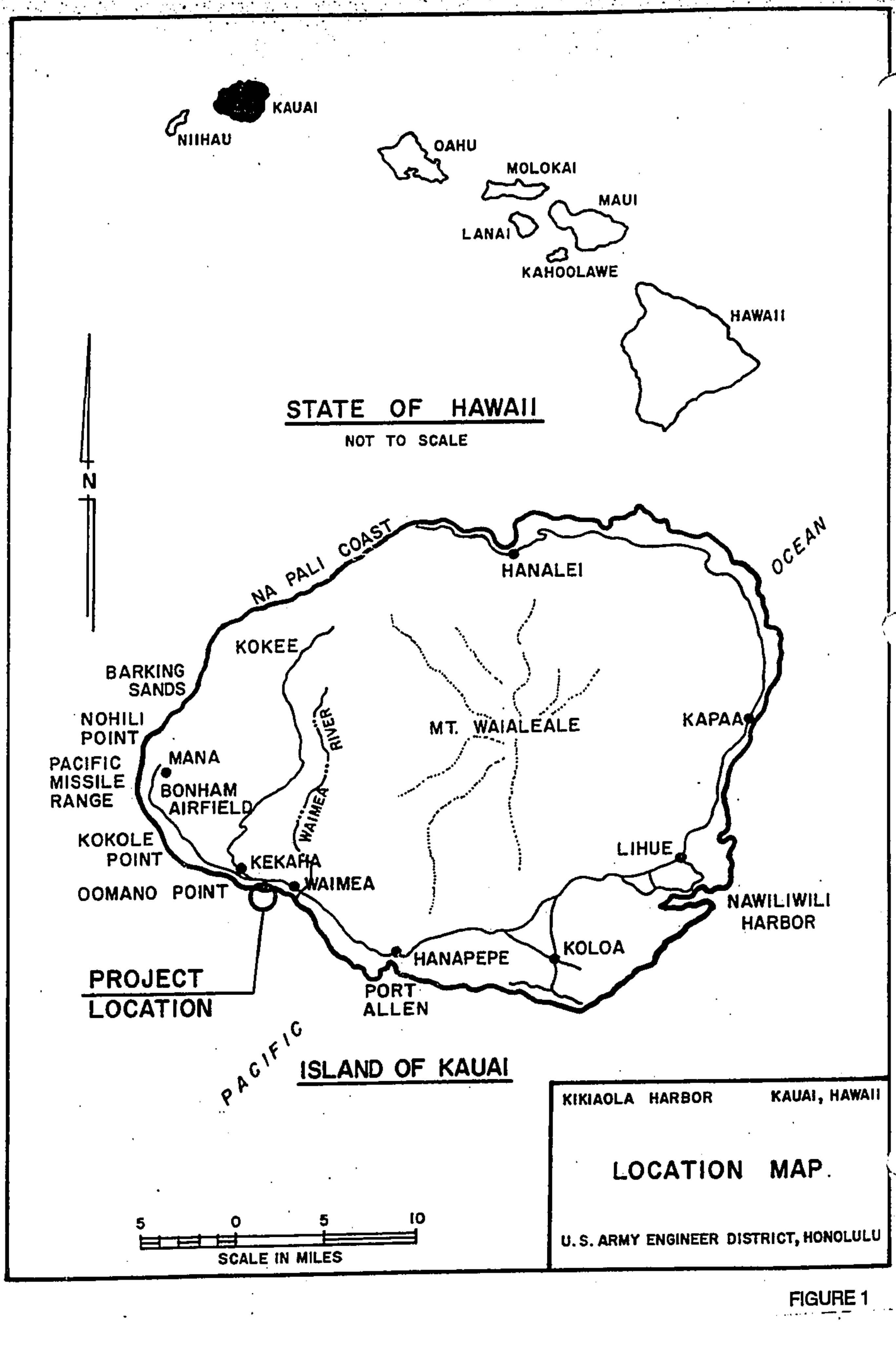
1.6 PRIOR STUDIES AND REPORTS

1.6.1 Interim Report on Survey of the Coast of the Hawaiian Islands Harbors for Light Draft Vessels, March 1963

This report was prepared to determine the need for additional harbors on the six major islands of Kauai, Oahu, Molokai, Lanai, Maui and the Big Island of Hawaii. The report concluded that Federal participation with the State of Hawaii in developing an improved and expanded system of boat harbors to meet the present and projected needs of the State is warranted and desirable in the public interest.

1.6.2 Report on Survey of the Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels, June 1967

This report was prepared to investigate the need for harbor modifications at three existing State light-draft vessel harbors. The report concluded that Federal participation with the State of Hawaii in expanding or improving the existing light-draft vessel facilities at Kikiaola Harbor (Kauai), Ala Wai Harbor (Oahu) and Maalaea Harbor (Maui) are warranted and desirable in the public interest.


KAUAI
NIIHAU
OAHU
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
STATE OF HAWAII
NOT TO SCALE
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KOKEE
BARKING SANDS
NOHILI POINT
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MANA
BONHAM AIRFIELD
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KAPAA
WAIMEA RIVER
KOKOLE POINT
KEKAHA
WAIMEA
OOMANO POINT
LIHUE
NAWILIWILI HARBOR
KOLOA
HANAPEPE
PORT ALLEN
PROJECT LOCATION
PACIFIC
ISLAND OF KAUAI
5 0 5 10
SCALE IN MILES
KIKIAOLA HARBOR
KAUAI, HAWAII
LOCATION MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1

1.6.3 General Design Memorandum (GDM) and Environmental Impact Statement (EIS) for Kikiaola Harbor for Light-Draft Vessels, September 1980

This document describes the feasibility and environmental impacts of navigation improvements for Kikiaola Harbor. The project concept and site were previously authorized by Congress in 1968. This document reaffirms the basic planning decisions made during the preauthorization studies. The proposed improvements were designed to alleviate adverse navigation conditions. The scope of this report included problem identification, examination of various alternative plans of improvement, and an evaluation of the plans from a technical, economic, environmental and social viewpoint. The scope of the EIS included identifying the purpose and need for undertaking the proposed action and evaluating the environmental, cultural and social impact on the study area resulting from the various alternative plans. This report evaluated five alternative plans and selected one as the recommended plan of improvement.

The recommended plan of improvement consisted of dredging a 725-foot long entrance channel and a 320-foot long access channel, removing 150 feet of the existing outer east stub breakwater, modifying 820-feet of the existing east breakwater, modifying 220 feet of the existing west breakwater, and removing and constructing an 85-foot long inner east stub breakwater.

1.6.4 Littoral Transport Study, Kekaha, Kauai, May 1977

A littoral transport study was conducted in 1977 by Hydrophysics Corporation for the U.S. Army Corps of Engineers to investigate the beach erosion problem along the western shores at Kekaha. The primary purpose of this study was to gather existing and new pertinent data to determine whether littoral drift patterns in the area from Kokole Point to the mouth of the Waimea River are being disrupted by shoreline construction projects in the Kekaha area. The Kikiaola Harbor, originally developed by the State of Hawaii in 1959, is located within the study area.

1.6.5 Circulation, Sediment, and Water Quality Study, Kikiaola Boat Harbor, Waimea, Kauai. Hawaii, May 1980

A study was conducted in 1980 by Sea Engineering Services, Inc./R.M. Towill Corporation, A Joint Venture, for the U.S. Army Corps of Engineers to determine and evaluate circulation patterns, sediment transport rates and water quality within and adjacent to the existing Kikiaola Harbor. The data obtained from this study supplemented previous existing data and was used in evaluating design criteria and the preparation of the environmental impact statement for improvements to the existing harbor. The specific work tasks completed under this study included the following: Surface and mid-depth measurement of various water quality parameters; Characterization of circulation patterns utilizing drogues in and around the harbor during ebb and flood tide conditions; emplacement of sediment traps seaward of the harbor entrance to measure alongshore bedload sediment transport; and emplacement of sedimentation bottles within the harbor basin to measure the sedimentation rate of suspended material.

1.7 REPORT PREPARATION

This GRR is a single document that integrates the General Reevaluation Report, Environmental Assessment and all other National Environmental Policy Act (NEPA) documentation. The report consists of a main report and appendices. The main report is a self-contained document that describes the planning process and discusses the environmental aspects of this project. The appendices contain technical and detailed information and background data to support the information presented in the main report.

2 PROFILE OF EXISTING BASE CONDITIONS

2.1 HISTORY

The town of Waimea, located 1.5 miles east of the harbor, was the site of Captain Cook's first discovery of the Hawaiian Islands in 1778, a Russian fort built in 1817 and the area's first sugar cane industry in the 1880's. The modern village of Kekaha, 1 mile to the west of Waimea was founded in 1897. In 1787, Captain George Dixon walked west from "Wy'maia" through "very dry" country of grass-covered light red soil and came upon "A Tappa" (or Kekaha) village just inland of O'omano Point. He found "amongst these cocoa-nut trees (at Kekaha village), a good deal of wet swampy ground which is well laid out in plantations of taro and sugarcane."

2.2 PHYSICAL ENVIRONMENT

2.2.1 Site Geology

The existing Kikiaola Harbor is located on a uniformly straight, low and wide beach that extends for 2.7 miles from the Waimea River to the west, to Oomano Point at Kekaha. The adjacent land is a flat, alluvial terrace (or platform), 10-15 feet in elevation above sea level, 1 mile in width and underlain by both alluvial and marine sediments. On the outer or seaward edge of the terrace lies a low beach with calcareous sand dune ridges. At the inner edge, spurs of lava flows (Waimea Canyon Volcanic Series) are truncated by an ancient sea cliff. The sea covered the terrace in ancient times and deposited a series of calcareous sandstone and sandy limestone benches and reefs. The rock benches and reefs have been removed (at least down to -12 feet Mean Lower Low Water (MLLW)) over most of the harbor.

2.2.2 Climate

Temperatures on the coastal plain are generally mild throughout the year, varying from a mean monthly temperature of 70 degrees F in winter to 78 degrees F in summer. At the 1,000 foot and higher elevations, temperatures are slightly cooler with averages from 67 degrees F in winter to 75 degrees F in summer. The Waimea-Kekaha coastal plain is located on the leeward side of Kauai and receives the least amount of rainfall for the island. The average annual rainfall is 22 inches at Kekaha and 21 inches at Waimea. At the higher elevations rainfall totals average 100 inches annually.

2.2.3 Winds

The prevailing northeast tradewinds occur approximately 75 percent of the year. The tradewinds are most prevalent during the spring and summer months with typical speeds of 10-20 miles per hour. The tradewinds are frequently replaced during the winter months when low pressure systems called "Kona" storms or weather enter the Hawaiian Area. These systems will typically produce inclement conditions ranging from gale force southerly winds with heavy rain to calm, humid, or rainy weather.

2.2.4 Hurricanes

The severe damage sustained by Kauai by Hurricane Iwa in November 1982 and Hurricane Iniki in September 1992 underscore the fact that the Hawaiian Islands are susceptible to destructive hurricanes. The inner boat launching facilities at the Kikiaola Harbor were damaged from flooding; however, no major damage was sustained by the breakwater during Hurricane Iniki. Hurricanes that typically approach the Hawaiian Islands originate as tropical cyclones in the Central Pacific Ocean over warm tropical waters and will generally track in a westerly direction.

2.2.5 Tides

The tides in the Hawaiian Islands are semi-diurnal with pronounced diurnal inequalities. Tidal data, shown below, was obtained from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Ocean Survey. The nearest tide gage is located at Waimea Bay, approximately 1.8 miles east of Kikiaola Harbor. Tidal data for Kikiaola is as follows:

Highest Tide (Estimated)	3.00 feet
Mean Higher High Water	1.60
Mean High Water	1.20
Half Tide Level	0.70
Mean Low Water	0.20
Mean Lower Low Water	0.00
Lowest Tide (Estimated)	-1.00

2.2.6 Water Quality

Within the framework of the State Department of Health (DOH) Water Quality Standards, Kikiaola Harbor is classified as an artificial basin. Water quality criteria that apply are those specified for Class A marine waters. It is the objective of Class A waters that their use for recreational purposes and aesthetic enjoyment be protected. Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish and wildlife and with recreation in and on these waters. The marine bottom ecosystem classification for Kikiaola Harbor is Class II. The uses to be protected in this class are the same as for Class A waters.

2.2.7 Air Quality.

Air quality in the project area is good. There are no sources of industrial pollution in the vicinity. The State of Hawaii Department of Health has one air quality monitoring station on Kauai, located in Lihue, which monitors six pollutants. Between January 1988 and December 1990 none of the samples exceeded either the Federal Air Quality Standards or the State of Hawaii Standards (State of Hawaii, undated).

2.2.8 Noise

Noise levels are generally low in the harbor area. The noise from power boats is usually the dominant sound.

2.2.9 Waves

The current within the surf zone is the primary driving force for littoral transport and is generated by waves shoaling and breaking at an angle to the beach. The quantity and direction of littoral transport are related to the wave height, period, approach direction, bottom depth, and sediment characteristics. There are four distinct deep water wave types that impact the harbor area and thus influence littoral transport:

- Northeast trade wind waves are most prevalent occurring approximately 75 percent of the year and reach the site after refracting around the southern tip of Kauai.

- North Pacific swells are generated by winter storms in the North Pacific and approach from the northwest through northeast. These waves refract around the west end of Kauai and affect areas just west of Kikiaola Harbor.

- South swells are typically generated during the summer (Antarctic winter months) by strong winds blowing over long fetches of the southern Pacific and Indian Ocean and approach the site directly from the southeast, south, and southwest.

- Kona storm waves are typically generated during the winter and approach the site from the southeast through southwest. Large kona waves occur infrequently but may move large volumes of littoral material.

2.2.10 Seismicity

The 1991 Uniform Building Code designates Kauai in a seismic Zone 1 from a scale of Zones 0 to 4 with 4 being the highest. The potential for seismic damage is low.

2.2.11 Tsunami (Seismic Sea Waves)

The Kikiaola Harbor area is subject to potential tsunami or seismic sea wave inundation as are all low lying coastal areas in the Hawaiian Islands. A severe tsunami at the Kikiaola Harbor may cause an abnormal rising and falling of the sea level, resulting in flooding of low lying areas and grounding of boats in the harbor. Based on the latest Flood Insurance Rate Map prepared by the Federal Emergency Management Agency the Kikiaola Harbor is situated in a tsunami inundation area of Zone VE where the base flood elevation is approximately 9.0 feet above mean sea level.

2.3 ECONOMIC CHARACTERISTICS

Kauai County generated about $1 billion in gross business receipts in 1995. This amount represents about one-half the size of the economies of Maui and Hawaii and only three percent of Oahu's economy. There were approximately 24,000 jobs on Kauai in 1995 and 28,000 workers in the civilian labor force. Construction put in place came to about $126 million that year.

As it is with the other counties in the state, tourism is Kauai's largest economic sector. There are several large hotel complexes located in the southern, northern, and eastern portions of the island. They have a total of about 6,800 rooms for guests and provide about 3,200 jobs for residents. In 1995, Kauai hosted about 900,000 visitors and had a hotel occupancy rate of 65 percent. Construction, the military, and agriculture have been the other historically important sectors in the economy while high technology and filmmaking are becoming more prominent.

The economy of Kauai has yet to fully recover from the effects of Hurricane Iniki, which struck in 1992. Electric power sales, a measure of general economic activity, recently surpassed the 1991 level for the first time, but visitor arrivals have yet to reach pre-hurricane levels. Hotel reconstruction is on the rise, but Kauai County continues to have the highest unemployment rate in the state at 11.3 percent in 1996. Despite these mixed indicators, there is optimism that the Kauai economy is slowly getting back to normal.

2.4 ENVIRONMENTAL RESOURCES

2.4.1 Terrestrial Resources

Terrestrial flora consists largely of introduced and/or cultivated species, including coconut palms (Cocos nucifera), *kiawe* (Prosopis pallida), ironwood (Casurina equisetifolia), hau (Acacia farnesiana), banyan (Ficus sp.); Plumeria sp. beach *naupaka* (Scaevola taccada), beach morning glory (Ipomoea pes-caprae) and other hervaceous weeds and grasses, as well as commercially-cultivated sugarcane (Saccharum officinarum). Terrestrial fauna are predominantly domestic animals and livestock and introduced species such as the domestic dog (Canis familiaris), domestic cat (Felis catus), house mouse (Mus musculus), roof rat (Rattus rattus), and the Norway rat (Rattus norvegicus). The attached Environmental Assessment lists the common introduced and migratory birds likely to be found in and around the project site.

2.4.2 Marine Resources

Agricultural land use in the project area has had a profound effect on the nearshore marine environment. In the past, silt laden run-off from sugarcane fields has been collected and discharged into Kikiaola Harbor via a drainage ditch. Terrigenous sediments, predominantly red clay and silt, have accumulated in the harbor basin, which acts as a sediment trap. Nearshore waters are rendered a reddish-brown color, reducing Secchi disc measurements to as little as one foot in the inner harbor. Core samples indicate that these sediments have been deposited on the harbor bottom, overlying and mixing with calcareous and basaltic sands. The discharge of agricultural runoff is now regulated by a flap gate located 980 feet inland. The gate is only opened during periods of local flooding, about 2-3 times per year.

Salinity was measured using a refractometer. Values of 28-29 parts per thousand were measured at wharfside. These values are approximately four-fifths that of normal seawater, indicative of recent freshwater runoff or infiltration of groundwater through the permeable sandy substratum of the coastal plain. This condition may be exacerbated by relatively poor circulation between the harbor and open ocean waters.

Intertidal habitat includes both soft, silty-sand and hard, basaltic rock substrates which are inhabited by distinctly different flora and fauna.

Man-made breakwaters provide a hard substrate on which attached and encrusting algae are abundant. These include green algae (*Cladophora fascicularis* and *Ulva fasciata*), red algae (*Acanthophora spicifers*) and crustose (*Porolitithon onkodes*). The latter was found predominantly on the wave-washed seaward face of the east breakwater. Grapsid crabs (*Metapograpsus sp.*) are particularly abundant along this high energy intertidal zone, as well. Gastropod mollusks were more abundant in the calmenr intertidal habitat of the harbor. These species include the dotted periwinkle (*Littorina pintado pintado*) common nerite (*Nerita picea*) kneecap shell (*Cellana argentata*), black limpet (*C. exarata*), and false limpet (*Siphonaria normalis*) in descending order of abundance. Plecypod (bivalve) mollusks were found in the less rigorous environment of the inner harbor. These included the purse shell (*Isognomon californicum*) and the encrusted bottom shells of one or more unidentified species of oyster.

Soft, sandy substrates are located at the eastern end and in the northwest corner of Kikiaola Harbor. This habitat is occupied by one or two different species of ghost crab. Their burrows ranged in density from less than one per square meter to approximately 5 per square meter.

Five separate hauls were made at two different sites within the harbor using a 25-foot seine. Invertebrates collected by this means included the white crab (*Portunus sanguinolintus*) and an unidentified palaemonid shrimp. The predominant fish collected included the island silverside (*Pranesus insularum*), nehu (*Stolephorus purpureus*), aholehole (*Kuhlia sandvicensis*), and Samoan mullet (*Chelon engeli*).

One fisherman was observed fishing for mullet using a cast net near the shoreline at the east end of the harbor. Interviews with other local fishermen indicated that a fishery for moi (*Polydactylus sexfillis*) also exists in the harbor, although no specimens were collected.

2.4.3 Endangered Species

There is no appropriate habitat in the project area for the four endangered Hawaiian water birds or the rare Hawaiian forest birds; however, the Hawaiian owl (*Asio flammeus sandwichensis*) on the State of Hawaii endangered species list may occasionally forage in the area, but is not known to nest here. The federally listed endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) may also occasionally forage in the area, but it is not known to roost here. There are no protected species of plants or insects reported from the area.

The endangered humpback whale (*Megaptera novaeangliae*) is resident in Hawaiian waters from November thru May each year, and during this period they are commonly sighted in the waters near the project site. The threatened green turtle (*Chelonia mydas*) is now very common in the waters around the main Hawaiian islands, including the vicinity of the project area. The endangered hawksbill turtle (*Eretmochelys imbricata*) and the endangered Hawaiian monk seal (*Monachus schauinslandi*) occur in the waters around the island of Kauai only very rarely, and neither breeding or nesting is known to have occurred in the area around Kikiaola Harbor.

2.5 SOCIO-CULTURAL ENVIRONMENT

2.5.1 Land Use

The proposed land use plan, as described in the Waimea-Kekaha Development Plan, provides for moderate growth and development in the Waimea-Kekaha region. The Waimea-Kekaha area is primarily regarded as an agricultural region. Sugarcane fields dominate the region's productive coastal plain and lower elevation lands. Currently, adjacent land area to the east (Waimea) is cultivated for sugarcane production. The land area to the west (Kekaha) is presently undeveloped and open pasture land.

2.5.2 Historic Sites

There are no known prehistoric or historic sites in the immediate vicinity of Kikiaola including ones listed on or eligible for either the State or National Register of Historic Places. A cultural resource reconnaissance conducted in April 1980 found no evidence of any archaeological deposits in the project area.

2.5.3 Recreational Resources

There is some recreational fishing and picnicking at the harbor. There are no surf sites in the immediate vicinity.

3. PROBLEMS, NEEDS, AND OPPORTUNITIES

3.1 NATIONAL OBJECTIVES

The national planning objective, as defined by the "Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies" of the U.S. Water Resources Council, is to contribute to national economic development (NED) consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements.

The P&G requires formulation of a plan that reasonably maximizes net NED benefits, consistent with the national objective. Such a plan is to be identified as the NED plan. Other plans which reduce net NED benefits in order to further address other federal, state, local, and international concerns not fully addressed by the NED plan may be formulated. The P&G further requires that the alternative plan with the greatest net economic benefits be the plan recommended for federal action, unless an exception is granted by the Assistant Secretary of the Army for Civil Works (ASA(CW)).

3.2 PLANNING OBJECTIVES

The following planning objectives were developed to aid in the formulation of potential solutions to the identified problems and needs:

- Reduce navigation hazard in the entrance channel

- Minimize shoaling within the entrance channel and harbor basin.

- Minimize impacts to the marine and terrestrial environment and the recreational, cultural and archaeological resources of the study area.

- Formulate plans consistent with the existing and proposed uses of the study area.

- Address local community desires and concerns.

3.3 PLANNING CONSTRAINTS

Legislative and executive authorities have specified the range of impacts to be assessed and have set forth the planning constraints and criteria which must be applied when evaluating alternative plans. Plans must be developed with due regard to the benefits and costs, both tangible and intangible, as well as associated effects on the ecological, social, and economic well-being of the region. Federal participation in water resources development should also ensure that any plan is complete in itself, efficient, safe, economically feasible in terms of current prices, environmentally acceptable, and consistent with local, regional, and state plans. As far as practicable, plans should be formulated to maximize the beneficial effects and minimize the adverse impacts of the proposed improvements.

The most significant planning constraint for this project is that the site is fixed. The original harbor, owned and operated by the State of Hawaii, was built in 1959 on lands donated by the Kikiaola Land Company. Since the original construction, considerable investment has been provided by the State for the improvement and development of the area. In 1961, a boat ramp and additional breakwaters were built. Subsequently, rest room facilities and maintenance dredging have been provided. Other capital improvement projects scheduled to be completed at the Kikiaola Harbor are electrical upgrades to the existing navigation aid lights. In recent years the local boaters built an open air covered patio at the harbor and is now used extensively for local community gatherings.

Because of the considerable investment that has already been committed to the existing harbor site and other State commitments, the project sponsor and the local boating community had expressed strong support for developing and improving the existing Kikiaola Harbor. The development of alternative plans at sites outside of the existing Kikiaola Harbor would have resulted in considerable environmental, cultural and social investigation work. A high potential exists for significant impacts to any undeveloped coastal region. Since the alternative plans developed for this report maximize the utilization of the existing harbor facility, environmental, cultural and social impacts have been kept to a minimum. As a result, alternative sites were not considered to be feasible and acceptable and within the scope of this study.

3.4 PROBLEM IDENTIFICATION (NEEDS AND OPPORTUNITIES)

3.4.1 Existing Condition

The State of Hawaii initially constructed Kikiaola Harbor in 1959 with subsequent improvements made in 1961 and 1964. The original harbor consisted of an east and west breakwater. Later in 1961 a launch ramp was constructed by the State. The last major improvement occurred in 1964 with the addition of two stub breakwaters and an inner breakwater to reduce surge within the harbor basin. No dredging work was performed during the initial construction. However, in 1969 and 1971 and more recently in August 1996 the inner harbor areas were dredged to depths ranging from -5.0 feet to -6.5 feet. Today, the existing facility consists of a 1,280-foot long east breakwater with two short stub breakwaters; a 600-foot long west breakwater; a 225-foot long inner breakwater; a 150-foot long by 10-foot wide wooden wharf; a 50-foot long loading dock and adjacent launch ramp. There are no berthing facilities at Kikiaola Harbor. The nearest light draft harbor with berthing facilities is at Port Allen, approximately 8 miles southeast of Kikiaola Harbor.

3.4.2 Future Without Project Conditions

Without federal implementation of the proposed improvements, Kikiaola Harbor will remain undeveloped with little or no change from existing conditions. Boaters and fishermen will continue to experience hazardous conditions when venturing in and out of the harbor.

Navigation problems experienced at Kikiaola Harbor are primarily attributed to the shallow depths in the entrance channel and harbor basin. As a result of the shallow depth at the entrance channel, boaters confront steep wave fronts and breaking wave conditions several times a year. Maneuvering in and out of the harbor under these conditions is extremely hazardous even for the experienced boaters. In addition to these navigation problems, other issues confronted by boaters include the lack of protective berthing and adequate shoreside facilities, overtopping of the east breakwater, and shoaling of the entrance channel and harbor basin. Lack of a safe entrance channel and adequate protective structures will limit the State of Hawaii from developing Kikiaola into a fully operable boat harbor. Any increase in recreational and commercial fishing/boating opportunities, and resulting local expenditures, will largely be restricted to local boaters from the Waimea-Kekaha region.

3.4.3 Specific Problems and Opportunities

There have been numerous occasions in the past with boats sustaining minor damages from the shallow depths and surge within the basin and entrance channel. Because of these unsafe conditions the existing harbor has not been utilized to its fullest potential. The six mooring locations in the harbor basin are currently occupied by three commercial vessels and three recreational crafts. As of April 1997, there were five applicants for mooring locations at the Kikiaola Harbor. Of the five applicants three have indicated a desire to undertake commercial passenger operations. All other boaters utilizing the harbor launch their vessels from the existing boat ramp. These conditions are not expected to change substantially during the study period.

The number of applicants on the waiting list for this harbor is not indicative of this facility's popularity as a launch and mooring site. The proximity of Kikiaola Harbor makes it the closest harbor to the productive fishing grounds along Kauai's western coast and the areas adjacent to the Island of Niihau. In addition, the Na Pali Coastline along Kauai's north coast is a major visitor attraction making Kikiaola Harbor a strategic location for commercial boat operators. The future development of this harbor will play a vital role in the expansion and growth of the local economy. Local interests have expressed a desire to utilize this facility if proposed modifications are implemented to improve navigational safety and increase berthing areas within the existing harbor basin.

3.5 PUBLIC INVOLVEMENT

Public involvement has played an integral role in the plan formulation process. Throughout the long history of this project public participation has always been included as a key element in the decision making process. To insure that the desires and needs of the public were identified and considered a series of public workshops, meetings and informal discussions with key personnel from boating clubs, private interest groups, related businesses, private citizens, Federal, State and County personnel were conducted from the inception of this study. The most recent public workshop and coordination efforts with local and State agencies are further discussed in Section 9, "SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS." All public input and comments received at the public workshop have been reviewed and pertinent comments have been incorporated and were considered during the formulation of alternative plans. Prior to initiation of this GRR, close coordination was maintained with the project sponsor and the general public. During the post authorization studies in 1978, a series of public workshops and public meetings were held on December 14, 1978, November 1, 1979, February 20, 1979 and June 26, 1980 to discuss and identify the navigation problems, immediate and future needs of the harbor and the alternative and proposed plans.

Based on the general feedback received at the most recent public workshop and the informal meeting held with boaters from the Kikiaola Westside Boater's Club on May 13, 1997 at the Kikiaola Boat Harbor, the views and concerns expressed throughout the long history of this study have not changed significantly. The original authorized plan (Plan 1) is still the preferred plan by boaters. The major concerns confronting boaters utilizing the harbor continue to be the shallow depths at the entrance channel and harbor basin and a need for improvements to existing navigational aids. Boaters continue to support improvements to the existing Kikiaola Harbor rather than an alternative site.

4 PLAN FORMULATION

4.1 PLAN FORMULATION PROCESS

Plan formulation is the process of combining various management measures into comprehensive water and related land resources alternative plans of action that meet the goals defined in the study authorization. The process is a multi-disciplinary evaluation and assessment involving an examination of the environmental impacts, technical adequacy, economic efficiency, and social acceptability of possible solutions within the framework of national and local planning objectives. Significant adverse impacts resulting from any of the major components, without an acceptable resolution, may terminate further study of that alternative. Elimination of infeasible or undesirable plans will narrow the array of potential alternatives until an acceptable plan is developed.

4.2 FORMULATION AND EVALUATION CRITERIA

4.2.1 Institutional Criteria

- Institutional requirements imposed on the recommended plan should be an integral part of the project plan formulation.
- Coordination should be carried out with existing federal and local institutions that are operating in or have an interest in the study area.
- Areas of responsibility of federal and local institutions should be defined.
- The recommended plan should be institutionally implementable.

4.2.2 Technical Criteria

- The protective harbor basin will provide a safe maneuvering area for vessels.
- The entrance channel will have an adequate depth and width to safely permit two-way traffic.
- Protective structures will be designed to withstand the most severe combination of meteorological and sea conditions that are reasonably characteristic of the study area.
- Navigation improvements will be designed to accommodate a design vessel of 45-foot length, 14-foot beam, and 5-foot draft. Design vessel is discussed in Appendix B, Design Analysis.
- Alternative plans will be sound, practicable, technically feasible, and environmentally acceptable.

4.2.3 Economic Criteria

- The recommended plan of improvement will, as far as practicable, maximize net NED benefits.
- Tangible National Economic Development (NED) benefits must exceed total project costs.
- The benefits and costs will be expressed in comparable quantitative economic terms to the fullest extent possible. Annual costs will be based on a 50-year amortization period and will be evaluated at the authorized discount rate of 7-3/8 percent. Annual costs will also include estimated annual maintenance costs.

4.2.4 Environmental and Social Criteria.

- The recommended plan shall minimize long term disturbances to the physical environment.
- Short-term disturbances to the physical environment shall be controlled to prevent long term effects.
- Environmental protection guidelines will be followed to the maximum extent practicable.
- Both adverse and beneficial impacts of the alternative plans shall be identified and evaluated for each plan.
- Alternative plans which maximize net economic benefits (National Economic Development Plan), and those which make positive contributions to preserving, maintaining, restoring, or enhancing cultural or natural resources (Environmental Quality Plan) will be identified and designated.

- The plans will be developed to minimize conflicts and maximize compatibility with existing conditions and to insure a complete and adequate project.
- The desires of local interests including the general public, will be given full consideration.
- The alternate plans will be evaluated with respect to their effectiveness in meeting the established planning objectives.

4.3 PLAN FORMULATION RATIONALE

Formulating a plan requires the analysis of problems and logically developing solutions to resolve the problems and needs of the study area. Information received during the problem identification stage confirmed the need for investigating navigation hazards in the existing entrance channel and harbor basin. Furthermore, local interests have expressed strong support for harbor modifications. The alternative plans were developed to meet the national planning objectives as well as the public needs and desires. Investigation of alternate sites were not performed because of the substantial investment already committed at the authorized site, and because of the expressed public and project sponsor's desire to upgrade and improve the existing harbor.

4.4 NONSTRUCTURAL ALTERNATIVE

Nonstructural alternatives or measures are those actions that can meet the planning objectives without constructing new facilities or performing extensive modifications to the existing facilities. A typical nonstructural alternative might include improving the efficiency of existing facilities or periodic dredging of the entrance channel and harbor basin. Without performing extensive modifications to the existing facilities, hazardous wave conditions and shallow depths at the entrance channel and harbor basin and overtopping of the protective structures will continue to exist. Therefore, the nonstructural alternative was not considered an acceptable or viable solution in mitigating the existing navigation problem and does not fulfill the identified needs and objectives for Kikiaola Harbor.

4.5 COMPLIANCE WITH EXECUTIVE ORDER 11988

Kikiaola Harbor lies within the 100-year coastal inundation zone. Adverse impacts resulting from locating in the coastal flood zone include the risks of property damage and loss of life. The proposed action will require development in the inundation zone such as harbor backup facilities. There is no alternative location for these facilities. However, utilizing construction practices which meet the requirements of the National Flood Insurance Program will minimize tsunami or hurricane/storm surge damages.

Adverse impacts resulting from increased use of the coastal flood zone can be minimized by adequate tsunami and hurricane warning. A Statewide tsunami and hurricane warning system is presently in existence. Kikiaola Harbor would be evacuated in the event of a tsunami or hurricane warning. Under a tsunami warning, boats should not re-enter the harbor until the tsunami warning has been canceled.

4.6 DEVELOPMENT OF ALTERNATIVE PLANS

Preliminary planning focused on reevaluating the alternative plans formulated during the GDM study completed in September 1980. These plans were developed based on detailed engineering, economic, social and environmental studies and analysis. Basic input for these plans were obtained from the project sponsor, public workshops and other government agencies and private interest groups. The results of all public input and planning studies along with the desires of the project sponsor were considered in the tentative selection of the original plan of improvement presented at the final public meeting on June 26, 1980.

The original five alternative plans were presented and discussed at a public workshop held at the Kekaha Neighborhood Center on May 6, 1996. Public support for harbor modifications remained strong and a new alternative plan was suggested at the workshop. The new alternative recommended by a local boater reconfigures the existing harbor with a new opening to the west.

5. ASSESSMENT AND EVALUATION OF ALTERNATIVE PLANS

5.1 INTRODUCTION

Upon identifying the problem and needs, planning objectives, and the formulation and evaluation criteria, alternative harbor improvement plans were developed for Kikiaola Harbor. A detailed evaluation of these alternatives was conducted to determine the optimum improvement plan. A detailed description and impact assessment of each of the six alternative plans is provided in the following paragraphs.

5.2 DESCRIPTION AND ASSESSMENT OF ALTERNATIVE PLANS

5.2.1 Alternative Plan 1

5.2.1.1 Description

The proposed navigation improvements under Plan 1 (Figure 2) provides safe transit and haven for vessels through the harbor, minimizes initial dredging and future maintenance dredging requirements, minimizes environmental impacts and meets the needs and desires of the boating community. Plan 1 consists of:

- Removing 150 feet from the existing outer east stub breakwater which extends into the proposed channel alignment.

- Raising the east breakwater's crest elevation by four feet from Station 8+70 to Station 9+85 and three feet from Station 2+50 to Station 8+20.

- Flattening the seaward slope of the east breakwater to one vertical on two horizontal from Station 8+70 to Station 9+85.

- Removing and constructing an 85-foot long inner east stub breakwater.

- Modifying 220 feet of the existing west breakwater by resetting the armor stone so that it is keyed and fitted from Station 3+80 to Station 6+00.

- Dredging a 700-foot long entrance channel to a depth of 11 feet and varying in width from 105 to 205 feet with maneuvering area to facilitate a 90 degree right turn into the access channel.

- Dredging a 320-foot long access channel to a depth of seven feet and varying in width from 70 to 105 feet.

Plan 1 would also include about 1.8 acres of water area for berthing and access. The U.S. Coast Guard will provide the necessary modifications to the existing navigation aids.

5.2.1.2 Impact Assessment

Technical. The new entrance channel would provide safe navigation for the design vessel and others expected to use the harbor. The modified east breakwater would prevent waves from overtopping and provide a protected berthing area. Wave heights in the berthing area are expected to be less than two feet during reasonably expected sea conditions.

Environmental. Impacts resulting from the implementation of Plan 1 include:

- Approximately 4.8 acres of sand and silt bottoms and associated benthic organisms would be affected by dredging of the entrance and access channel and berthing area.

- Approximately 0.17 acre will be covered by the modified breakwater structure .

- Dredging work within the entrance and access channels will result in an estimated 30,100 cubic yards of consolidated coralline, sand and silt. The remaining dredging work (Project Sponsor Cost) for the berthing area (1.1 acres) is estimated to be 8,050 cubic yards of sand and silt.

The modified breakwater will provide habitat for marine organisms adapted to hard substrate or requiring shelter provided by the interstices of the breakwater. Some increase in populations of organisms favoring habitats provided by the breakwater structure is expected, upon project completion.

Dredging would displace or destroy benthic organisms inhabiting the limestone, sand and silt substrates. Dredging will also cause a resuspension and redistribution of bottom sediments and underlying coral material. Coarse material will settle quickly, but finer material may be transported to other areas by water currents and surge actions.

Along with the increased turbidity of harbor waters during dredging caused by the resuspension of silt, there will be an increase of organic detritus and nutrients in the water column. These effects are expected to be temporary and may create artificial feeding opportunities for fish which may be attracted to benthic organisms and organic detritus stirred up as a result of dredging. After project completion, water quality in the harbor is expected to improve as a result of removal of terrigenous silt deposits and improved water circulation.

The proposed disposal site for the initial dredged material will be on adjacent properties owned and managed by the Kikiaola Land Company.

Increased turbidity is anticipated during dredging operations. To minimize turbidity within the harbor and adjacent areas the contractor will implement construction controls such as movable silt barriers around the dredging plant. These barrier controls would contain the disturbed sediments caused by dredging operations and prevent further migration to other parts of the harbor.

Damages to existing reef areas and associated ecosystems can be limited by establishing a construction easement beyond which access and construction activity would be prohibited.

5.2.2 Alternative Plan 2

5.2.2.1 Description

Plan 2, shown on Figure 3, is identical to Plan 1 except for the removal of 40 feet from the inner stub breakwater and inclusion of a turning basin resulting in additional maneuvering area. The navigation features of Plan 2 consist of a 835-foot long entrance channel, varying in width from 105 to 205 feet and a channel depth of 11 feet; a 115-foot wide, 115-foot long, and 9-foot deep turning basin; and a 230-foot long access channel, varying in width from 70 to 105 feet and in depth from 7 to 9 feet.

This plan provides safe transit and haven for vessels utilizing the harbor and includes additional maneuvering area for vessels with a turning basin.

5.2.2.2 Impact Assessment

Technical. Same as Plan 1.

Environmental. Impacts resulting from implementation of Plan 2 would be the same as Plan 1 except for the following:

- Approximately 5.7 acres of sand and silt bottoms and associated benthic organisms would be affected by dredging of the entrance and access channel, turning basin and berthing area.
- Approximately 0.17 acre will be covered by the modified breakwater structure .
- Dredging work within the entrance and access channel and turning basin will result in an estimated 39,000 cubic yards of consolidated coralline, sand and silt. The remaining dredging work (Project Sponsor Cost) for the berthing area (1.1 acres) is estimated to be 8,050 cubic yards of sand and silt.

5.2.3 Alternative Plan 3

5.2.3.1 Description

Plan 3, shown on Figure 4, is similar to Plan 1 except for the removal of 130 feet from the inner stub breakwater and construction of a new 195-foot long inner east stub breakwater. The navigation features of Plan 3 consist of dredging a 820-foot long entrance channel varying in depth from 9 to 11 feet, and varying in width from 105 to 205 feet with maneuvering area to facilitate a 90 degree right turn into the access channel; and a 310-foot long, 70 to 105-foot wide, and 7-foot deep access channel.

This plan provides safe transit and haven for vessels through the harbor and maximizes utilization of the existing harbor layout.

5.2.3.2 Impact Assessment

Technical. Same as Plan 1.

Environmental. Impacts resulting from the implementation of Plan 3 would be the same as Plan 1 except for the following items:

- Approximately 5.0 acres of sand and silt bottoms and associated benthic organisms would be affected by dredging of the entrance and access channel and berthing area.
- Approximately 0.25 acre will be covered by the modified breakwater structure .

- Dredging work within the entrance and access channel will result in an estimated 28,000 cubic yards of consolidated coralline, sand and silt. The remaining dredging work (Project Sponsor Cost) for the berthing area (1.1 acres) is estimated to be 8,050 cubic yards of sand and silt.

5.2.4 Alternative Plan 4

5.2.4.1 Description

Plan 4, shown on Figure 5, is identical to Plan 1 except for the construction of a 140-foot long outer east stub breakwater. This plan was developed to minimize shoaling in the entrance channel with the construction of the outer east stub breakwater.

This plan also provides safe transit and haven for vessels through the harbor.

5.2.4.2 Impact Assessment

Technical. Same as Plan 1

Environmental. Impacts of Plan 4 would be the same as Plan 1 except for the following items:

- Approximately 4.8 acres of sand and silt bottoms and associated benthic organisms would be affected by dredging of the entrance and access channel and berthing area.

- Approximately 0.33 acre will be covered by the modified breakwater structure .

- Dredging work within the entrance and access channels will result in an estimated 30,100 cubic yards of consolidated coralline, sand and silt. The remaining dredging work (Project Sponsor Cost) for the berthing area (1.1 acres) is estimated to be 8,050 cubic yards of sand and silt.

5.2.5 Alternative Plan 5

5.2.5.1 Description

Plan 5, shown on Figure 6, was developed to maximize utilization of the existing harbor basin. This plan was initiated following an informal discussion with a HQ USACE representative during the preparation of the Final GDM Report in 1980. Plan 5 consists of:

- Removing 150 feet from the existing outer east stub breakwater which extends into the proposed channel.

- Raising the east breakwater's crest elevation by four feet from Station 8+70 to Station 9+85 and three feet from Station 2+50 to Station 8+20.

- Flattening the seaward slope of the east breakwater to one vertical on two horizontal from Station 8+70 to Station 9+85.
- Removing and constructing an 85-foot long inner east stub breakwater.
- Constructing a 600-foot long extension to the existing west breakwater.
- Dredging a 1,050-foot long, 105 to 205-foot wide entrance channel to a depth of 11 feet and a maneuvering area to facilitate a 90 degree right turn into the access channel.
- Dredging a 325-foot long access channel to a depth of 7 feet and varying in width from 70 to 150 feet.

5.2.5.2 Impact Assessment

Technical. Same as Plan 1

Environmental. Impacts of Plan 5 would be the same as Plan 1 except for the following items:

- Approximately 6.8 acres of sand and silt bottoms and associated benthic organisms would be affected by dredging of the entrance and access channel and berthing area.
- Approximately 0.69 acres will be covered by the modified breakwater structure.
- Dredging work within the entrance and access channels will result in an estimated 47,700 cubic yards of consolidated coralline, sand and silt. The remaining dredging work (Project Sponsor Cost) for the berthing area (1.1 acres) is estimated to be 8,050 cubic yards of sand and silt.

5.2.6 Alternative Plan 6.

5.2.6.1 Description

Plan 6, shown on Figure 7, is a new alternative plan that was recommended and supported by boaters at the last public workshop held on Kauai during the summer of 1996. Plan 6 would also minimize shoaling in the harbor basin. Plan 6 consists of:

- Removing 150 feet from the existing outer east stub breakwater.
- Extending the east breakwater by 325 feet with a crest elevation of 12 feet.
- Flattening the seaward slope of the east breakwater extension to one vertical on two horizontal.

- Modifying 750 feet of the existing east breakwater by placing keyed and fitted armor stones and raising the crest elevation to 11 feet.

- Removing 285 feet of the existing west breakwater and modifying 85 feet of the remaining breakwater by placing armor, underlayer and bedding stones.

- Dredging a 1,050-foot long entrance channel 11 feet deep and 105 feet wide.

- Dredging a 620-foot long access channel 7 feet deep and 70 feet wide.

5.2.6.2 Impact Assessment.

Technical. Same as Plan 1.

Environmental. Impacts resulting from the implementation of Plan 6 include:

- Approximately 6.3 acres of sand and silt bottoms and associated benthic organisms would be affected by dredging of the entrance and access channel and berthing area.

- Approximately 0.64 acres of existing breakwater structure will be covered by the modified breakwater structure .

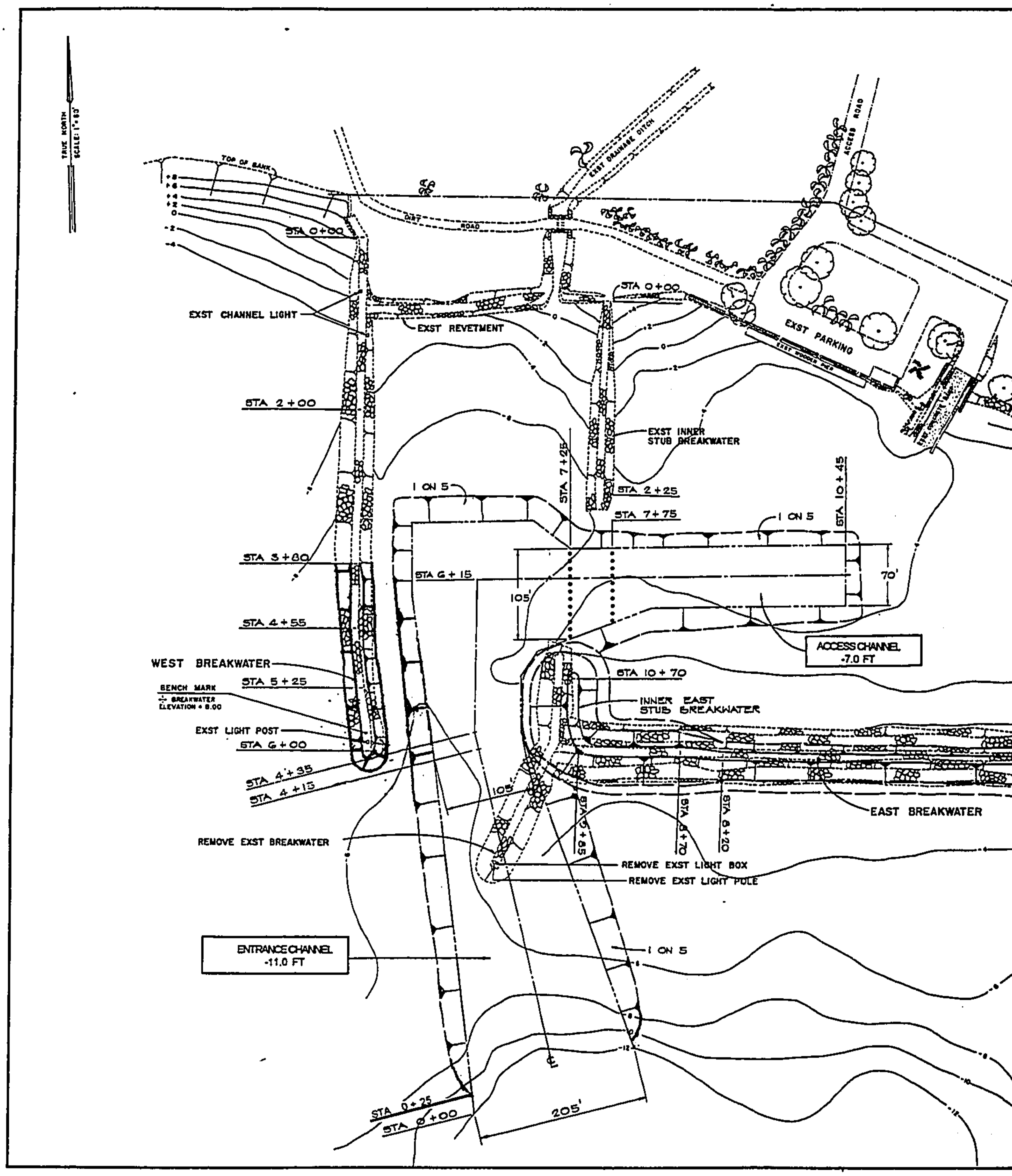
- Dredging work within the entrance and access channels will result in an estimated 32,500 cubic yards of consolidated coralline, sand and silt. The remaining dredging work (Project Sponsor Cost) for the existing harbor basin (1.1 acres) is estimated to be 8,050 cubic yards of sand and silt.

5.3 COST EVALUATION OF ALTERNATIVE PLANS

Cost evaluations were conducted in accordance with the procedures and standards prescribed by the Water Resources Council and Corps of Engineers policy. The computations are based on an interest rate of 7-3/8 percent and a 50-year project life.

5.3.1 Project First Costs

The estimated project first costs for the alternative plans of improvement are shown on Table 1. The cost estimates are based on October 1997 price levels in the project area. The estimated dredging cost includes upland disposal of the dredged material from the entrance and access channel and berthing area. Total costs include a 15 percent contingency and a factor to account for price escalation during construction. First costs also include costs for post authorization planning, engineering and design, supervision and administration, engineering during construction, a floating dock system and U.S. Coast Guard navigation aids. The recommended plan of improvement requires dredging of approximately 38,150 CY of material from the channel and berthing area.



TRUE NORTH
SCALE: 1"=83'
TOP OF BANK
EAST DRAINAGE DITCH
ACCESS ROAD
DIRT ROAD
STA 0+00
EXST CHANNEL LIGHT
EXST REVETMENT
EXST PARKING
STA 2+00
EXST INNER STUB BREAKWATER
STA 7+25
STA 2+25
1 ON 5
STA 7+75
STA 10+45
STA 3+80
STA 6+15
105'
70'
STA 4+55
ACCESS CHANNEL -7.0 FT
WEST BREAKWATER
STA 5+25
STA 10+70
BENCH MARK
BREAKWATER ELEVATION + 8.00
INNER EAST STUB BREAKWATER
EXST LIGHT POST
STA 6+00
STA 4+35
STA 4+13
STA 8+70
STA 8+20
EAST BREAKWATER
REMOVE EXST BREAKWATER
REMOVE EXST LIGHT BOX
REMOVE EXST LIGHT POLE
ENTRANCE CHANNEL -11.0 FT
STA 0+25
STA 0+00
205'

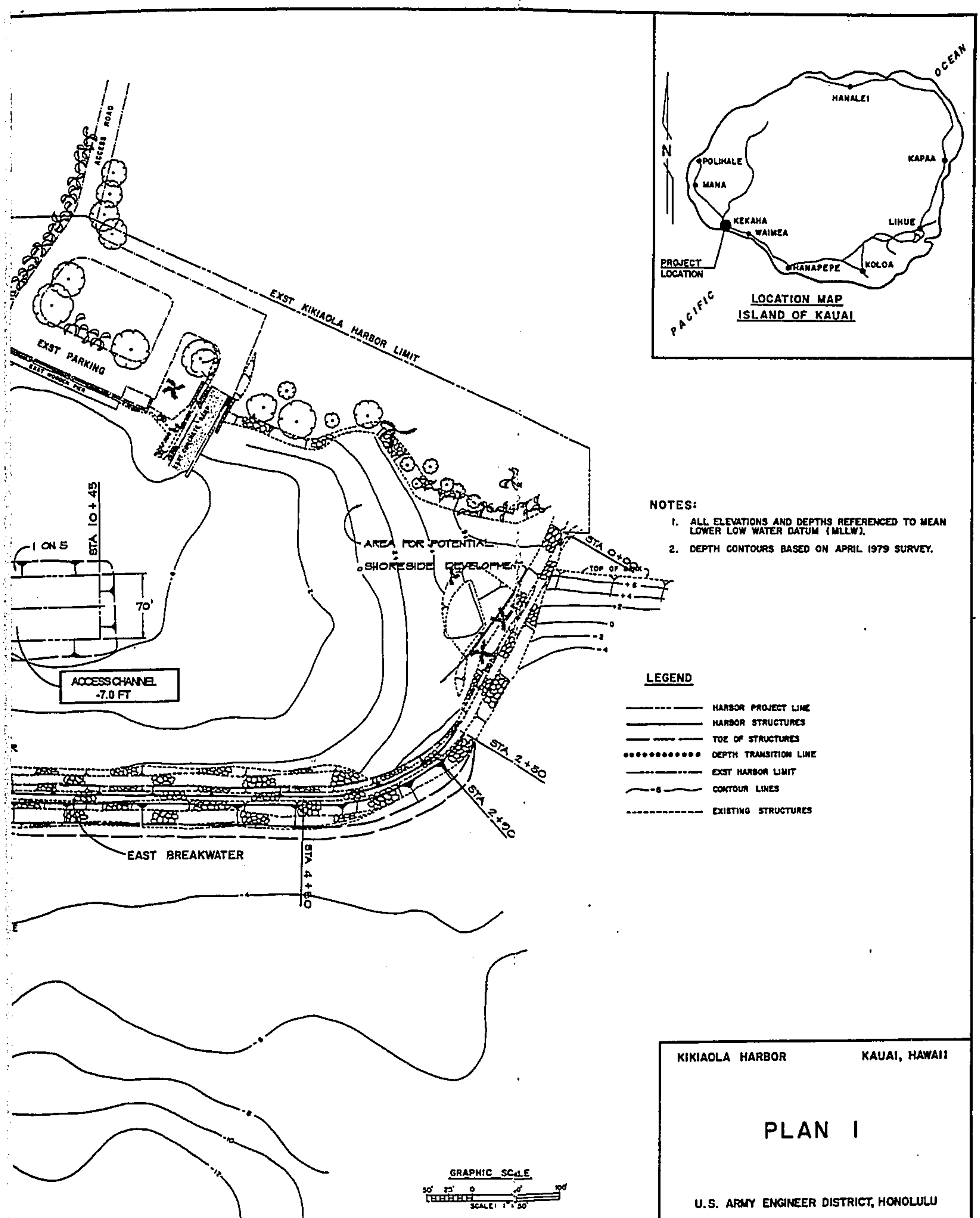
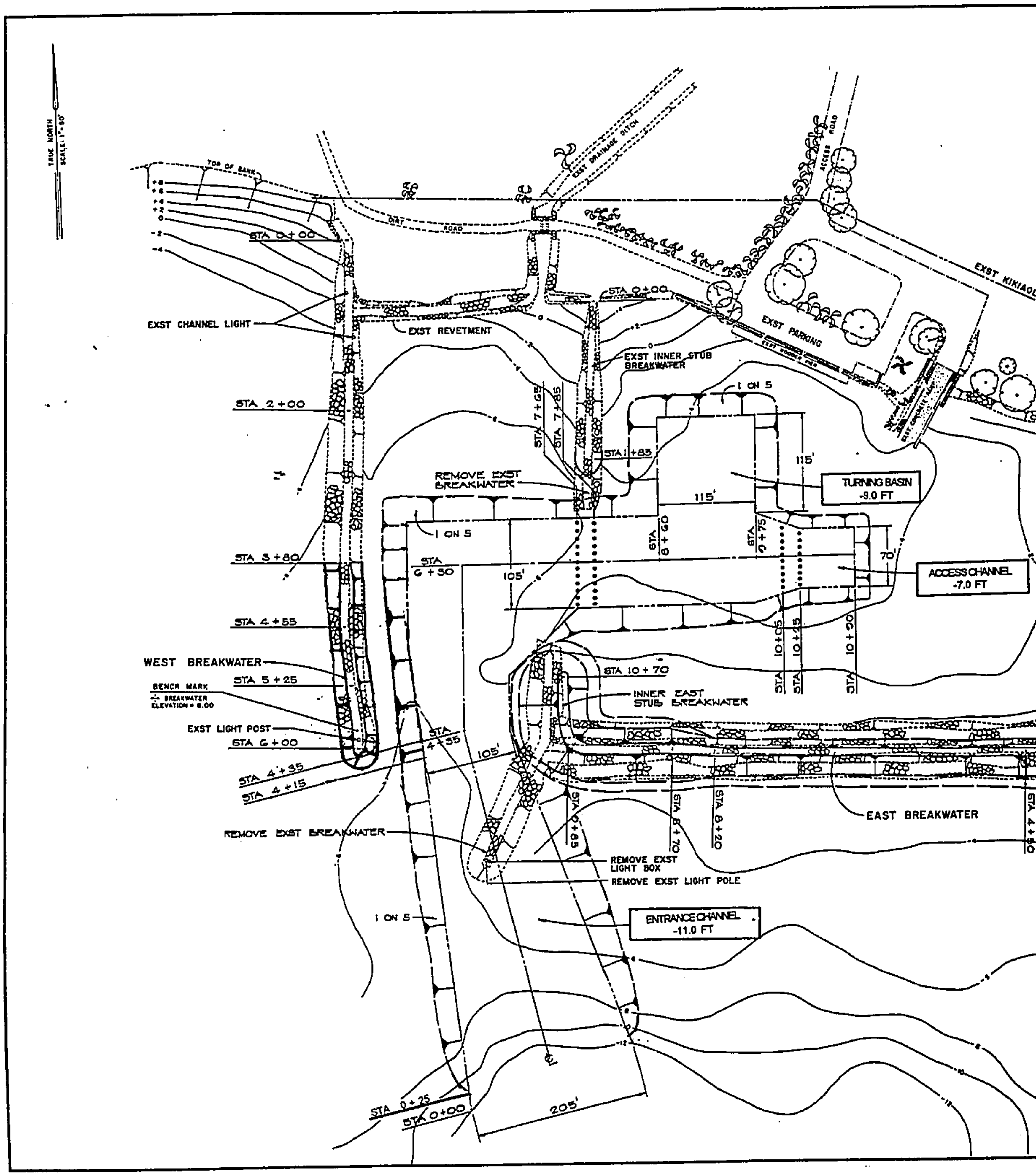
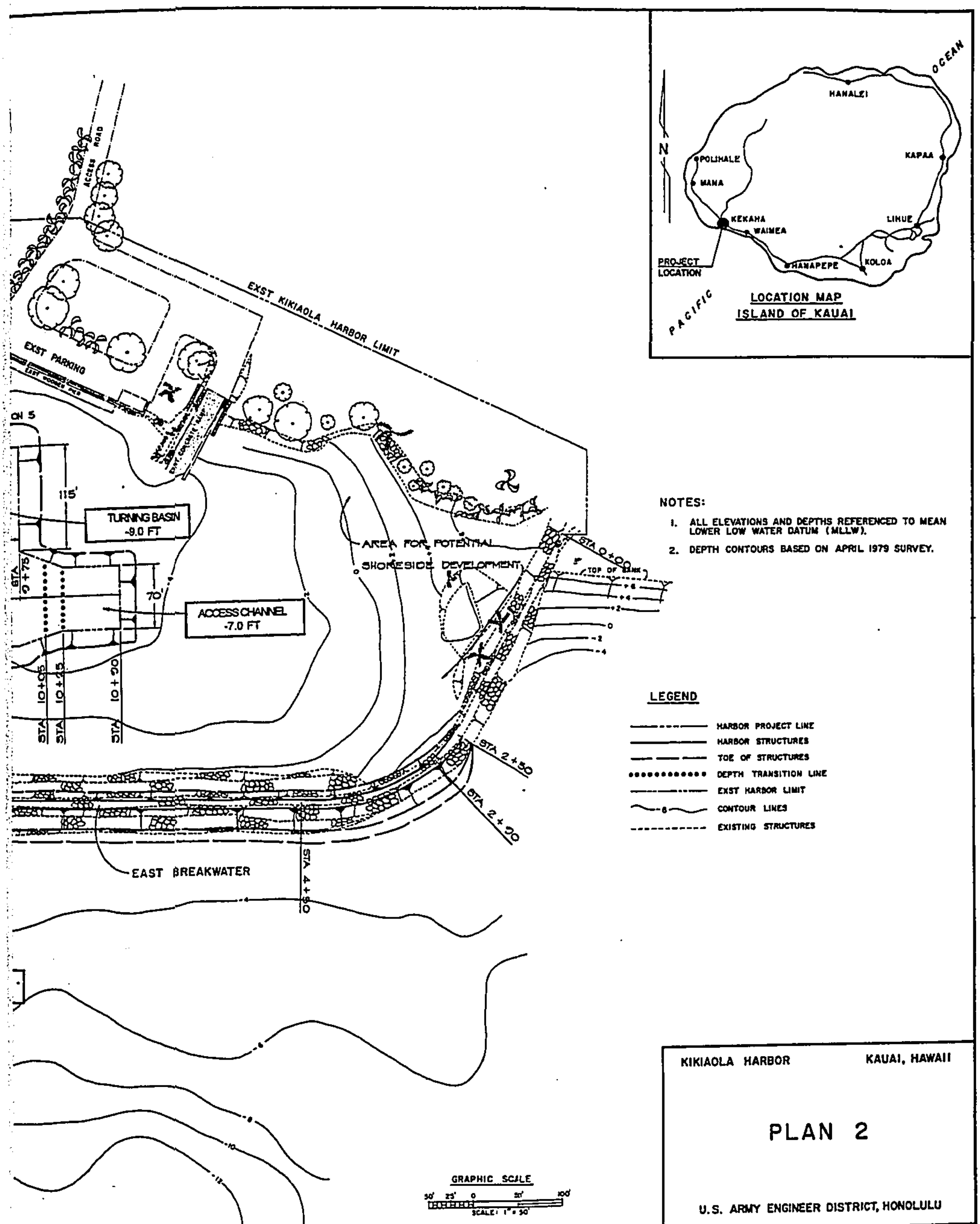

ACCESS ROAD
EXST KIKIAOLA HARBOR LIMIT
EXST PARKING
AREA FOR POTENTIAL
SHORESIDE DEVELOPMENT
STA 10 + 45
1 ON 5
70'
ACCESS CHANNEL
-7.0 FT
STA 0+00
TOP OF BANK
STA 2+50
STA 2+90
STA 4+80
EAST BREAKWATER
LOCATION MAP
ISLAND OF KAUAI
N
HANALEI
POLIHALE
MANA
KAPAA
KEKAHA
WAIMEA
LIHUE
HANAPEPE
KOLOA
PROJECT LOCATION
PACIFIC
OCEAN
NOTES:
1. ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EXST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
GRAPHIC SCALE
KIKIAOLA HARBOR
KAUAI, HAWAII
PLAN I
U.S. ARMY ENGINEER DISTRICT, HONOLULU

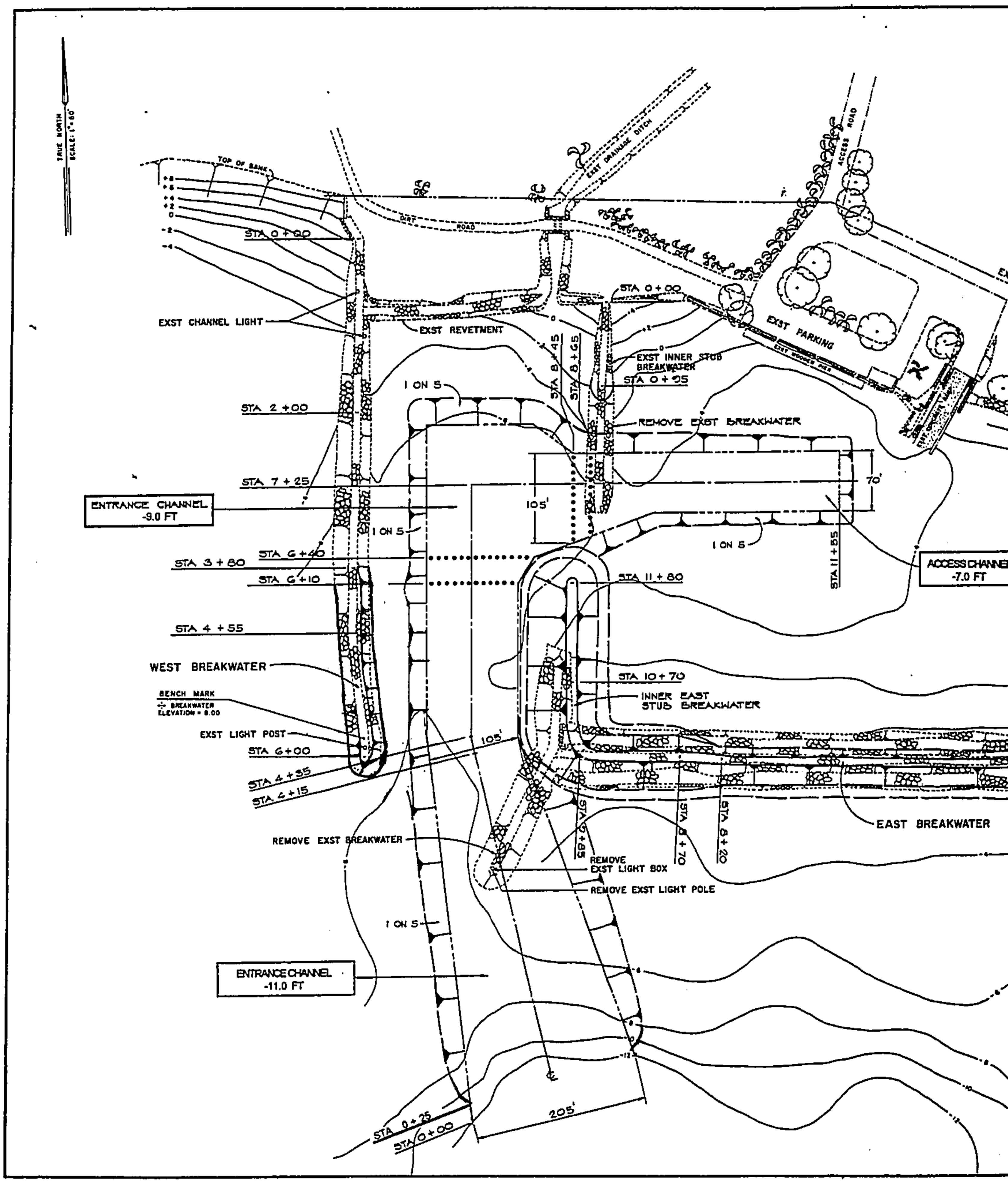
FIGURE 2


TRUE NORTH
TOP OF BANK
EXST ROAD
EXST DRAINAGE DITCH
ACCESS ROAD
EXST KIKIAOL
EXST PARKING
STA 0+00
EXST CHANNEL LIGHT
EXST REVETMENT
EXST INNER STUB BREAKWATER
STA 2+00
STA 7+65
STA 7+85
STA 1+85
1 ON 5
115'
TURNING BASIN
-9.0 FT
REMOVE EXST BREAKWATER
STA 8+60
STA 9+75
70'
ACCESS CHANNEL
-7.0 FT
STA 3+80
STA 6+30
105'
STA 4+55
STA 10+05
STA 10+25
STA 10+90
WEST BREAKWATER
STA 5+25
BENCH MARK
BREAKWATER ELEVATION = 8.00
STA 10+70
INNER EAST STUB BREAKWATER
EXST LIGHT POST
STA 6+00
STA 4+35
STA 4+15
STA 9+85
STA 8+70
STA 8+20
EAST BREAKWATER
REMOVE EXST LIGHT BOX
REMOVE EXST LIGHT POLE
ENTRANCE CHANNEL
-11.0 FT
STA 0+25
STA 0+00
205'



LOCATION MAP
ISLAND OF KAUAI
PACIFIC
OCEAN
HANALEI
KAPAA
LIHUE
KOLOA
HANAPEPE
WAIMEA
KEKAHA
MANA
POLIHALE
PROJECT LOCATION
N
EXST KIKIAOLA HARBOR LIMIT
ACCESS ROAD
EXST PARKING
TURNING BASIN
-9.0 FT
ACCESS CHANNEL
-7.0 FT
115'
70'
AREA FOR POTENTIAL
SHORESIDE DEVELOPMENT
TOP OF BANK
STA 0+00
STA 2+50
STA 2+90
STA 4+50
STA 9+75
STA 10+05
STA 10+45
STA 10+90
EAST BREAKWATER
NOTES:
1. ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EXST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
GRAPHIC SCALE
SCALE: 1" = 50'
KIKIAOLA HARBOR
KAUAI, HAWAII
PLAN 2
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3


TRUE NORTH
TOP OF BANK
DIRT ROAD
EXST DRAINAGE DITCH
ACCESS ROAD
STA 0 + 00
EXST CHANNEL LIGHT
EXST REVETMENT
STA 0 + 00
EXST PARKING
EXST INNER STUB BREAKWATER
STA 0 + 25
STA 8 + 45
STA 8 + 65
1 ON 5
STA 2 + 00
REMOVE EXST BREAKWATER
STA 7 + 25
ENTRANCE CHANNEL
-9.0 FT
105'
70'
1 ON 5
STA 6 + 40
STA 3 + 80
STA 6 + 10
1 ON 5
STA 11 + 55
ACCESS CHANNEL
-7.0 FT
STA 11 + 80
STA 4 + 55
WEST BREAKWATER
STA 10 + 70
INNER EAST STUB BREAKWATER
BENCH MARK
BREAKWATER ELEVATION = 8.00
EXST LIGHT POST
STA 6 + 00
105'
STA 4 + 35
STA 4 + 15
REMOVE EXST BREAKWATER
STA 9 + 85
STA 8 + 70
STA 8 + 20
EAST BREAKWATER
REMOVE EXST LIGHT BOX
REMOVE EXST LIGHT POLE
1 ON 5
ENTRANCE CHANNEL
-11.0 FT
205'
STA 0 + 25
STA 0 + 00

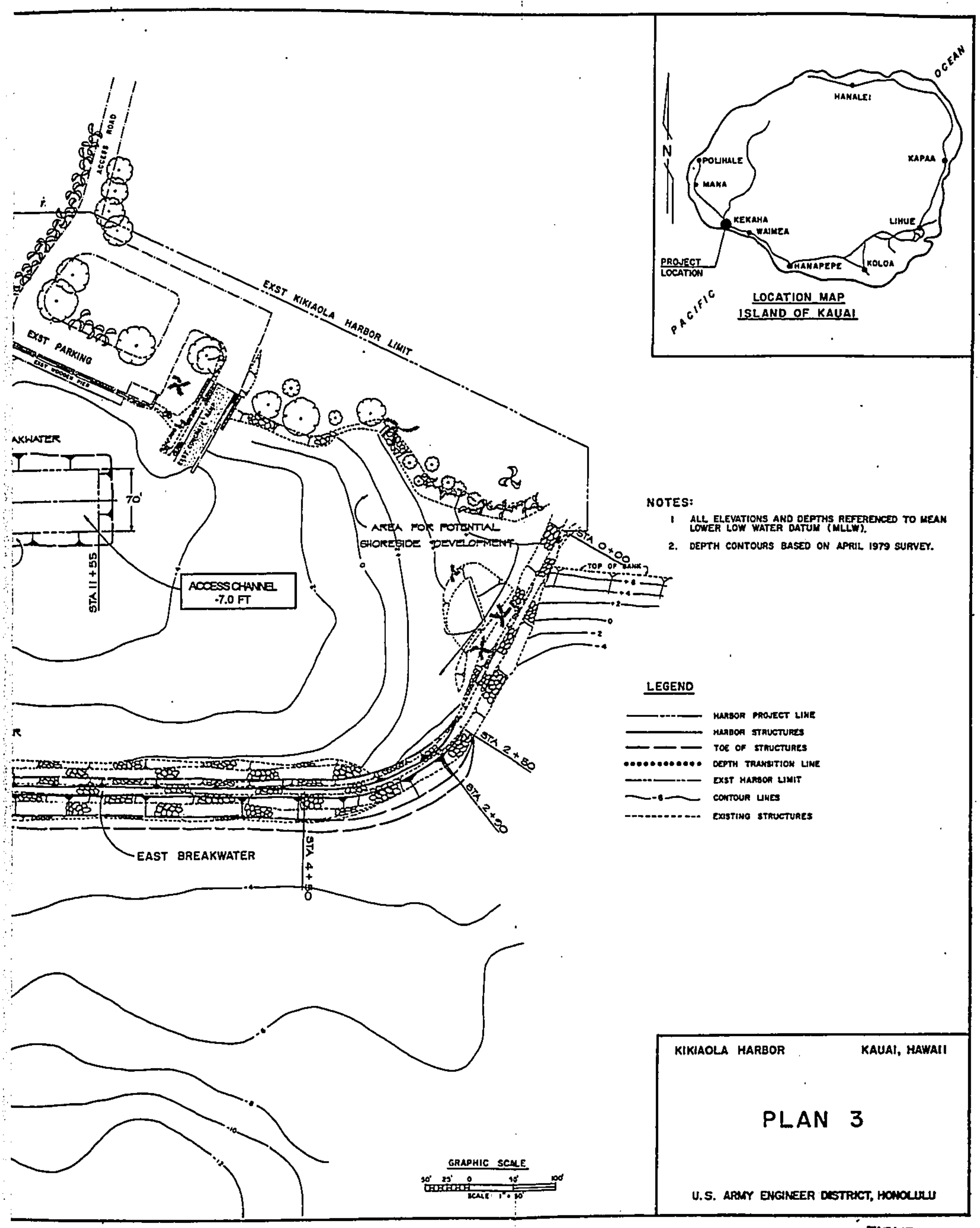
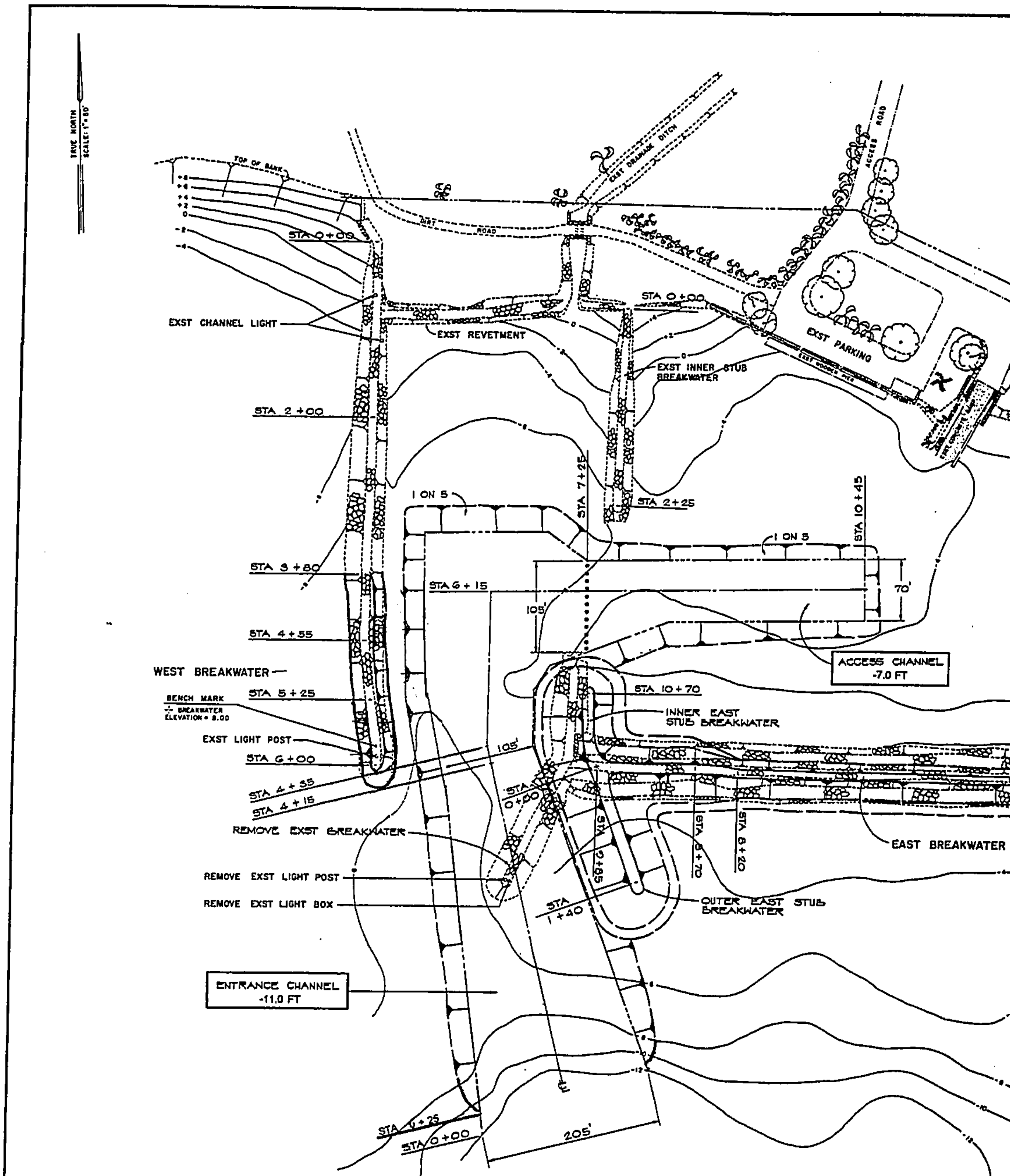
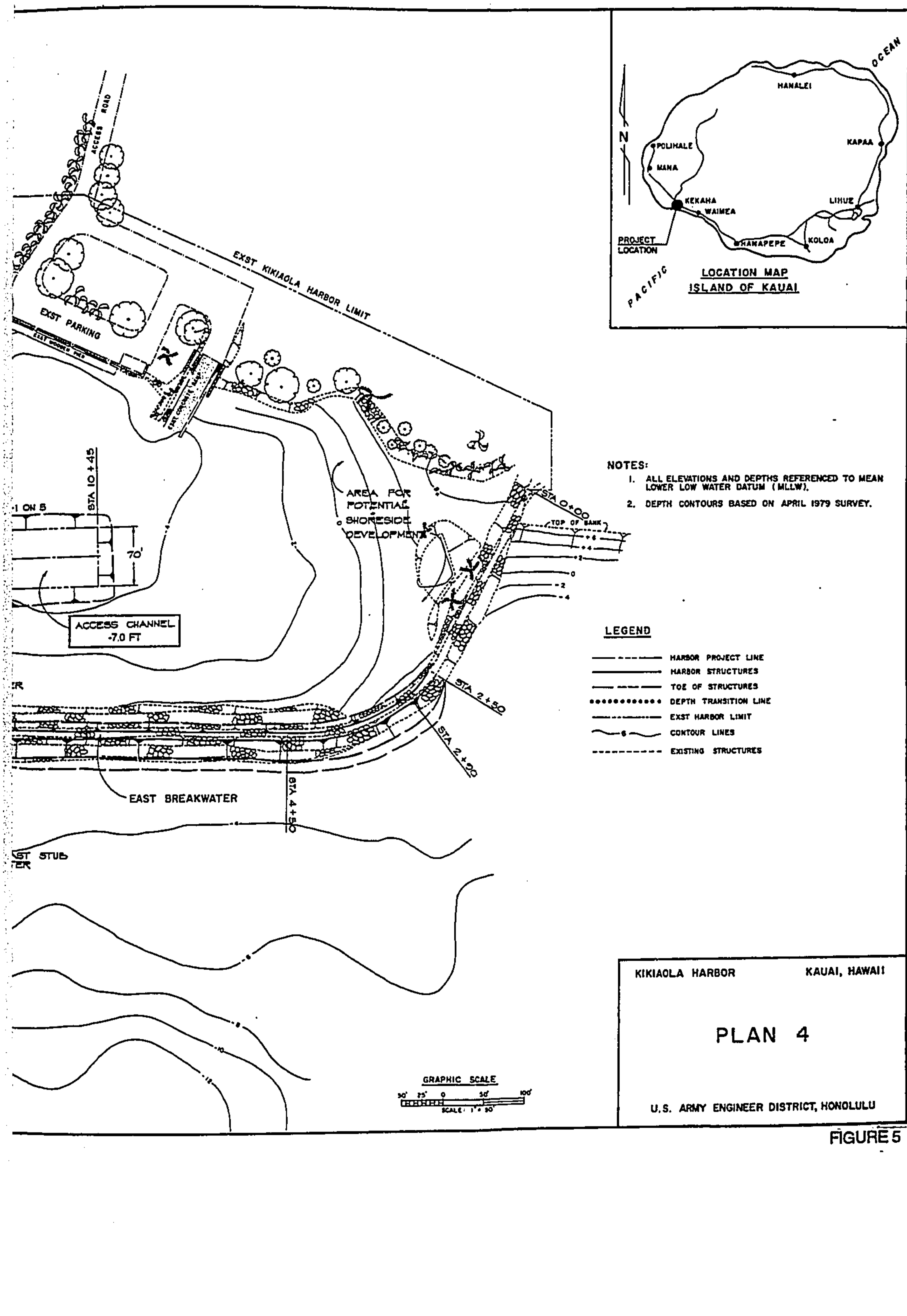

LOCATION MAP
ISLAND OF KAUAI
PACIFIC
OCEAN
HANALEI
KAPAA
POLIHALE
MANA
KEKAHA
WAIMEA
LIHUE
HANAPEPE
KOLOA
PROJECT LOCATION
N
EXST KIKIAOLA HARBOR LIMIT
EXST PARKING
ACCESS ROAD
70'
AREA FOR POTENTIAL SHORESIDE DEVELOPMENT
ACCESS CHANNEL -7.0 FT
STA 11+55
STA 0+00
TOP OF BANK
STA 2+50
STA 4+50
EAST BREAKWATER
NOTES:
1 ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EXST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
GRAPHIC SCALE
KIKIAOLA HARBOR
KAUAI, HAWAII
PLAN 3
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4


TRUE NORTH
SCALE: 1"=60'
TOP OF BANK
DIRT ROAD
EXST DRAINAGE DITCH
ACCESS ROAD
STA 0+00
EXST CHANNEL LIGHT
EXST REVETMENT
STA 0+00
EXST INNER STUB BREAKWATER
EXST PARKING
STA 2+00
STA 7+25
STA 2+25
1 ON 5
STA 10+45
1 ON 5
STA 3+80
STA 6+15
105'
70'
STA 4+55
ACCESS CHANNEL
-7.0 FT
WEST BREAKWATER
STA 10+70
STA 5+25
BENCH MARK
BREAKWATER ELEVATION = 8.00
INNER EAST STUB BREAKWATER
EXST LIGHT POST
STA 6+00
105'
STA 4+35
STA 4+15
STA 0+00
STA 2+85
STA 8+70
STA 8+20
EAST BREAKWATER
REMOVE EXST BREAKWATER
REMOVE EXST LIGHT POST
REMOVE EXST LIGHT BOX
STA 1+40
OUTER EAST STUB BREAKWATER
ENTRANCE CHANNEL
-11.0 FT
STA 0+25
STA 0+00
205'


LOCATION MAP
ISLAND OF KAUAI
PACIFIC
OCEAN
HANALEI
KAPAA
POLIHALE
MANA
KEKAHA
WAIMEA
LIHUE
HANAPEPE
KOLOA
PROJECT LOCATION
N
ACCESS ROAD
EXST KIKIAOLA HARBOR LIMIT
EXST PARKING
AREA FOR POTENTIAL SHORESIDE DEVELOPMENT
STA 10+45
1 ON 5
70'
ACCESS CHANNEL -7.0 FT
STA 0+00
TOP OF BANK
STA 2+50
STA 2+90
STA 4+50
EAST BREAKWATER
NOTES:
1. ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EXST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
GRAPHIC SCALE
KIKIAOLA HARBOR
KAUAI, HAWAII
PLAN 4
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FIGURE 5

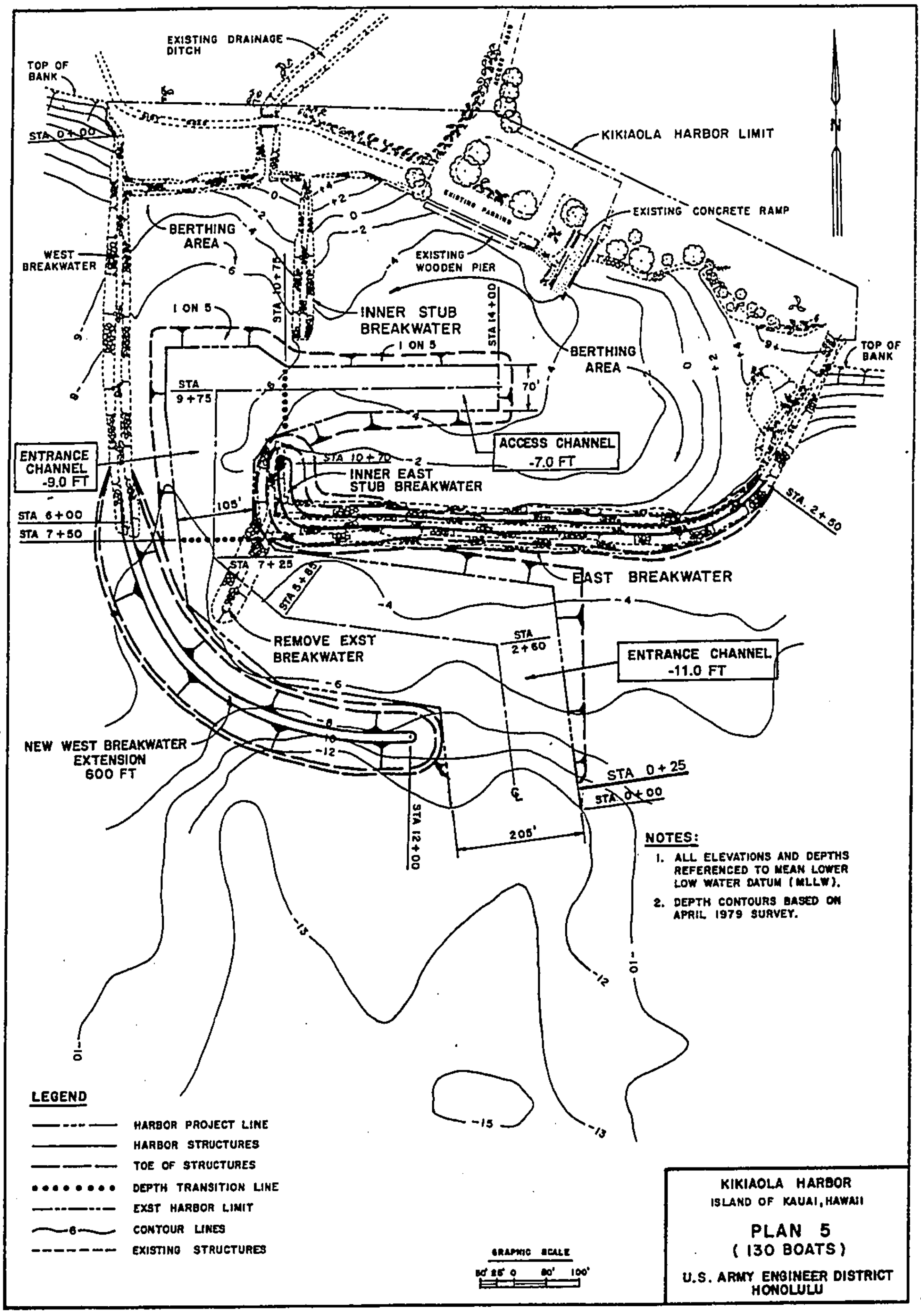
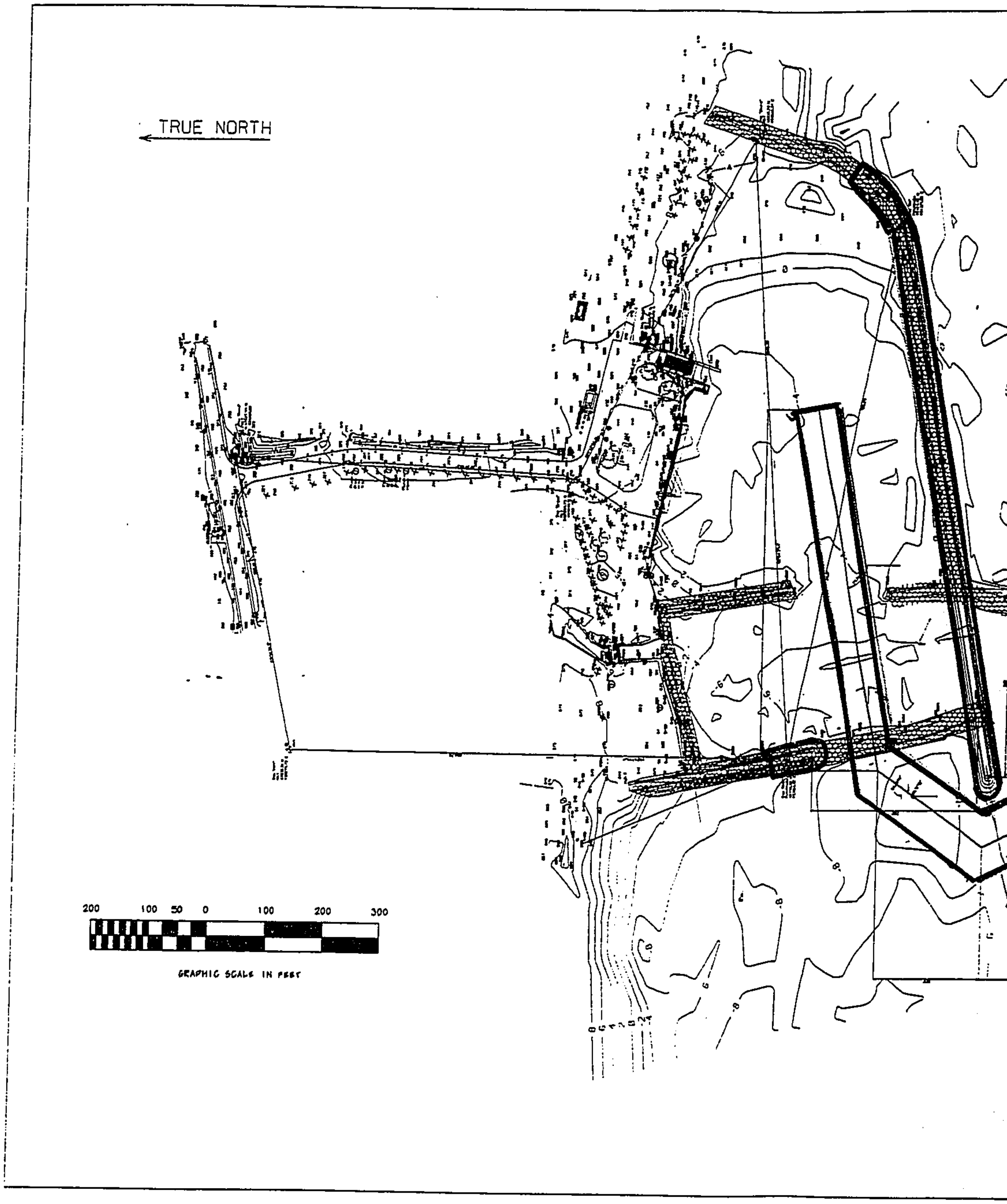
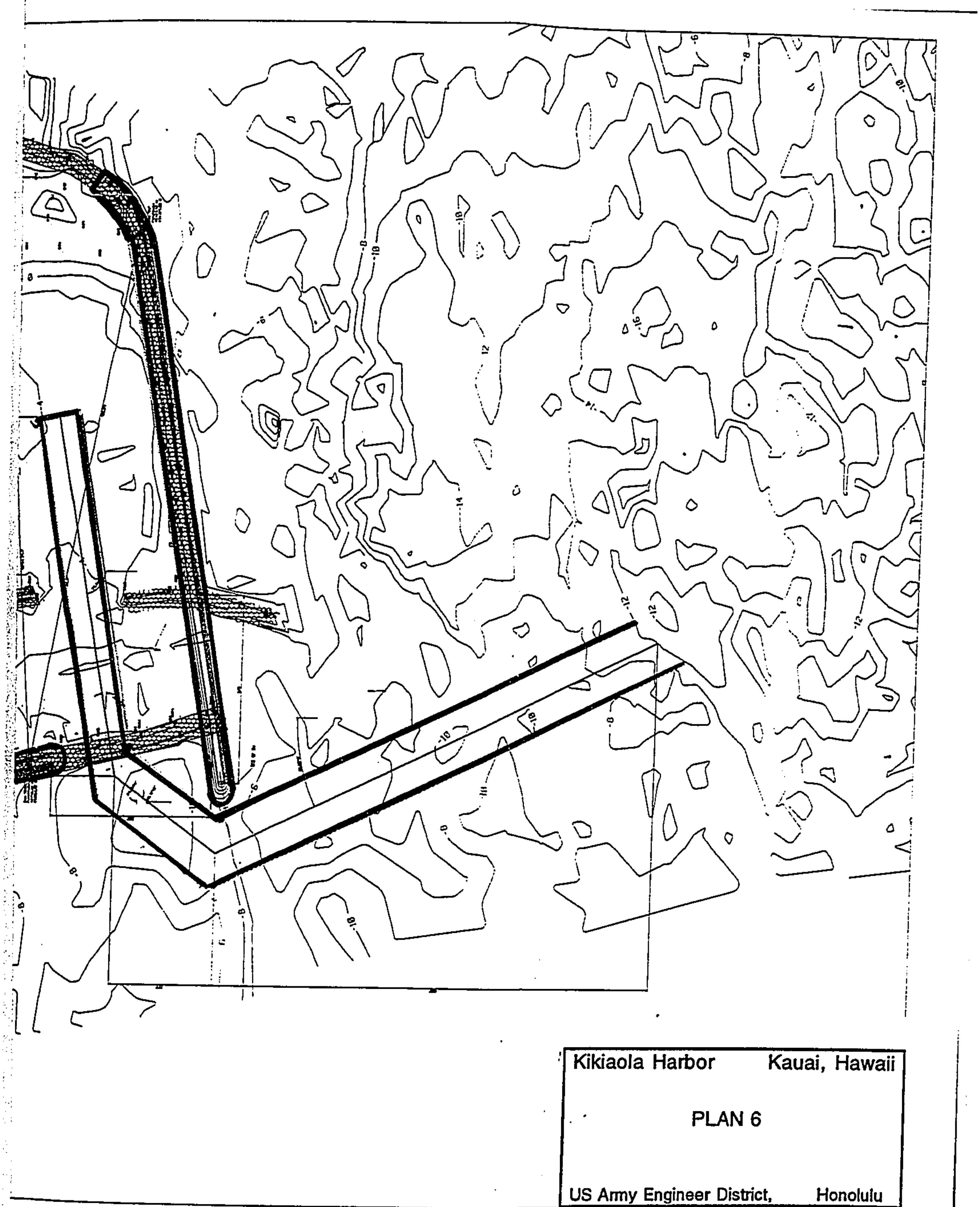

EXISTING DRAINAGE DITCH
TOP OF BANK
STA 0+00
KIKIAOLA HARBOR LIMIT
EXISTING CONCRETE RAMP
BERTHING AREA
WEST BREAKWATER
EXISTING WOODEN PIER
INNER STUB BREAKWATER
1 ON 5
STA 10+75
STA 14+00
BERTHING AREA
TOP OF BANK
STA 9+75
70'
ACCESS CHANNEL -7.0 FT
ENTRANCE CHANNEL -9.0 FT
STA 10+70
INNER EAST STUB BREAKWATER
STA 2+50
105'
STA 6+00
STA 7+50
STA 7+25
STA 8+85
EAST BREAKWATER
REMOVE EXST BREAKWATER
STA 2+60
ENTRANCE CHANNEL -11.0 FT
NEW WEST BREAKWATER EXTENSION 600 FT
STA 0+25
STA 0+00
STA 12+00
205'
NOTES:
1. ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EXST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
GRAPHIC SCALE
KIKIAOLA HARBOR
ISLAND OF KAUAI, HAWAII
PLAN 5
(130 BOATS)
U.S. ARMY ENGINEER DISTRICT HONOLULU

FIGURE 6


TRUE NORTH
200 100 50 0 100 200 300
GRAPHIC SCALE IN FEET



Kikiaola Harbor Kauai, Hawaii

PLAN 6

US Army Engineer District, Honolulu

FIGURE 7

5.3.2 Cost Evaluation of Alternative Disposal Sites

During our investigation and evaluation, three potential disposal sites were considered as viable alternatives for the estimated 38,150 CY of dredged material. The potential sites included upland disposal at the Kekaha Landfill, adjacent private property owned and operated by the Kikiaola Land Company and ocean disposal at EPA's approved ocean dumpsite offshore from Port Allen Harbor. An overall cost evaluation of these alternatives is presented below based on mobilization/demobilization, transportation and associated testing costs.

Disposal Site	Miles from Harbor	Addt'l Mob/ Demob Cost	Transportation Cost (Load & Haul)	Testing	Total Cost
Kikiaola Land Co. Property	N/A	0	$35,000	$4,362	$39,362
Kekaha Landfill	4.5 miles	0	$175,000	$4,362	$179,362
EPA Approved Ocean Dumpsite	11.5 miles	$500,000	$17,500	$74,362	$591,862

Based on the above cost evaluation, dredged material from construction dredging will be placed on property owned and managed by the Kikiaola Land Company.

5.3.3 Average Annual Costs

Average annual cost estimates include the amortization of project first costs over a 50-year economic life at an interest rate of 7-3/8% and estimated average annual maintenance costs. Annual maintenance costs includes breakwater repair, maintenance dredging and sand bypassing. The average annual costs are shown on Table 2.

5.3.3.1 Sediment Infill from Existing Drainage Ditch

The average annual maintenance dredging cost directly attributed to sediment deposition from the existing drainage ditch has been included in the benefit to cost comparisons for the alternative plans. Based on the existing land use of the area and soil/loss estimates, it was estimated that 1,600 cubic yards of sediment would be deposited into the channel and harbor basin each year. The periodic maintenance dredging requirement was based on a 2-foot infill of sediment deposits into the harbor channels and berthing area. Periodic maintenance dredging varying between 10 to 14 years would be required.

The dredged material obtained from subsequent maintenance dredging of the harbor is proposed to be delivered and placed at the Kekaha Landfill site approximately 4.5 miles away from the harbor. The estimated average annual maintenance dredging cost for the recommended plan is

TABLE 1. ESTIMATED PROJECT FIRST COSTS ($1,000s) 1/

	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
A. FEDERAL NAVIGATION WORK						
Mob & Demob	$252	$252	$252	$252	$252	$252
Dredging	$1,138	$1,298	$1,048	$1,138	$1,842	$1,064
Breakwaters & Seawalls	$1,619	$1,612	$1,965	$2,067	$3,227	$2,948
Contingency	$553	$583	$598	$627	$906	$741
TOTAL DIRECT COST	$3,562	$3,745	$3,863	$4,084	$6,227	$5,005
Planning, Engineering & Design	$1,205	$1,205	$1,205	$1,205	$1,205	$1,205
Engineering During Construction	$36	$37	$39	$41	$62	$50
Supervision & Administration	$392	$412	$425	$449	$685	$551
TOTAL CORPS OF ENGINEERS FIRST COST	$5,194	$5,399	$5,532	$5,779	$8,179	$6,811
USCG Navigation Aids	$30	$30	$30	$30	$30	$40
TOTAL FEDERAL COST	$5,224	$5,429	$5,562	$5,809	$8,209	$6,851
B. NON-FEDERAL NAVIGATION WORK						
Floating Dock System	$388	$388	$388	$388	$388	$388
Dredge Berthing Area	$127	$127	$127	$127	$127	$127
LERR	$95	$95	$95	$95	$95	$95
TOTAL NON-FEDERAL COST	$610	$610	$610	$610	$610	$610
C. TOTAL FEDERAL & NON-FEDERAL FIRST COST	**$5,834**	**$6,039**	**$6,172**	**$6,419**	**$8,819**	**$7,461**

1/ October 1997 price level per ER 1105-2-100, 28 Dec 90

TABLE 2. BENEFIT TO COST COMPARISON 1/

	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
TOTAL PROJECT FIRST COST	5,834,000	6,039,000	6,172,000	6,419,000	8,819,000	7,461,000
Interest During Construction	281,737	291,783	356,379	391,146	567,467	407,740
PROJECT INVESTMENT COST	6,115,737	6,330,783	6,528,379	6,810,146	9,386,467	7,868,740
AVERAGE ANNUAL COST (7-3/8%)						
Investment Cost	464,246	480,570	495,569	516,958	712,527	597,316
Maintenance Cost (Breakwater)	9,375	9,367	11,397	11,987	18,654	17,018
Maintenance Cost (Entrance & Access Channel)	44,587	45,040	45,850	44,587	37,223	38,195
Maintenance Cost (Berthing Area)	10,304	8,860	10,304	10,304	6,117	6,777
Sand Bypass	7,111	7,111	7,111	7,111	7,111	7,111
TOTAL AVERAGE ANNUAL COST	535,623	550,947	570,231	590,947	781,631	666,418
AVERAGE ANNUAL BENEFITS	643,000	643,000	643,000	643,000	643,000	643,000
BENEFIT/COST RATIO	1.20	1.17	1.13	1.09	0.82	0.96
NET NED BENEFITS	107,377	92,053	72,769	52,053	(138,631)	(23,418)

1/ October 1997 price level per ER 1105-2-100, 28 Dec 90.

based on a periodic maintenance requirement of every 10 years and includes mobilization and demobilization, dredging and transportation costs.

5.3.3.2 Sediment Infill from Longshore Littoral Transport

A review of historical data confirms the existence of a predominant westerly longshore littoral drift resulting in the transport of sediment originating from the Waimea River. Since the construction of the original harbor by the State of Hawaii in 1959, substantial accretion has occurred along the eastern shoreline of Kikiaola Harbor and at the same time substantial erosion has taken place along the western shoreline of the harbor. Recent studies seem to indicate a stabilization of the eastern shoreline. This stabilization leads us to believe that further accretion in this area will be minimal and any additional material within the offshore littoral zone will bypass this area and continue in the predominant westerly littoral drift until being deposited in the entrance and access channel and berthing area or offshore areas. A sediment transport rate of 3,500 cubic yards per year was derived from historical beach changes observed in old aerial photographs. This sediment transport rate was assumed to be directly attributable to the infilling of the harbor's entrance and access channel.

5.3.3.3 Sand Bypass Program

To minimize future maintenance dredging requirements for the entrance and access channel and berthing area we have investigated and considered the potential implementation of a sand bypass program. Our review and evaluation of historical and recent studies, investigations and aerial photographs conducted in the study area suggests that sand bypassing may mitigate existing coastal erosion occurring along the western shoreline if sufficient quantities of sand can be placed from the updrift side to the downdrift side of Kikiaola Harbor. Sand bypassing would be accomplished mechanically by removing material along the eastern shoreline above the high water mark and placing it adjacent to the high water mark along the western shoreline by dump truck and loader. This sand bypassing technique would allow continual accretion to occur along the eastern shoreline thereby preventing introduction of sediments into the offshore portion of the littoral zone. Sediment transport within the predominant westerly littoral drift beyond the east breakwater would be substantially reduced resulting in minimal deposition of sand and sediments into the harbor.

Based on the estimated sediment transport rate of 3,500 cubic yards per year and a 2-foot infill dredging criteria for the channels and berthing area (Recommended Plan), periodic sand bypassing would be required approximately every 4.5 year. It is estimated that 16,000 CY of material would need to be removed from the eastern shoreline and placed along the western shoreline to allow accretion to continue in the east. All applicable county, state and federal permits as well as rights-of-entries and testing requirements would be obtained and completed by the responsible government agency prior to sand bypassing.

Other mechanical means were considered such as utilization of pumps. However, due to the high initial investment of between $2.0 million to $5.0 million for planning, design and construction,

the annual maintenance cost, aesthetic and noise impacts to the surrounding area and impacts to the marine environment, this idea was dropped from further consideration.
The development and implementation of this sand bypass program (Beach Nourishment) has been fully supported by the project sponsor as well as the public. The State of Hawaii Department of Land and Natural Resources, Boating and Ocean Recreation Division will implement this program upon project completion.

5.3.3.4 Operation and Maintenance Plan

Upon completion of construction of this project, the harbor will be turned over to the project sponsor. As project sponsor for this project the State of Hawaii, DLNR, Division of Boating and Ocean Recreation, will be responsible for the daily administration and operation of the Kikiaola Light Draft Harbor. In addition, the State will be responsible for all operation and maintenance requirements outside of the Federal dredging limits which includes the maintenance of the existing launch ramp, all interior shoreside revetments, wooden pier, other existing shoreside facilities, periodic maintenance dredging of the berthing area and the sand bypass program.

The U.S. Army Corps of Engineers will be responsible for monitoring and maintaining all Federal navigation features of this project. The Federal navigation features for this project include the entrance and primary access channels and all breakwater structures. Depending on localized conditions and shoaling rates in the area, periodic hydrographic surveys are typically conducted by the Corps of Engineers to determine actual Federal maintenance requirements. Annual inspections of the protective structures will be conducted annually by the Corps.

The other Federal cost that is required for this project is the breakwater maintenance cost. The average annual breakwater maintenance cost was estimated to be 0.5% of the breakwater construction cost.

5.3.4 Average Annual Benefits

A detailed discussion of the average annual benefits is presented in Section 12.1 "ECONOMIC ANALYSIS, APPENDIX A". Average annual benefits of $643,000 were derived by comparing without-project conditions to the estimated with-project conditions for the different alternatives. They include increased net revenue for ongoing commercial passenger and commercial fishing operations, improved efficiency for existing tour companies, new commercial businesses and recreational boating. Commercial navigation benefits make up about 79 percent of the totals for the alternatives analyzed. Recreational benefits contribute about 21 percent.

5.3.5 Benefit to Cost Comparison and Net Benefits.

Based on the estimated average annual costs and benefits, the benefit to cost ratios for the alternatives plans are noted on Table 2.

5.3.6 National Economic Development (NED) Plan

The NED plan is that plan which reasonably maximizes net national economic development benefits (Difference between average annual benefits and average annual costs). The NED plan best fulfills the Federal objective of increasing the value of the nation's output of goods and services and improving economic efficiency, and is the Federally preferred plan. Alternative Plan 1 is the plan with the greatest positive net benefits and is designated the NED plan.

6 COMPARISON OF ALTERNATIVE PLANS

6.1 TRADE OFF ANALYSES

The evaluation of alternative plans were based on the following basic criteria suggested by the U.S. Water Resources Council:

- Completeness. Completeness is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the proposed action.
- Effectiveness. Effectiveness is defined as a measure of the extent to which the plan achieves its objectives.
- Efficiency. Efficiency is the cost effectiveness of the plan expressed in terms of net benefits.
- Acceptability. Acceptability is defined as acceptance of the plan by the concerned public.

The evaluation of the alternative plans based on the above criteria are summarized in Table 3, Summary Comparison of Alternative Plans and System of Accounts. The trade-off analyses included an evaluation of the economic, environmental, social, regional, and aesthetic effects associated with each plan. Table 3 is designed to provide a comprehensive comparison and evaluation of the alternative plans. This table displays the significant features and contributions of each plan, the beneficial and adverse effects, and the extent to which various planning objectives and criteria are met or not met by each plan.

7 SELECTION OF RECOMMENDED PLAN

7.1 SELECTION AND RATIONALE

The selection of the most desirable plan of improvement involves comparison and tradeoffs among the alternative plans. A comparison of the alternative plans was performed on the basis of 1) beneficial and adverse effects of each alternative, 2) relative contribution to the planning objectives, and 3) response to associated evaluation criteria. Based on the comparison of alternative plans and system of accounts presented in Table 3, Plan 1 is selected as the recommended plan of improvement.

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
A. PLAN DESCRIPTION	Navigation Features: No defined existing channels Protective Structures: Existing 1,280 ft. long east breakwater ; 600 ft long west breakwater; & 225 ft long inner breakwater.	Navigation Features: A 700 ft long, 105 ft to 205 ft wide, 11 ft deep entrance channel; & a 320 ft long, 70 ft to 105 ft wide, 7 ft deep access channel. Protective Structures: Removing 150 ft of the outer east stub breakwater; Removing & constructing 85 ft long inner east stub breakwater; modifying 220 ft of west breakwater.	Navigation Features: A 835 ft long, 105 ft to 205 ft wide , 11 ft deep entrance channel; a 115 ft wide, 115 ft long, 9 ft deep turning basin, & a 230 ft long , 70 ft to 105 ft wide , 7 ft to 9 ft deep access channel. Protective Structures: Same as Plan 1, except for removing 40 ft of inner stub breakwater.	Navigation Features: An 820 ft long, 105 ft to 205 ft wide, 9 ft to 11 ft deep entrance channel; & a 310 ft long, 70 ft to 105 ft wide , 7 ft deep access channel. Protective Structures: Same as Plan 1 except for removing 130 ft of inner stub breakwater & removing & constructing 195 ft long inner east stub breakwater.	Navigation Features: Same as Plan 1. Protective Structures: Same as Plan 1, except for constructing a 140 ft long outer east stub breakwater.	Navigation Features: A 1,050 ft long , 105 ft to 205 ft wide, 11 ft deep entrance channel; & a 325 ft long, 70 ft to 105 ft wide, 7 ft deep access channel. Protective Structures: Removing 150 ft from the existing outer east stub breakwater; Removing & constructing 85 ft long inner east stub breakwater; Constructing a new 600 ft long west breakwater extension.	Navigation Features: A 1,050 ft. long, 105 ft wide , 11 ft deep entrance channel, & a 620 ft long, 70 ft wide, 7 ft deep access channel. Protective Structures: Removing 150 ft from the existing outer east stub breakwater, Removing 85 ft long inner east stub breakwater, Removing 285 ft of the existing west breakwater, Extending the east breakwater by 325 ft & Modifying 750 ft of the existing east breakwater & 85 ft of the west breakwater.
B. IMPACT ASSESSMENT							
1. Economic							
a. Local Govt Finance	No impact on property values or tax revenues.	Increased property values & tax revenues around harbor	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS (CONT'D)

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
b Land Use	No Change	No Change	No Change	No Change	No Change	No Change	No Change
c. Public Facilities & Services	Continued hazardous navigation through harbor channel	Substantial improvement to berthing & channel navigation safety	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
d. Regional Growth	Poor harbor facility hampers regional growth	Enhanced economic growth & increased opportunities with project	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
e. Employment	No Change	Increased employment opportunities with project	Same as Plan 1	Same as Plan 1.	Same as Plan 1.	Same as Plan 1	Same as Plan 1
f. Business & Industry	No Change.	Increased business opportunities	Same as Plan 1.	Same as Plan 1.	Same as Plan 1.	Same as Plan 1	Same as Plan 1
2. Environmental							
a. Construction Effects	No Change	Short term increase in turbidity, noise, dust & exhaust emissions	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
b. Water Quality	No Change	No long term change expected from pre-construction conditions	Same as Plan 1 .	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS (CONT'D)

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
c. Air Quality	No Change	No long term change expected from pre-construction conditions	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
d. Aquatic Resources	No Change	No long term change expected from pre-construction conditions	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
e. Terrestrial Resources	No Change	No long term change expected from pre-construction conditions	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
f. Endangered Species	No Change	No Change	No Change	No Change	No Change	No Change	No Change
3. Social							
a. Noise	No Change	Temporary increase due to construction & long term increase due to additional harbor activity	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
b. Population	No impact	Would enhance population growth in the harbor vicinity. No displacement of people.	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
c. Aesthetic Values	No Change	Visual intrusion from improvements	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
d. Historic, Cultural, & Archaeological Resources	No Change	No Change	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS (CONT'D)

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
e. Community Growth & Well-Being	Continued danger & emotional stress during high wave conditions	Would enhance community growth & development & community well-being due to increased opportunities & safety.	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
f. Boating Opportunities	No Change	Would enhance recreational & commercial boating opportunities.	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
C. PLAN EVALUATION							
1. Contributions to Planning Objectives							
a. Reduce Navigation Hazard	No Change	Substantially reduces navigation hazard in the entrance channel	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
b. Provide Adequate & Protected Berthing Area	No Change	Provides protective berthing area & allows development of existing harbor basin	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
c. Minimize Shoaling Within the Channel & Harbor Basin	No Change	Sand bypassing would minimize shoaling of the channel.	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Shoaling in harbor basin is reduced by elimination of direct exposure to onshore littoral movement.

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS (CONT'D)

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
d. Minimize Impacts to Marine & Terrestrial Environment & Recreational, Cultural & Archaeological Resources of Study Area	No Change	No substantial impact	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
e. Plans Consistent with Existing & Proposed Uses of the Study Area	NA						
f. Plans Address Community Desires & Concerns	Does not address community desires & concerns	Plan addresses community desires & concerns	Same as Plan 1	Same as Plan 1	Same as Plan 1	Does not address community desires & concerns	Same as Plan 1
2. Response to Formulation Criteria							
a. Technical							
(1) Safe Navigation Conditions	Unsafe entrance channel with breaking waves	Yes	Yes	Yes	Yes	Yes	Yes
(2) Protective Structures Designed for Severe Storm	Existing structure not designed for severe storm conditions	Yes	Yes	Yes	Yes	Yes	Yes
(3) Able to Accommodate Design Vessel	Existing depths are too shallow to accommodate design vessel	Yes	Yes	Yes	Yes	Yes	Yes

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS (CONT'D)

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
(4) Sound, Practicable, Technically Feasible & Environmentally Acceptable	N/A	Yes	Yes	Yes	Yes	No	Yes
b. Economic Criteria							
(1) Net Benefits Maximized	N/A	Yes	No	No	No	No	No
(2) Benefits Exceed Costs	N/A	Yes	Yes	Yes	Yes	No	No
c. Environmental & Social Criteria							
(1) Minimize Long Term Effects	No Change	Yes	Yes	Yes	Yes	Yes	Yes
(2) Protect and/or Enhance Environmental Resources	No Change	Yes	Yes	Yes	Yes	Yes	Yes
(3) Consider all Public & Local Interest Desires	N/A	Yes	Yes	Yes	Yes	No	Yes
3. Relationship to National Economic Development							
a. Average Annual Benefits	N/A	$643,000	$643,000	$643,000	$643,000	$643,000	$643,000
b. Average Annual Costs	N/A	$529,170	$544,495	$563,779	$584,495	$775,179	$659,965
c. Net Annual Benefits	N/A	$113,830	$98,505	$79,221	$58,505	($132,179)	($16,965)
d. Benefits to Costs Ratio	N/A	1.22	1.18	1.14	1.10	0.83	0.97

TABLE 3. SUMMARY COMPARISON OF ALTERNATIVE PLANS & SYSTEM OF ACCOUNTS (CONT'D)

	NO ACTION ALTERNATIVE	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6
D. OTHER FACTORS IN PLAN EVALUATION							
1. Acceptability	N/A	High	Low	Low	Low	Low	Medium
2. Completeness	N/A	Complete as described with periodic maintenance.	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1	Same as Plan 1
3. Effectiveness	N/A	Effective	Same as Plan 1	Same as Plan 1	Same as Plan 1	Not Effective	Same as Plan 1
4. Efficiency	N/A	High	Low	Low	Low	Not Efficient	High
E. IMPLEMENTATION RESPONSIBILITIES							
1. Corps of Engineers	N/A	Provide estimated first cost share of $4.5M for PED & construction of breakwater & entrance & access channel.	Provide estimated first cost share of $4.7M for PED & construction of breakwater ,entrance & access channel & turning basin.	Provide estimated first cost share of $4.8M for PED & construction of breakwater & entrance & access channel.	Provide estimated first cost share of $5.1M for PED & construction of breakwater & entrance & access channel.	Provide estimated first cost share of $7.2M for PED & construction of breakwater & entrance & access channel.	Provide estimated first cost share of $6.0M for PED & construction of breakwater & entrance & access channel.
2. State of Hawaii	N/A	Provide estimated first cost share of $1.7M for floating dock system, dredging of berthing area, GNF's, LERR&D & local assurances and cooperation.	Provide estimated first cost share of $1.6M for floating dock system, dredging of berthing area, GNF's, LERR&D & local assurances and cooperation.	Provide estimated first cost share of $1.6M for floating dock system, dredging of berthing area, GNF's, LERR&D & local assurances and cooperation.	Provide estimated first cost share of $1.7M for floating dock system, dredging of berthing area, GNF's, LERR&D & local assurances and cooperation.	Provide estimated first cost share of $2.2M for floating dock system, dredging of berthing area, GNF's, LERR&D & local assurances and cooperation.	Provide estimated first cost share of $1.9M for floating dock system, dredging of berthing area, GNF's, LERR&D & local assurances and cooperation.
F. CONSTRUCTION PERIOD	N/A	16 months	16 months	16 months	16 months	19 months	16 months

7.2 SENSITIVITY ANALYSIS

The reliability of the results from the benefit-cost study is examined in this sensitivity analysis. This analysis entails assessing the magnitude of the changes in the major benefit categories that will alter the outcome of the study. Dependable results are affected only by large variations in the benefit categories. Conversely, results affected by small changes are less dependable.

The sensitivity of the results to variations in the benefits from increased efficiency was considered. Increased efficiency benefits would have to be reduced by 66 percent or more for the recommended alternative to become infeasible. This could occur if the tour operator moving into Kikiaola does not begin running two tours a day as assumed. This seems unlikely given the economic incentives of offering that second tour. The demand for Na Pali coast tours is strong while setting up that second tour will not be difficult. Alternative 1 will remain feasible with reductions of less than 66 percent in this benefit category. The benefit analysis is deemed insensitive to changes in increased efficiency benefits.

A second sensitivity analysis investigated the impacts of variations in the trailered commercial fishing benefit category. A decline of more than 33 percent in this benefit category would render Alternative 1 infeasible. This translates into reducing new full-time commercial fishing trips launching out of an improved Kikiaola harbor from 262 to 129 trips. Likewise, a reduction in part-time commercial fishing trips from 451 to zero trips plus a reduction of full-time fishing trips from 262 to 243 would also cause Alternative 1 to be infeasible. The information on the number of new trips taken out of an improved Kikiaola Harbor was obtained from a survey of boaters on Kauai. The accuracy of the survey results can be called into question, but it is unlikely that the survey results are inaccurate by the magnitude needed to dispute the justification of Alternative 1. The benefit analysis is deemed insensitive to changes in this benefit category.

7.3 COST APPORTIONMENT

The apportionment of costs is based on Section 101 of the Water Resources Development Act of 1986 (WDRA 86), Public Law 99-662. If, as a result of this GRR, a decision on construction authorization for a project is made, Section 101 of PL 99-662 requires that the construction costs for general navigation features (GNF) be shared 20 percent non-Federal , 80 percent Federal for commercial navigation projects where depths are modified up to 20 feet. Costs not associated with GNF are 100 percent the responsibility of the non-Federal sponsor.

The initial construction cost of the GNF for the recommended plan (Plan 1) is $5,552,000. This costs includes $1,205,000 of planning, engineering, and design (PED) costs expended and programmed through FY99 by the Corps of Engineers to complete the General Reevaluation Report and the plans and specifications for the Kikiaola Harbor. In addition, this cost also includes the value of lands, easements and rights-of-way and Relocations (LERR) estimated at $101,000.

The initial Federal investment is 90 percent of the construction cost, or $4,997,000, which includes the $1,205,000 previously expended and programmed. The initial local share is 10 percent of the construction cost, or $555,000. The project sponsor must also contribute an additional 10 percent $454,000, plus interest, over a period not to exceed 30 years after completion of the general navigation features. The sponsor would be credited toward this last 10 percent cost with the value of LERR&D. Ultimately the total costs for GNF would be shared $1,110,000 Non-Federal and $4,543,000 Federal.

The project sponsor is also responsible for 100 percent of the financial cost for the inner harbor facilities, dredging of the berthing area and LERR&D which is estimated at $658,000. These inner harbor facilities, which includes a floating dock system and the initial dredging of this berthing area, must be furnished by the project sponsor to provide the benefits for the NED plan. The fully funded cost apportionment for both the navigation features and the inner harbor facilities is summarized in Table 4.

8 PLAN IMPLEMENTATION

8.1 PLANS AND SPECIFICATIONS

The U.S. Army Corps of Engineers will prepare construction plans and specifications upon approval and allocation of funds by the Chief of Engineers.

8.2 PROJECT APPROVAL AND CONSTRUCTION FUNDING

When plans and specifications are sufficiently complete, project approval and construction funding will be requested. The request will be accompanied by a draft copy of the Project Cooperation Agreement (PCA), which includes, but is not limited to, the provisions of a Section 221 agreement. Upon approval, the PCA will be executed between the U.S. Army Corps of Engineers and the State of Hawaii, Department of Land and Natural Resources (DLNR).

8.3 CONSTRUCTION

Construction will be accomplished by a contract awarded to a construction contractor under the U.S. Army Corps of Engineers competitive bid process. The estimated performance period for the construction of the recommended plan is 16 months.

TABLE 4. ESTIMATED COST APPORTIONMENT FOR RECOMMENDED PLAN 1/

ITEM	FEDERAL	NON-FEDERAL
General Navigation Features (GNF):		
• Planning, Engineering & Design (PED)	$1,205,000	
• Initial Construction	$3,792,000 [1]	$555,000 [2]
• Final 10% payment	($454,000) [3]	$454,000 [3]
SUBTOTAL	$4,543,000	$1,009,000
• *LERR&D:*	0	101,000
ULTIMATE COST	**$4,543,000**	**$1,110,000**
Inner Harbor Facilities:		
• U.S. Coast Guard Navigation Aids	$35,000	0
• Floating Dock System	0	$420,000
• Berthing Area Dredging	0	$137,000
SUBTOTAL	$35,000	$557,000
TOTAL FIRST COSTS [4]	**$4,578,000**	**$1,667,000**

[1] 90 % of GNF construction cost less PED cost.
[2] Initial local share of 10% cash payment on GNF construction cost.
[3] Final local share of 10% payment repaid to Federal Government over a period not to exceed 30 years after completion of the project (Includes credit for LERR&D).
[4] April 2001 price level (Estimated midpoint of construction).

8.4 LOCAL COOPERATION

A PCA will be developed and coordinated with the project sponsor (State of Hawaii, DLNR). Section 101 of P.L. 99-662, harbor and navigation projects, require all non-federal interests to comply with the following requirements:

- Provide support personnel to operate, maintain, repair, replace, and rehabilitate at its own expense, the local service facilities in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

- Provide without cost to the United States all lands, easements, and rights-of-way, including those for suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features;

- Accomplish all removals determined necessary by the Federal Government other than those removals specifically assigned to the Federal Government;

- Provide, during the period of construction, a cash contribution equal to 10 percent of the total cost of the general navigation features for costs attributable to dredging to a depth of 20 feet.

- Repay with interest, over a period not to exceed 30 years following completion of the period of construction of the project, an additional 10 percent of the total cost of construction of general navigation features depending upon the amount of credit given for the value of lands, easements, rights-of-way, and relocations provided by the non-Federal sponsor for the general navigation features. If the amount of credit exceeds 10 percent of the total cost of construction of the general navigation features, the non-Federal sponsor shall not be required to make any contribution under this paragraph, nor shall it be entitled to any refund for the value of lands, easements, rights-of-way, and relocations in excess of 10 percent of the total cost of construction of the general navigation features;

- Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the general navigation features for the purposes of operating, maintaining, repairing, replacing and rehabilitating the general navigation features;

- Hold and save the United States free from all damages arising from the construction, maintenance, repair, replacement and rehabilitation of the project, any betterments, and the local service facilities, except for damages due to the fault or negligence of the United States or its contractors;

- Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total cost of construction of the general navigation features, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR Section 33.20;

- Perform, or cause to be performed, any investigations for hazardous substances as are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, maintenance, repair, replacement, or rehabilitation of the general navigation features. However, for lands that the Government determines to be subject to the navigation servitude, only the Government shall perform such investigation unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

- Assume complete financial responsibility, as between the Federal Government and the non-Federal sponsor, for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features;

- To the maximum extent practicable, perform its obligations in a manner that will not cause liability to arise under CERCLA;

- Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for construction, operation, maintenance, repair, replacement, and rehabilitation of the general navigation features, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

- Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

8.5 DISTRICT ASSESSMENT OF PROJECT SPONSOR'S FINANCING CAPABILITY

The PCA for Navigation Improvements at the Kikiaola Light Draft Harbor is scheduled for execution in April 2000. The project sponsor, State of Hawaii, DLNR has submitted a letter of intent to provide the local assurances and financial support to participate in the implementation of the recommended plan. The local contribution will be obtained through State of Hawaii budget appropriations. The project sponsor has included this project as its top priority for capital improvement project starts in Fiscal Year 2000.

The State of Hawaii, DLNR will provide the non-Federal share of funds for this project in accordance with the draft PCA between the Department of the Army and the State of Hawaii, DLNR. The cost estimate indicates a total project first cost of $6.2M of which $4.6 M and $1.7M is a Federal and Non-Federal responsibility respectively.

The initial Non-Federal share is 10 percent of the construction cost for General Navigation Features or $555,000. This initial payment for construction will be made using State appropriated funds. The remaining Non-Federal share of $1.1M will also be obtained through State appropriated funds. Subsequent operation and maintenance costs for the protective structures and entrance and access channels will be entirely funded by the Federal Government. Non-Federal interests will fund the operation and maintenance of the berthing area, dock and shoreside facilities.

The financial capability statement submitted by the State of Hawaii, DLNR provides adequate intent and justification of funding availability for this project. In addition the State of Hawaii has been reasonably successful in obtaining the required funding for past civil works construction projects. Therefore, based on the district's assessment of the project sponsor's intent and prior financial history it was determined that the project sponsor has the capability to finance its portion of the project costs.

8.6 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE (HTRW)

An assessment of the project site was conducted to determine the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) on lands necessary for project construction, operation, and maintenance.

Discussions were held with local county officials, the State of Hawaii Department of Health and long time Kekaha residents to determine the historical land use of the Kikiaola Harbor area. Based on these discussions and previous site visits to the area there are no indications of past or present hazardous, toxic and radioactive wastes (HTRW) at the study site.

Sediment testing and analysis were conducted on several samples taken at various locations within the existing Kikiaola Harbor to determine if the presence of HTRW exists at the project site. Based on the current listing of hazardous substances regulated under CERCLA, a comprehensive evaluation of the data was conducted and compared to the existing stated EPA limits. The inspection of the data indicates that none of the samples contained any detectable levels of pesticides, herbicides, volatiles or semivolatiles. In addition, none of the detected metals were above the stated EPA limits.

9 SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

The U.S. Army Corps of Engineers, Honolulu Engineer District, has been responsible for conducting and coordinating the overall study. Public participation has played a key role during the course of this study. To insure that the desires and needs of the public were identified and addressed, a public involvement program was developed. During the early stages of this study and prior to the plan formulation process our planning efforts focused on problem identification. Coordination has been maintained with federal, state, county and other local agencies and private citizens to address the navigational safety and other related concerns. Feedback from the coordination was used to develop the study scope, planning objectives, the extent of the study area, applicable constraints and controls, and how subsequent planning action would be scheduled.

The Corps of Engineers and the project sponsor, State Department of Land and Natural Resources (DLNR) have worked closely in the development and formulation of the alternative plans. The State DLNR participated in the last public workshop held in Kekaha on May 6, 1996. The public workshop was held at the Kekaha Neighborhood Center. The purpose of this workshop was to inform the public of the study and to review the previously authorized plan as well as the other alternatives that had been investigated under the original General Design Memorandum. The public was provided the opportunity to express their views and concerns regarding this project. The meeting was well attended with approximately 50 people representing residents, boaters and fishermen. Some of the more immediate concerns voiced by the audience are summarized below:

- Boaters and fishermen expressed an immediate need to dredge the existing harbor basin and channel.
- A resident expressed concern over what he felt was a very narrow channel opening of 105' between the end of the west breakwater and the inner east stub breakwater.
- Boaters and fishermen expressed an interest in a new alternative plan 6, which utilizes an entrance channel that faces in the westerly direction.
- To improve existing harbor in lieu of relocation.
- Improvement of existing navigational aids.

All relevant views and comments gathered from this public workshop were incorporated into our plan formulation process. The proposed recommended plan was presented to State DLNR, local county officials, commercial boaters and the Kikiaola Westside Boater's Club Board members on May 13, 1997. All interests were supportive of the proposed recommended plan.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

The recommended plan of improvement at Kikiaola Harbor, as described in this report, is the most efficient means of improving navigation conditions at the harbor. This plan provides safe navigation and berthing conditions for vessels using the harbor and satisfies the planning objectives established in this General Reevaluation Report. The proposed improvements were developed in accordance with accepted engineering, economic, environmental and social criteria and involved a detailed assessment and evaluation of alternative solutions to navigation problems in accordance with the Water Resources Council's Principles and Standards. Six alternative plans were investigated and coordinated with interested federal and local government agencies and the general public. The recommended plan of improvement is supported by the project sponsor and general public and is consistent with existing land use plans developed by the State of Hawaii. The project sponsor has indicated its willingness to provide the necessary local cooperation requirements outlined in this report. Any adverse effects, which may result from implementation of the recommended plan, are substantially outweighed by other considerations of national interest. In summary, the overall public interest is best served by the implementation of the recommended plan of improvement.

10.2 RECOMMENDATIONS

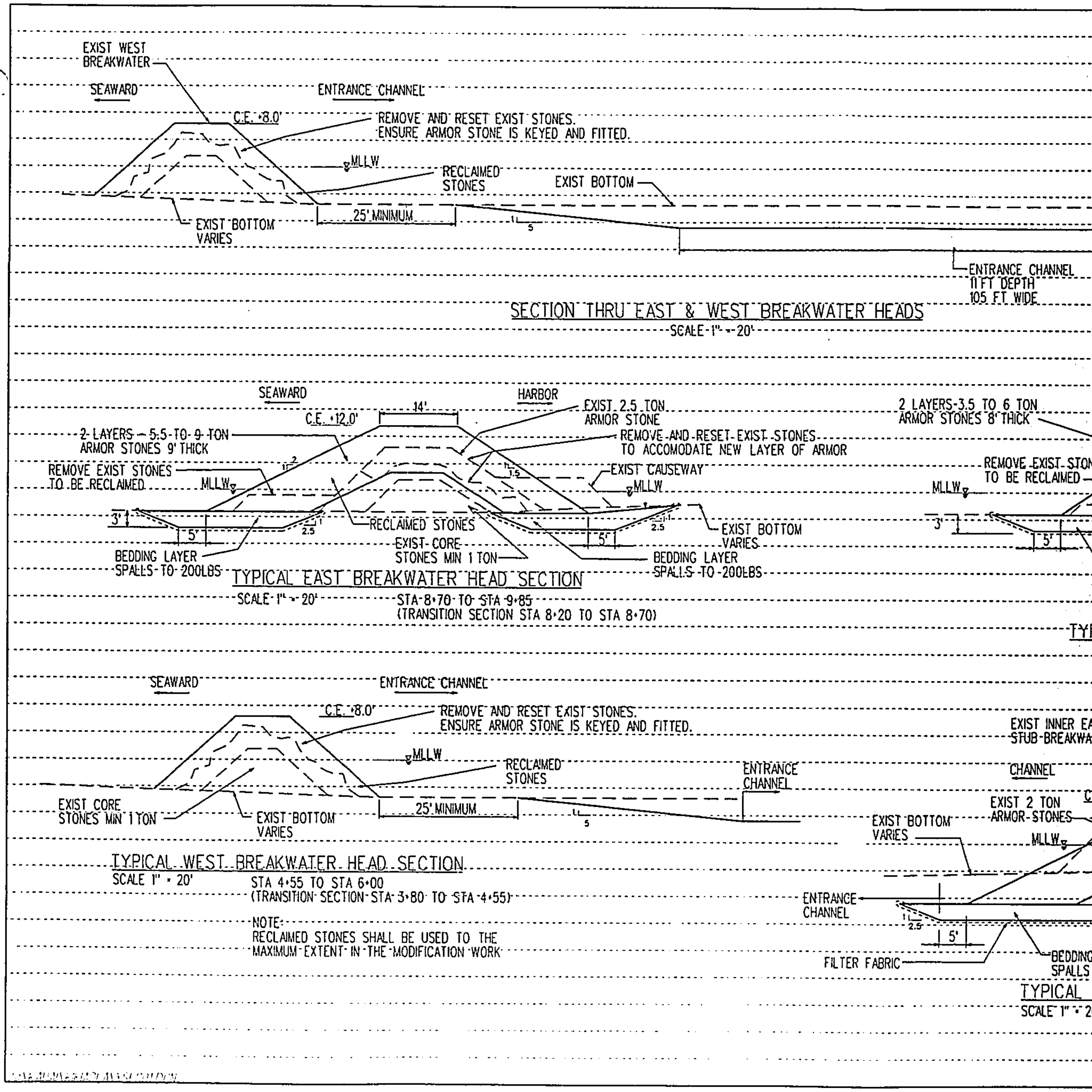
The District Engineer, having considered all substantial aspects in the overall public interest, recommends that Plan 1, selected herein to provide substantial improvement to navigation safety, be authorized as a Federal project. The recommended general navigation features (GNF) of Plan 1 consist of extensions and modifications to existing breakwaters and the dredging of an entrance and access channel. The ultimate total project first cost for GNF and LERR&D is estimated at $5,653,000. This cost would be cost shared at $4,543,000 for Federal and $1,110,000 for non-Federal interests. The proposed improvements would incur estimated average annual operation and maintenance costs for dredging at $10,000 and $45,000 to be borne by non-Federal and Federal interests respectively. Annual net benefits accruing from this plan of improvement are estimated at $114,000 with a benefit cost ratio of 1.22 to 1.

The foregoing recommendation is subject to the condition that non-Federal interests agree, in writing, to carry out the items set forth in Section 8.4 "Local Cooperation" of this main report. The non-Federal interests must agree to the Cost Apportionment requirements outlined in Table 4. The Chief of Engineers shall determine the exact amount of non-Federal contributions prior to project implementation.

The recommendations contained herein reflect both the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and/or implementation funding.

Ralph H. Graves
Lieutenant Colonel, U.S. Army
District Engineer

3 June 1998
Date


EXIST WEST BREAKWATER
SEAWARD
ENTRANCE CHANNEL
C.E. +8.0'
REMOVE AND RESET EXIST STONES.
ENSURE ARMOR STONE IS KEYED AND FITTED.
MLLW
RECLAIMED STONES
EXIST BOTTOM
EXIST BOTTOM VARIES
25' MINIMUM
ENTRANCE CHANNEL
11 FT DEPTH
105 FT WIDE
SECTION THRU EAST & WEST BREAKWATER HEADS
SCALE 1" = 20'
SEAWARD
HARBOR
14'
C.E. +12.0'
EXIST 2.5 TON ARMOR STONE
2 LAYERS - 5.5 TO 9 TON ARMOR STONES 9' THICK
REMOVE AND RESET EXIST STONES TO ACCOMODATE NEW LAYER OF ARMOR
REMOVE EXIST STONES TO BE RECLAIMED
MLLW
EXIST CAUSEWAY
MLLW
3'
5'
2.5
RECLAIMED STONES
EXIST CORE STONES MIN 1 TON
5'
2.5
EXIST BOTTOM VARIES
BEDDING LAYER SPALLS TO 200LBS
BEDDING LAYER SPALLS TO 200LBS
TYPICAL EAST BREAKWATER HEAD SECTION
SCALE 1" = 20'
STA 8+70 TO STA 9+85
(TRANSITION SECTION STA 8+20 TO STA 8+70)
2 LAYERS-3.5 TO 6 TON ARMOR STONES 8' THICK
REMOVE EXIST STON TO BE RECLAIMED
MLLW
3'
5'
TYI
SEAWARD
ENTRANCE CHANNEL
C.E. +8.0'
REMOVE AND RESET EXIST STONES.
ENSURE ARMOR STONE IS KEYED AND FITTED.
MLLW
RECLAIMED STONES
ENTRANCE CHANNEL
EXIST CORE STONES MIN 1 TON
EXIST BOTTOM VARIES
25' MINIMUM
TYPICAL WEST BREAKWATER HEAD SECTION
SCALE 1" = 20'
STA 4+55 TO STA 6+00
(TRANSITION SECTION STA 3+80 TO STA 4+55)
NOTE:
RECLAIMED STONES SHALL BE USED TO THE MAXIMUM EXTENT IN THE MODIFICATION WORK
EXIST INNER EA
STUB BREAKWA
CHANNEL
EXIST 2 TON ARMOR STONES
EXIST BOTTOM VARIES
MLLW
ENTRANCE CHANNEL
2.5
5'
FILTER FABRIC
BEDDING
SPALLS
TYPICAL
SCALE 1" = 2

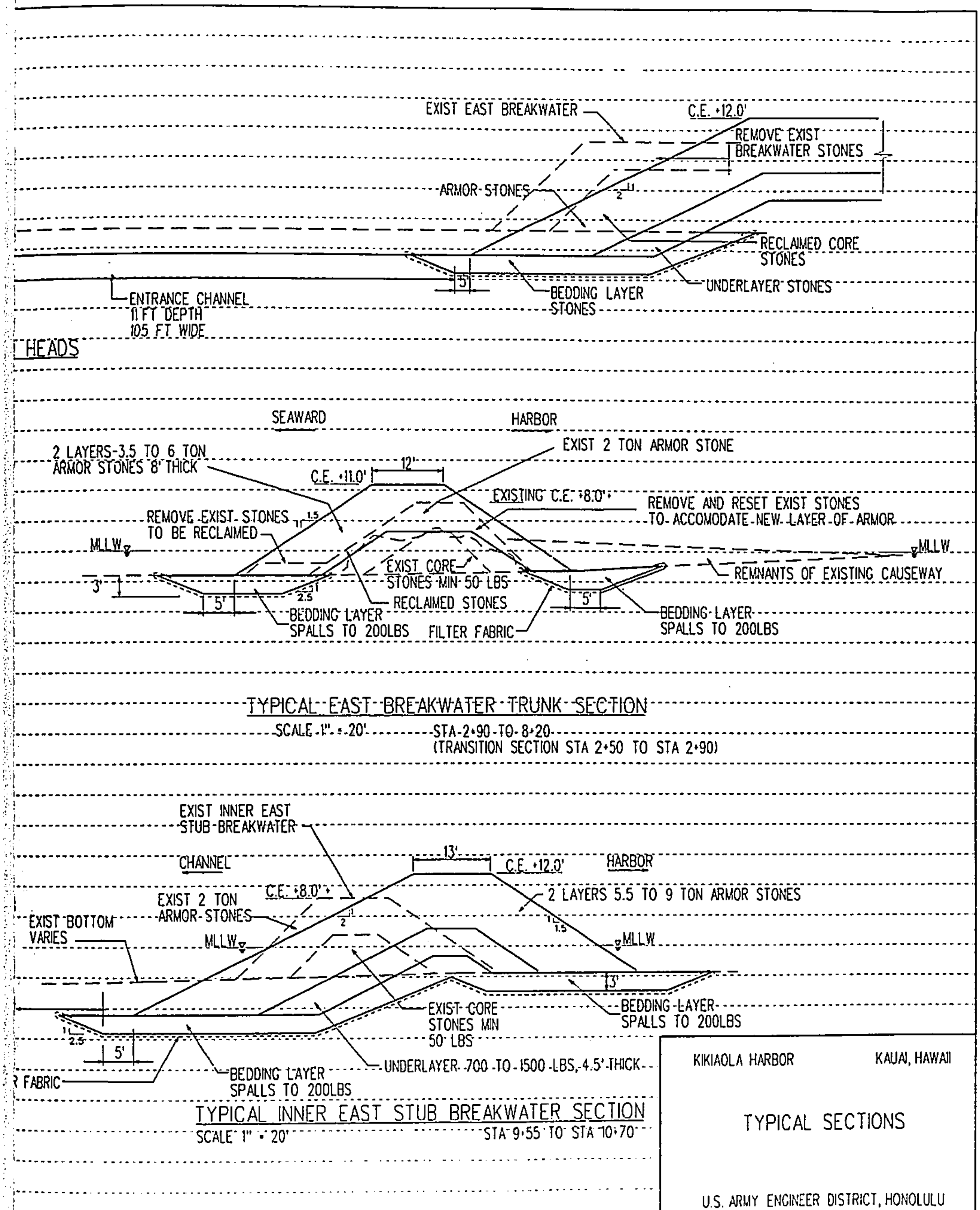
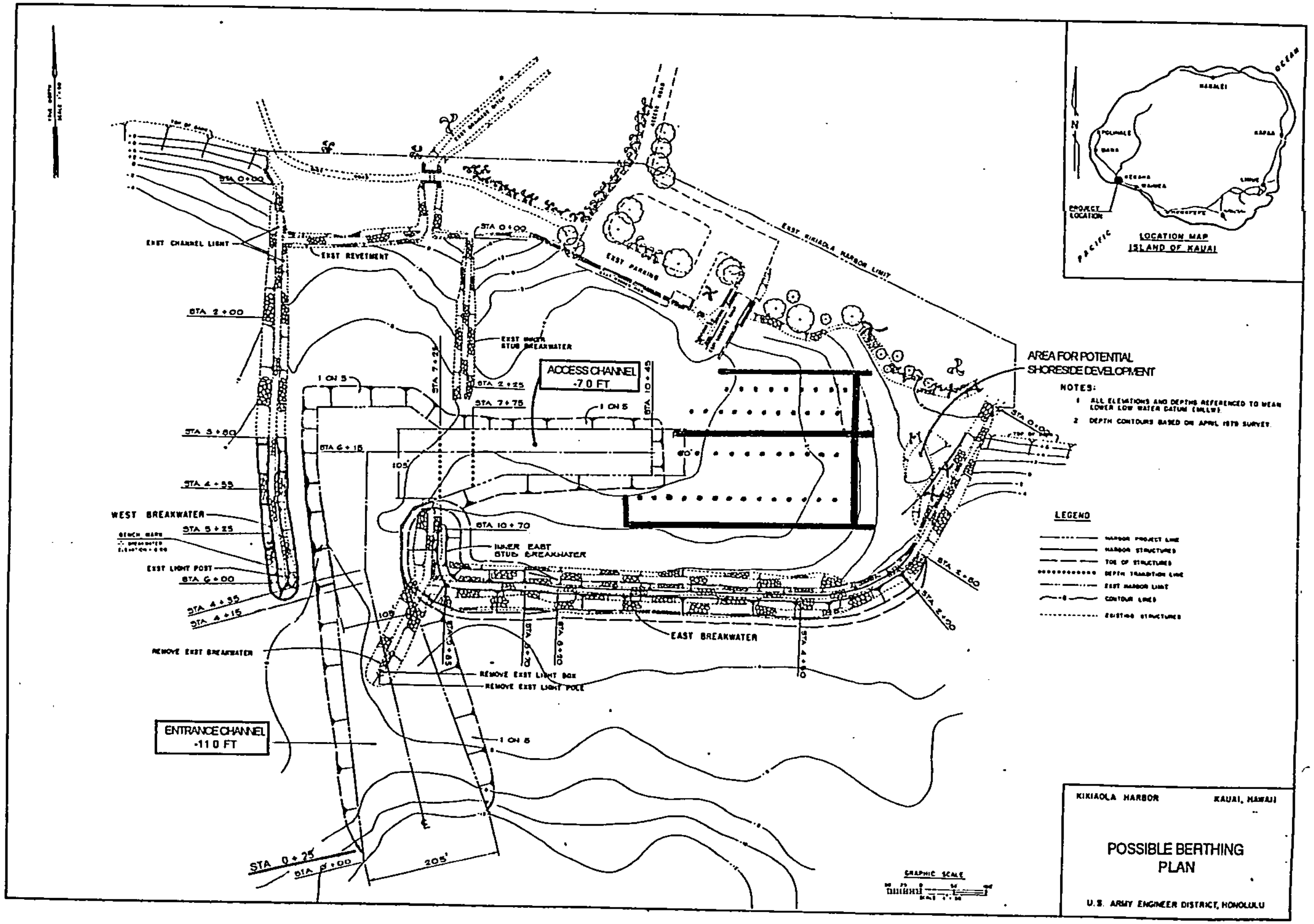

EXIST EAST BREAKWATER
C.E. +12.0'
REMOVE EXIST BREAKWATER STONES
ARMOR STONES
RECLAIMED CORE STONES
UNDERLAYER STONES
BEDDING LAYER STONES
ENTRANCE CHANNEL 11 FT DEPTH 105 FT WIDE
HEADS
SEAWARD
HARBOR
2 LAYERS-3.5 TO 6 TON ARMOR STONES 8' THICK
EXIST 2 TON ARMOR STONE
C.E. +11.0'
12'
EXISTING C.E. +8.0'+
REMOVE AND RESET EXIST STONES TO ACCOMODATE NEW LAYER OF ARMOR
REMOVE EXIST. STONES TO BE RECLAIMED
MLLW
EXIST CORE STONES MIN 50 LBS
REMNANTS OF EXISTING CAUSEWAY
RECLAIMED STONES
BEDDING LAYER SPALLS TO 200LBS
FILTER FABRIC
BEDDING LAYER SPALLS TO 200LBS
TYPICAL EAST BREAKWATER TRUNK SECTION
SCALE 1" = 20'
STA 2+90 TO 8+20
(TRANSITION SECTION STA 2+50 TO STA 2+90)
EXIST INNER EAST STUB BREAKWATER
CHANNEL
13'
C.E. +12.0'
HARBOR
C.E. +8.0'+
EXIST 2 TON ARMOR STONES
2 LAYERS 5.5 TO 9 TON ARMOR STONES
EXIST BOTTOM VARIES
MLLW
EXIST CORE STONES MIN 50 LBS
BEDDING LAYER SPALLS TO 200LBS
UNDERLAYER 700 TO 1500 LBS, 4.5' THICK
FABRIC
BEDDING LAYER SPALLS TO 200LBS
TYPICAL INNER EAST STUB BREAKWATER SECTION
SCALE 1" = 20'
STA 9+55 TO STA 10+70
KIKIAOLA HARBOR
KAUAI, HAWAII
TYPICAL SECTIONS
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 8



LOCATION MAP
ISLAND OF KAUAI
PROJECT LOCATION
PACIFIC
OCEAN
N
EAST CHANNEL LIGHT
EAST REVETMENT
STA 0+00
STA 2+00
STA 3+60
STA 4+55
WEST BREAKWATER
STA 5+25
EXST LIGHT POST
STA 6+00
STA 4+35
STA 4+15
REMOVE EXST BREAKWATER
ENTRANCE CHANNEL
-11.0 FT
STA 0+25
STA 0+00
205'
EXST INNER STUB BREAKWATER
ACCESS CHANNEL
-7.0 FT
STA 7+25
STA 2+25
STA 7+75
STA 10+45
1 ON 5
STA 6+15
105'
60'
STA 10+70
INNER EAST STUB BREAKWATER
EAST BREAKWATER
STA 4+50
STA 2+60
STA 2+00
REMOVE EXST LIGHT BOX
REMOVE EXST LIGHT POLE
EXST PARKING
EAST KIKIAOLA HARBOR LIMIT
AREA FOR POTENTIAL SHORESIDE DEVELOPMENT
NOTES:
1. ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EAST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
GRAPHIC SCALE
KIKIAOLA HARBOR
KAUAI, HAWAII
POSSIBLE BERTHING PLAN
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 9

SECTION 11 - ENVIRONMENTAL ASSESSMENT

Section 11 - Environmental Assessment
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CHAPTER 1

SUMMARY

1.1 MAJOR CONCLUSIONS OF THE 1980 ENVIRONMENTAL IMPACT STATEMENT. The General Design Memorandum and Final Environmental Impact Statement (GDM/EIS) for Navigation Improvements for Kikiaola Light-draft Harbor, Waimea, Kauai, Hawaii, dated September 1980 concluded that the proposed plan (Alternative 1) was the National Economic Development (NED) Plan, and that it was also the least environmentally damaging plan. None of the plans enhanced the physical or cultural environment. The proposed modifications were determined to have no adverse effects on endangered species, long term significant adverse effects on aquatic resources, and no effect on cultural resources. The project was determined to be consistent, to the maximum extent practicable, with the State of Hawaii Coastal Zone Management Program, and was in compliance with Executive Order 11988 concerning flood plain management.

1.2 MAJOR CONCLUSIONS OF THIS ENVIRONMENTAL ASSESSMENT. This restudy of the project has concluded that the proposed plan identified in the 1980 GDM/EIS (Alternative 1) is still the NED Plan, and therefore the preferred alternative. Based on the results of recent coordination with resource agencies, it is again concluded that the proposed project will have no significant effects on endangered or threatened species, or other biological resources; and will have no effect on cultural resources. The project has been determined to be consistent with the State of Hawaii Coastal Zone Management Program, and in compliance with Executive Order 11988, Flood Plain Management. Water Quality Certification is being requested from the State of Hawaii Department of Health under Section 401 of the Clean Water Act.

1.3 AREAS OF CONTROVERSY. None

1.4 UNRESOLVED ISSUES. None

1.5 RELATIONSHIP TO OTHER ENVIRONMENTAL DIRECTIVES. Compliance with all applicable environmental directives has been completed up to this phase of planning for the project. In some cases coordination/compliance is an on-going process. Table 1 shows the present compliance status of applicable environmental directives.

TABLE 1

COMPLIANCE WITH FEDERAL AND STATE ENVIRONMENTAL PROTECTION DIRECTIVES

Federal Statutes	Applicability	Compliance Status
American Folklore Preservation Act	No	NA
Anadromous Fish Conservation Act	No	NA
Antiquities Act of 1906	No	NA
Archaeological Resources Protection Act	No	NA
Bald Eagle Act	No	NA
Clean Air Act	Yes	Full
Clean Water Act	Yes	Full
Coastal Zone Management Act	Yes	Full
Endangered Species Act	Yes	Full
Estuaries Protection Act	No	NA
Federal Environmental Pesticide Control Act	No	NA
Federal Water Project Recreation Act	No	NA
Fish and Wildlife Coordination Act	Yes	Full
Historic Sites Act	No	NA
Land and Water Conservation Fund Act	No	NA
Marine Mammal Protection Act	Yes	Full
Marine Protection, Research and Sanctuaries Act	No	NA
Migratory Bird Conservation Act	Yes	Full
Migratory Bird Treaty Act	Yes	Full
National Environmental Policy Act	Yes	Full
National Historic Preservation Act	Yes	Full
Native American Religious Freedom Act	No	NA
Resource Conservation and Recovery Act	Yes	Full
River and Harbor Act of 1899	Yes	Full
Submerged Lands Act	No	NA
Surface Mining Control and Reclamation Act	No	NA
Toxic Substances Control Act	No	NA
Watershed Protection and Flood Protection Act	Yes	Full
Wild and Scenic Rivers Act	No	NA

TABLE 1 (continued)

COMPLIANCE WITH FEDERAL AND STATE ENVIRONMENTAL PROTECTION DIRECTIVES

	Applicability	Compliance Status
Presidential Executive Orders		
11514 - Protection and Enhancement of Environmental Quality	Yes	Full
11593 - Protection and Enhancement of the Cultural Environment	Yes	Full
11988 - Floodplain Management	Yes	Full
11990 - Protection of Wetlands	Yes	Full
12088 - Federal Compliance with Pollution Control Standards	Yes	Full
State Of Hawaii Statutes		
HRS Chapter 6E - Historic Preservation	Yes	Full
HRS Chapter 54 - Water Quality	Yes	Full
HRS Chapter 343 - EIS Rules	Yes	Full

Notes:

a. **Yes.** (Statute is Applicable). Statute is applicable and compliance is required.

b. **No.** (Statute is Not Applicable). Statute is not applicable or resource covered is not in the project area.

c. **Full** (Full Compliance). Having met all requirements of the statute for the current stage of planning. Additional compliance may be required during later phases of planning or during construction.

d. **Partial** (Partial Compliance). Less than full compliance at this stage of planning

d. **NA** (Not Applicable). No requirement for the statute, or the resource is not present at the project site.

CHAPTER 2

PURPOSE AND NEED FOR THE PROPOSED ACTION

2.1 PURPOSE OF THE PROPOSED ACTION. The purpose of the project is to eliminate the navigation hazards and shoaling and improve the Kikiaola Light-draft Harbor so that the harbor can better serve the needs of the users, and the local sponsor can develop berths and other infrastructure.

2.2 NEED FOR THE PROPOSED ACTION. The harbor improvements are needed to eliminate the shallow depths in the entrance channel which pose a hazard to vessels using the harbor, particularly during south swell conditions. When the south swell is running, usually during the summer, surf up to 15 feet breaks approximately 1,000 yards off the harbor entrance where the bottom rises from 70-80 feet to about 15 feet. The swell then reforms and breaks again right at the channel entrance. Boats trying to leave the harbor under these conditions must make a "running start." If timing is not right and the outer break begins breaking, boats are forced to turn around and return to the protection of the harbor. Only faster boats with speeds greater than 18-20 knots can attempt exiting the harbor when the south swell is up. For larger, slower boats the harbor is inaccessible during periods of moderate to high south swell which occur with greatest frequency from approximately June to August. This situation is aggravated by the summer Yellow Fin Tuna *(Ahi)* run which usually occurs during this period. Fishing boat owners do not want to risk being inadvertently harbor bound due to high surf any time during the *Ahi* run.

2.3 BACKGROUND. Kikiaola Harbor was originally developed by the State of Hawaii in 1959. In 1961 the State constructed the launch ramp, and in 1964 the two stub breakwaters and a short inner breakwater were constructed to reduce surge within the harbor basin. Congress authorized a federal project to modify the State harbor in 1968, but no construction funds were provided. Post-authorization studies were initiated in 1978, including an evaluation of environmental impacts required by various laws and regulations enacted since the project was initially authorized, but again, no construction funds were authorized. The present proposed plan of improvement is essentially the same as that documented in the post authorization study General Design Memorandum and Final Environmental Impact Statement (GDM/EIS) in September, 1980. The GDM/EIS evaluated five alternatives and selected Alternative Plan 1 as the National Economic Development (NED) Plan and the least environmentally damaging plan, and therefore the recommended plan. This is also the proposed plan of improvement evaluated in this environmental assessment.

CHAPTER 3

ALTERNATIVES

3.0 GENERAL. Six alternatives to the proposed plan were evaluated for this assessment and the General Reevaluation Report (GRR). The GRR contains more details about the alternatives, including figures showing the various features of each plan. Table 2 shows a comparison of the plan features and impacts.

3.1 THE PROPOSED ACTION (Alternative Plan 1). The Proposed Plan (Alternative 1) would accommodate about 45 boats and consists of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; and removing and reconstructing an inner east stub breakwater 85 feet long.

3.2 ALTERNATIVES TO THE PROPOSED ACTION.

3.2.1 Alternative Plan 2. Alternative Plan 2 would accommodate about 45 boats and would consist of dredging an entrance channel 835 feet long; an access channel 230 feet long; a turning basin 115 long and 115 feet wide; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; removing and reconstructing an inner east stub breakwater 85 feet long; and removing 40 feet of the inner stub breakwater.

3.2.2 Alternative Plan 3. Alternative Plan 3 would accommodate about 45 boats and would consist of dredging an entrance channel 820 feet long; an access channel 310 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; and removing 130 feet from the inner stub breakwater; and constructing a new inner east stub breakwater 195 feet long.

3.2.3 Alternative Plan 4. Alternative Plan 4 would accommodate about 45 boats and would consist of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; removing and reconstructing an inner east stub breakwater 85 feet long; and constructing an outer east stub breakwater 140 feet long.

3.2.4 Alternative Plan 5. Alternative Plan 5 would provide berthing for approximately 45 boats. It was developed to utilize the open space between the west and inner stub breakwaters for additional mooring spaces. Plan 5 consists of dredging a 1,050 foot long entrance channel, removing 150 feet from the existing outer east stub breakwater; raising the east breakwater's crest elevation by four feet from Station 8+70 to Station 9+85 and three feet from Station 2+50 to Station 8+20; flattening the seaward slope of the east breakwater to one vertical on two horizontal from Station 8+70 to Station 9+85; removing and reconstructing an 85 foot long inner east stub breakwater; and constructing a 600 foot long extension to the existing west breakwater.

3.2.5 Alternative Plan 6. Alternative Plan 6 was developed in response to public input during an information meeting held with users. Plan 6 would provide berthing for 45 boats and consists of dredging a 1050 foot long entrance channel and a 620 foot long access channel; removing 150 feet from the existing outer east stub breakwater; extending the east breakwater by 325 feet and raising the elevation to 11 feet and flattening the seaward slope; modifying approximately 750 feet of the existing east breakwater by raising the crest elevation to 11 feet; removing 285 feet of the existing west breakwater and modifying approximately 85 feet of the remaining breakwater.

3.2.6 No Action Alternative. For this alternative there would be no improvements to the harbor by either the Federal or State of Hawaii governments.

3.3 ALTERNATIVES ELIMINATED FROM DETAILED STUDY FOR THIS EVALUATION.

3.3.1. The Plan of Improvement authorized in 1968, was eliminated from detailed study during this evaluation based on the findings of the 1980 DPR/EIS. That study found design deficiencies in the 1968 plan. For example, it was determined that crest elevations of the 1968 plan were not adequate for the design wave regime, and that because of the soft bottom involved, the stable side slope for dredging should be 1 vertical to 5 horizontal instead of the 1V to 2H of the 1968 plan. Based on those findings there was no reason to again analyze this plan in detail.

3.3.2. Alternative sites were not considered during this evaluation, because relocating the harbor would be much more expensive, and cause much more environmental damage than modifying the existing harbor.

TABLE 2
Features and Effects of Alternative Plans

FEATURES	Proposed Plan Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Entrance channel	Dredge 700 feet long, 11 feet deep 105-205 feet wide	Dredge 835 feet long, 11 feet deep, 105-205 feet wide	Dredge 820 feet long, 9-11 feet deep, 105-205 feet wide	Same as Alt 1	Dredge 1,050 feet long 11 feet deep 105-205 feet wide	Dredge 1,050 feet long 11 feet deep 105 feet wide
Access channel	Dredge 320 feet long, 7 feet deep, 70-105 feet wide	Dredge 230 feet long, 7-9 feet deep, 70-105 feet wide	Dredge 310 feet long, 8 feet deep, 70-105 feet wide	Same as Alt 1	NA	Dredge 620 feet long 7 feet deep 70 feet wide
Turning basin	NA	115 feet long, 10 feet deep, 115 feet wide	NA	NA	Maneuvering area	NA
Inner stub breakwater	NA	Remove 40 feet	Remove 130 feet	NA	NA	NA
Outer east stub breakwater	Remove 150 feet	Same as Alt 1	Same as Alt 1	Remove 150 feet, reconstruct 140 feet	Remove 150 feet	Remove 150 feet
Inner east stub breakwater	Remove and reconstruct 85 feet	Same as Alt 1	Remove 85 feet and reconstruct 195 feet	Same as Alt 1	Same as Alt 1	Remove 85 feet
East breakwater	Raise crest elevation and flatten seaward slope	Same as Alt 1	Same as Alt 1	Same as Alt 1	Same as Alt 1	Extend 325 feet, raise crest elevation and flaten seaward slope
West breakwater	Modify 220 feet	Same as Alt 1	Same as Alt 1	Same as Alt 1	Extend 600 feet	Remove 285 feet Modify 85 feet.
Boats	45	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1
Dredge quantity Area dredged	38,000 Cubic Yards 4.8 Acres	47,000 Cubic Yards 5.7 Acres	36,000 Cubic Yards 5.0 Acres	38,000 Cubic Yards 4.8 Acres	56,000 Cubic Yards 6.8 Acres	41,000 Cubic Yards 6.3 Acres
Fill quantity (Breakwater)	28,000 Tons	28,000 Tons	36,000 Tons	35,000 Tons	66,000 Tons	46,000 Tons
Area covered	0.17 Acres	0.17 Acres	0.25Acres	0.33 Acres	0.69 Acres	0.64 Acres

EFFECTS						
Construction Effects	Short-term increase in turbidity, noise, dust & exhaust emmissions	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt 1	Same as Alt 1
Water Quality	No long-term change expected from pre-construction conditions	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt 1	Same as Alt 1
Air Quality	No long-term change expected from pre-construction conditions	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt 1	Same as Alt 1
Noise	No long-term change expected from pre-construction conditions	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt 1	Same as Alt 1
Aquatic Resources	No long-term change expected from pre-construction conditions	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt 1	Same as Alt 1
Terrestrial Resources	No long-term change expected from pre-construction conditions	Same as Alt. 1	Same as Alt. 1	Same as Alt. 1	Same as Alt 1	Same as Alt 1
Endangered Species	No effect	No effect	No effect	No effect	No effect	No effect
Cultural Resources	No effect	No effect	No effect	No effect	No effect	No effect

CHAPTER 4

AFFECTED ENVIRONMENT

4.1 LOCATION. Kikiaola Harbor is located on the southwest coast of Kauai approximately half way between the towns of Kekaha and Waimea. Kauai, the northernmost of the eight major Hawaiian Islands, is 103 statute miles west and slightly north of Honolulu. The roughly circular island is fourth largest in land area with 549 square miles. The broad coastal plain on which Kikiaola is situated was formed by wave action along a prehistoric shoreline with was higher and farther inland than it is today. This emergent marine terrace was subsequently overlain with alluvial deposits from upland erosion.

4.2 PHYSICAL CONDITIONS.

4.2.1 Climate. The climate of the Waimea-Kekaha region is characterized by a two-season year (summer and winter) with mild and uniform temperature ranging from a monthly mean of 70° F. in the winter to 78° F. in the summer. The average annual rainfall of 22 inches per year at Kekaha is the lowest on the island. Northeast trade winds prevail 80-90 percent of the time during the summer decreasing to about 60 to 70 percent during the winter.

4.2.2 Natural Hazards. According to the Federal Emergency Management Agency Flood Insurance Rate Map Community Panel Number 150002 0156 D, revised September 30, 1995, the project area is located in an area of coastal flooding with velocity hazard (wave action), with a base flood elevation of 11 feet. Kauai is in Zone 1 for seismic activity (Zones 0-4, 4 highest) according to the Uniform Building Code, 1991 Addition, so the potential for seismic damage is low; however, the potential for severe damage from hurricanes is very real, with two (*Iwa* and *Iniki*) occurring within the past 15 years.

4.2.3 Air Quality. Air quality in the project area is good. There are no sources of industrial pollution in the vicinity. The State of Hawaii Department of Health has one air quality monitoring station on Kauai , located in Lihue, which monitors six pollutants. Between January 1988 and December 1990 none of the samples exceeded either the Federal Air Quality Standards or the State of Hawaii Standards (State of Hawaii, undated).

4.2.4 Noise. Noise levels are generally low in the harbor area. The noise from powerboats is usually the dominant sound

4.2.5 Water Quality. The harbor waters are turbid, primarily due to agricultural runoff (see Par. 4.3.2 below). The State of Hawaii Department of Health has no record of water quality sampling from the harbor area; however, the Corps will perform a survey to determine baseline values for several water quality parameters. A Public Notice No. CW96-0002 was issued on 20 August, 1996 under Section 404 of the Clean Water Act (CWA).

4.2.6 Dust. Due to the low level of activity occurring at the existing Kikiaola Harbor the potential for fugitive dust is relatively low and infrequent.

4.2.7 Littoral Sediment Transport. A review of historical data confirms the existence of a predominant westerly longshore littoral drift resulting in the transport of large quantities of sediment originating from the Waimea River. Since the construction of the original harbor by the State of Hawaii in 1959, substantial accretion has occurred along the eastern shoreline of Kikiaola Harbor and at the same time substantial erosion has taken place along the western shoreline of the harbor. Recent studies seem to indicate a stabilization of the eastern shoreline. This stabilization leads us to believe that further accretion in this area will be minimal and any additional material within the offshore littoral zone will bypass this area and continue in the predominant westerly littoral drift until being deposited in the entrance and access channel and berthing area or offshore areas. A sediment transport rate of 3,500 cubic yards per year was derived from historical beach changes observed in old aerial photographs. This sediment transport rate was assumed to be directly attributable to the infilling of the harbor's entrance and access channel.

4.3 BIOLOGICAL RESOURCES. The following information has been taken largely from the Detailed Report Kikiaola Harbor for Light-Draft Vessels Kekaha, Kauai, Hawaii, dated August 8, 1980, prepared by the U. S. Fish and Wildlife Service, as well as updated information contained in their letters dated 27 November, 1995 and 13 February, 1996 and the letter from the National Marine Fisheries Services dated 16 February, 1996 (Appendix I). In a February 1996 letter from the U.S. Fish and Wildlife Service (FWS) to the Corps of Engineers, the FWS stated that an update of the 1980 2(b) report would not be necessary.

4.3.1 Terrestrial Resources. Terrestrial flora consists largely of introduced and/or cultivated species, including coconut palms (Cocos nucifera), *kiawe* (Prosopis pallida), ironwood (Casurina equisetifolia), hau (Acacia farnesiana), banyan (Ficus sp.); Plumeria sp. beach *naupaka* (Scaevola taccada), beach morning glory (Ipomoea pes-caprae) and other herbaceous weeds and grasses, as well as commercially-cultivated sugarcane (Saccharum officinarum). Terrestrial fauna are predominantly domestic animals and livestock and introduced species such as the domestic dog (Canis familiaris), domestic cat (Felis catus), house mouse (Mus musculus), roof rat (Rattus rattus), and the Norway rat (Rattus norvegicus). Table 3 lists the common introduced and migratory birds likely to be found in and around the project site.

TABLE 3

List of Birds commonly Found in the Kekaha-Mana Area
(Adapted from FWS 2(b) Report dated 8/8/80
After Pyle, 1977 and Telfer)

Common Name	Scientific Name
Cattle Egret	*Bubulous ibis*
Black-crowned Night Heron	*Nycticorax n. hoactli*
Shoveler Duck	*Spatula clypeata*
Pintail Duck	*Anas acuta*
Ring-necked Pheasant	*Phasianus colchicus*
American Golden Plover	*Pluvialia dominica*
Wandering Tattler	*Heteroscelus incanus*
Ruddy Turnstone	*Arenaria interpres*
Sanderling	*Caldris alba*
Lace-necked Dove	*Streptopelia chinensis*
Barred Dove	*Geopelia striata*
Barn Owl	*Tyto alba*
Hawaiian Owl	*Asio flammeus sandwichensis* (H)
Chinese Thrush	*Garrulax canorus*
Mocking Bird	*Mimus polyglotus*
Japanese White-eye	*Zosterope japonica*
Common Mynah	*Acridotheres tristis*
Western Medowlark	*Sturnella neglecta*
Spotted Munia (Ricebird)	*Lonchura cardinalis*
House Sparrow	*Passer domesticus*
Northern Cardinal	*Cardinalis cardinalis*

(H) indicates listed as endangered by the State of Hawaii

4.3.2 Aquatic Resources. Agricultural land use in the project area has had a profound effect on the nearshore marine environment. In the past, silt-laden run-off from sugarcane fields has been collected and discharged into Kikiaola Harbor via a drainage ditch. Terrigenous sediments, predominantly red clay and silt, have accumulated in the harbor basin, which acts as a sediment trap. Nearshore waters are rendered a reddish-brown color, reducing Secchi disc measurements to as little as one foot in the inner harbor. Core samples indicate that these sediments have been deposited on the harbor bottom, overlying and mixing with calcareous and basaltic sands. The discharge of agricultural runoff is now regulated by a flap gate located 980 feet inland. The gate is only opened during periods of local flooding, about 2-3 times per year. As a result of the degradation of the existing marine environment due to siltation, conditions within and adjacent to the harbor are not conducive to the propagation and sustained growth of live coral.

Intertidal habitat includes both soft, silty-sand and hard, basaltic rock substrates which are inhabited by distinctly different flora and fauna.

Man-made breakwaters provide a hard substrate on which attached and encrusting algae are abundant. These include green algae (Cladophora fascicularis and Ulva fasciata) , the red alga (Acanthophora spicifers) and crustose alga Porolitithon onkodes. The latter was found predominantly on the wave-washed seaward face of the east breakwater. Grapsid crabs (Metapograpsus sp.) are particularly abundant along this high energy intertidal zone, as well. Gastropod mollusks were more abundant in the calmer intertidal habitat of the harbor. These species include the dotted periwinkle (Littorina pintado pintado) common nerite (Nerita picea) kneecap shell (Cellana argentata), black limpet (C. exarata), and false limpet (Siphonaria normalis) in descending order of abundance. Plecypod (bivalve) mollusks were found in the less rigorous environment of the inner harbor. These included the purse shell (Isognomon californicum) and the encrusted bottom shells of one or more unidentified species of oyster.

Soft, sandy substrates are located at the eastern end and in the northwest corner of Kikiaola Harbor. This habitat is occupied by one or two different species of ghost crab. Their burrows ranged in density from less than one per square meter to approximately 5 per square meter.

Five separate hauls were made at two different sites within the harbor using a 25-foot seine. Invertebrates collected by this means included the white crab (Portunus sanguinolintus) and an unidentified palaemonid shrimp. The predominant fish collected included the island silverside (Pranesus insularum), *nehu* (Stolephorus purpureus), *aholehole* (Kuhlia sandvicensis), and Samoan mullet (Chelon engeli).

One fisherman was observed fishing for mullet using a cast net near the shoreline at the east end of the harbor. Interviews with other local fishermen indicated that a fishery for *moi* (Polydactylus sexfillis) also exists in the harbor, although no specimens were collected.

Other fishery resources include the common pelagic species (tunas marlins, mahimahi, etc.) and demersal or bottom fish species (snappers, jacks, and grouper) that occur in deeper water and open ocean areas fished by boat out of Kikiaola Harbor (Table 4: Species Landings, pp. EA-II-50 and 60). Of the bottom fish species, onaga and ehu have been listed as recruitment overfished for the Main Hawaiian Islands. These species are major components of the Kekaha/Kikiaola bottom fish catch.

4.3.3 Threatened and Endangered Species. The Hawaiian owl (Asio flammeus sandwichensis) (*pueo*) on the State of Hawaii endangered species list may occasionally forage in the area, but is not know to nest there. The federally listed endangered Hawaiian hoary bat (Lasiurus cinereus semotus) may also occasionally forage in the area, but it is not known to roost there. There are no protected species of plants or insects reported from the area. Critical habitat has not been designated or proposed for any of the listed species under the jurisdiction of the Fish and Wildlife Service in or near the project area.

The endangered humpback whale (Megaptera novaeangliae) is resident in Hawaiian waters from November through May each year, and during this period they are commonly sighted in the waters near the project site. The threatened green turtle *honu* (Chelonia mydas) is now very common in the waters around the main Hawaiian islands, including the vicinity of the project area. The endangered hawksbill turtle (Eretmochelys imbricata) and the endangered Hawaiian monk seal (Monachus schauinslandi) occur in the waters around the island of Kauai only very rarely, and neither breeding or nesting is known to have occurred in the area around Kikiaola Harbor. Critical habitat has not been designated or proposed for any of the listed species under the jurisdiction of the National Marine Fisheries Service in or near the project area.

4.4 CULTURAL/ARCHAEOLOGICAL RESOURCES. There are no such resources in the project area. The State of Hawaii Deputy Historic Preservation Officer concurred in this determination by letter dated 2 November, 1995.

4.5 RECREATIONAL RESOURCES. There is some recreational fishing and picnicking at the harbor. There are no surf sites in the immediate vicinity.

4.6 LAND USE. Land use immediately adjacent to the harbor is designated for Agriculture and Open Pasture and Other Uses. There is also a small portion designated Urban. The nearby town of Kekaha is designated Urban.

CHAPTER 5

ENVIRONMENTAL CONSEQUENCES

5.0 General. Unless indicated otherwise, the environmental consequences are expected to be substantially the same for all the alternatives.

5.1 EFFECTS ON PHYSICAL CONDITIONS.

5.1.1 Climate. The proposed project will have no effect on the climate in the area

5.1.2 Natural Hazards. The proposed project will have no effect on natural hazards, but will lessen the damage caused by high waves.

5.1.3 Air Quality. There will be an increase in exhaust emissions from the additional boats which will eventually use the harbor; however, this increase is not expected to have a significant effect on air quality in the project area. The potential for nuisance odors resulting from stockpiled dredged material will be minimal. Dredged material will be dewatered at the harbor, then trucked to a nearby 10-acre site owned by Kikiaola Land Company. The approximately 40,000 cubic yards of material will be spread uniformly over the 10 acres, resulting in an overall depth of about 2 feet. This shallow layer of dredged material would dry quickly, eliminating the generation of unpleasant nuisance odor. Based on previous dredging operations conducted at the harbor in recent years, nuisance odors emanating from stockpiling or disposal in the vicinity of the harbor is not expected to be a problem.

5.1.4 Noise. There will be an increase in engine noise from the additional boats which will eventually use the harbor; however, this increase is not expected to have a significant effect on the general noise climate of the harbor area.

5.1.5 Water Quality. Water quality is not expected to change significantly due to the proposed project, although there may be a slight decrease in turbidity because of the dredging which will remove much of the accumulated terrigenous sediment in the harbor. An application for Water Quality Certification under Section 401 of the CWA is being submitted to the State of Hawaii Department of Health.

5.1.6 Dust. There will be an increase in fugitive dust due to the increased construction activities in the vicinity of the existing harbor and especially in the area of the Contractor's proposed storage site. The increased dust level due to construction activity will be temporary in nature lasting approximately 16 months.

5.1.7 Littoral Sediment Transport. The predominantly westerly littoral drift will continue to deposit sediment in the entrance channel, turning basin, and berthing area of Kikiaola Harbor. Increasing the depth of these features will increase the capacity for storage of sediments deposited here. Beach erosion along the down drift shoreline west of the harbor would continue unabated. Mitigation of this effect is addressed in section 5.8.4 of the EA.

5.2 EFFECTS ON BIOLOGICAL RESOURCES.

5.2.1 Terrestrial Resources. The proposed project is not expected to have a significant effect on terrestrial resources

5.2.2 Aquatic Resources. In general, benthic organisms within the footprint of either the dredged area or the new breakwaters will be destroyed. The extent of destruction will vary with each alternative (see Table 2).

The harbor improvements are projected to double the present fishing effort for pelagic and bottom fish resources in the Kekaha/Kikiaola area. If Kekaha boat landings doubled, this would still amount to only about 4% of the State's total commercial pelagic landings, and about 26% of Kauai's commercial landings. None of the pelagic species have biologically-distinct populations on one side of Kauai or separate populations on individual islands. The expected increase would have no impact on pelagic stocks.

Of the bottomfish species (snappers, groupers, jacks), onaga and ehu have been listed as recruitment overfished for the Main Hawaiian Islands - a condition that has existed for a number of years. These species are major components of the Kekaha/Kikiaola bottomfish catch (24% and 18%, respectively). As such, any further fishing mortality placed on these species would be considered detrimental to the stock. The State of Hawaii, however, is in the final stages of establishing a bottomfish management plan which should be in place well before any change in vessel activity could be achieved after dredging the Kikiaola Harbor. The plan centers around closing 20% of the habitat of onaga and ehu to fishing and thereby protecting 20% of the breeding population. With this plan in place, an increase in effort outside of the closed areas may slow population recovery but would not jeopardize the State's management actions to recover these stocks from recruitment overfishing.

5.2.3 Endangered Species. Coordination with the Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) was undertaken during the GRR investigation to update the status of listed species in the project area and reconfirm the earlier finding that the project is not likely to adversely affect protected species. The FWS letter dated February 18,1996 stated that - based on a site visit - the determination was made that roosting habitat and food resources for the Hawaiian hoary bat would not be affected by the proposed project. The NMFS letter dated February 16, 1996 stated that the proposed harbor improvements at Kikiaola are not likely to adversely affect humpback whales or green sea turtles. Both agencies concluded that the requirements of Section 7 of the Endangered Species Act have been satisfied (see Appendix 1).

5.3 EFFECTS ON CULTURAL/ARCHAEOLOGICAL RESOURCES.

There are no such resources in the project, and by letter dated 2 November, 1995 the State of Hawaii Historic Preservation Officer has concurred in our determination of "No Effect".

5.4 EFFECTS ON RECREATIONAL RESOURCES.

The proposed project will have no effect on land-based recreational fishing, picnicking or surfing. The project will improve offshore recreational fishing by improving the safety of the recreational fishing boats.

5.5 EFFECTS ON LAND USE AND THE COASTAL ZONE.

5.5.1 This project is not expected to affect land use designations or development in the vicinity.

5.5.2 The 1980 determination that the project is consistent to the maximum extent practical with the State of Hawaii Coastal Zone Management Program was affirmed as still valid by the State of Hawaii Department of Business, Economic Development and Tourism by letter dated 13 February, 1996.

5.6 MITIGATION RECOMMENDED BY U.S. FISH AND WILDLIFE SERVICE (FWS).

The following measures were recommended by the FWS to minimize project impacts. Only the recommendation at Paragraph 5.6.3 will not be accepted.

5.6.1 The use of existing upland spoil disposal and quarry sites is encouraged. If new sites are selected, the FWS will be given the opportunity to evaluate the environmental effects of these activities.

5.6.2 Field stone, if used will be acquired from agricultural or cleared lands and not from forested lands

5.6.3 Dredging will be performed during periods of low tide and low surf.

5.6.4 Silt curtains will be deployed as necessary to control turbidity.

5.6.5 No dredged material will be stockpiled in the marine environment.

5.6.6 On land spoil disposal will be conducted behind maintained berms above the influence of the tide.

5.6.7 No spoil will be placed in any watercourse or wetland.

5.6.8 Only clean runoff water from the spoil disposal area will be allowed to reenter an waterway.

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

5.3 EFFECTS ON CULTURAL/ARCHAEOLOGICAL RESOURCES.

There are no such resources in the project, and by letter dated 2 November, 1995 the State of Hawaii Historic Preservation Officer has concurred in our determination of "No Effect".

5.4 EFFECTS ON RECREATIONAL RESOURCES.

The proposed project will have no effect on land-based recreational fishing, picnicking or surfing. The project will improve offshore recreational fishing by improving the safety of the recreational fishing boats.

5.5 EFFECTS ON LAND USE AND THE COASTAL ZONE.

5.5.1 This project is not expected to affect land use designations or development in the vicinity.

5.5.2 The 1980 determination that the project is consistent to the maximum extent practical with the State of Hawaii Coastal Zone Management Program was affirmed as still valid by the State of Hawaii Department of Business, Economic Development and Tourism by letter dated 13 February, 1996.

5.6 MITIGATION RECOMMENDED BY U.S. FISH AND WILDLIFE SERVICE (FWS).

The following measures were recommended by the FWS to minimize project impacts. Only the recommendation at Paragraph 5.6.3 will not be accepted.

5.6.1 The use of existing upland spoil disposal and quarry sites is encouraged. If new sites are selected, the FWS will be given the opportunity to evaluate the environmental effects of these activities.

5.6.2 Field stone, if used will be acquired from agricultural or cleared lands and not from forested lands

5.6.3 Dredging will be performed during periods of low tide and low surf.

5.6.4 Silt curtains will be deployed as necessary to control turbidity.

5.6.5 No dredged material will be stockpiled in the marine environment.

5.6.6 On land spoil disposal will be conducted behind maintained berms above the influence of the tide.

5.6.7 No spoil will be placed in any watercourse or wetland.

5.6.8 Only clean runoff water from the spoil disposal area will be allowed to reenter an waterway.

5.6.9 All permanent spoil disposal areas will be stabilized with vegetative cover or other suitable means to prevent erosion.

5.6.10 Terrestrial vegetation at the project site will be restored and erodible embankments will be stabilized immediately following construction.

5.6.11 The FWS will be notified of any change in project design or construction methodology so that potential impacts can be evaluated.

5.7 MITIGATION RECOMMENDED BY THE NATIONAL MARINE FISHERIES SERVICE.

5.7.1 One or two surveys for sea turtles immediately prior to the start of construction will be conducted to confirm the findings of earlier surveys by the USFWS and the Corps. Additional surveys during and post-construction will be conducted as necessary.

5.7.2 To the extent possible, construction activities should be concentrated during the period June through November, to reduce any possible effects from noise or turbidity on humpback whales.

5.8 OTHER MITIGATION.

5.8.1 The construction contractor will be required to prepare an environmental protection plan which will include site and equipment specific Best Management Practices and other means to comply with applicable State and Federal environmental laws and regulations.

5.8.2 The construction contractor will be expressly required to comply with State of Hawaii Water Quality Standards.

5.8.3 Construction activities will comply with provisions of Hawaii Administrative Rules (HAR), Chapter 11-60.1, "Air Pollution Control," Section 11-60.1-33 on Fugitive Dust.

5.8.4 Our review and evaluation of historical and recent studies, investigations and aerial photographs conducted in the study area suggests that sand bypassing may mitigate existing coastal erosion occurring along the western shoreline if sufficient quantities of sand can be placed from the updrift side to the downdrift side of Kikiaola Harbor. Sand bypassing would be accomplished mechanically by removing material along the eastern shoreline above the high water mark and placing it along the western shoreline by dump truck and loader. This sand bypassing technique would allow continual accretion to occur along the eastern shoreline thereby preventing introduction of sediments into the offshore littoral zone. Sediment transport within the predominant westerly littoral drift beyond the east breakwater will be reduced substantially resulting in minimal deposition of sand and sediments into the harbor channels.

Based on the estimated sediment transport rate of 3,500 cubic yards per year and a 2-foot infill dredging criteria for the channels and berthing area (Recommended Plan), periodic sand bypassing would be required approximately every 4.5 years. It is estimated that 16,000 cubic yards of material would need to be removed from the eastern shoreline and placed along the western shoreline to allow accretion to continue in the east. All applicable county, state, and federal permits as well as rights-of-entries and testing requirements would be obtained and completed by the responsible government agency prior to sand bypassing.

CHAPTER 6

DISTRIBUTION LIST

6.1 FEDERAL AGENCIES

Field Supervisor Office of Environmental Services U.S. Fish & Wildlife Service P.O. Box 50088 Honolulu, HI 96850	Commander Pacific Missle Range Facility Barking Sands Kekaha, Kauai, HI 96752	Ms Vicki Tsuhako U.S. Environmental Protection Agency 300 Ala Moana Blvd, Room 1302 P.O. Box 50003 Honolulu, HI 96850
National Park Service Pacific Area Director 300 Ala Moana Boulevard P.O. Box 50167 Honolulu, HI 96850	Department of the Interior Geological Survey Water Resources Division 677 Ala Moana Blvd, Rm 415 Honolulu, HI 96813	Mr. John Naughton Pacific Island Environmental Coordinator National Marine Fisheries Service 2570 Dole Street, Room 106 Honolulu, HI 96822-2396
Mr. Eugene Nitta Endangered Species Coordinator Pacific Area Office National Marine Fisheries Service 2570 Dole Street, Room 106 Honolulu, HI 96822-2396	National Resources Conservation Service Department of Agriculture Prince Kuhio Federal Building P.O. Box 50004 Honolulu, HI 96850	Postmaster 4441 Rice Street Lihue, Kauai, HI 96766
U.S. Department of Commerce National Oceanic & Atmospheric Administration National Marine Fisheries Service ATTN: R. Michael Laurs 2570 Dole St. Honolulu, HI 96822-2396	Commander Fourteenth Coast Guard District ATTN: Aids to Navigation Branch 300 Ala Moana Blvd., 9th Floor Honolulu, HI 96850	

6.2 STATE OF HAWAII AGENCIES

Historic Preservation Officer Department of Land & Natural Resources 33 South King Street, 6th Floor Honolulu, HI 96813	Director Office of Environmental Quality Control 235 S. Beretania St., Suite 702 Honolulu, HI 96813	Aquatic Resources Division Department of Land & Natural Resources 1151 Punchbowl Street Honolulu, HI 96813
Director Office of State Planning Coastal Zone Management Program Office of the Governor P.O. Box 3540 Honolulu, HI 96811-3540	Chief Highways Division Construction & Maintenance Br Department of Transportation 869 Punchbowl Street Honolulu, HI 96813	Clean Water Branch Environmental Management Division Department of Health P.O. Box 3378 Honolulu, HI 96801-3378
Administrator Department of Land & Natural Resources Forestry & Wildlife Division P.O. Box 3378 Honolulu, HI 96809	Chairperson (2) Department of Land & Natural Resources P.O. Box 621 Honolulu, HI 96809	Office of Conservation & Environmental Affairs P.O. Box 621 Honolulu, HI 96809

6.2 STATE OF HAWAII AGENCIES (continued)

Administrator State Parks Division Department of Land & Natural Resources P.O. Box 621 Honolulu, HI 96809	Administrator Department of Land & Natural Resources Division of Boating & Ocean Recreation 333 Queen Street, Suite 300 Honolulu, HI 96813	Director Department of Health P.O. Box 3378 Honolulu, HI 96801
Chief Environmental Management Division Department of Health P.O. Box 3378 Honolulu, HI 96801	Harbors District Manager Kauai District Office Department of Land & Natural Resources 3242 Waapa Road Lihue, Kauai, HI 96766	Harbors Administrator Harbors Division Department of Transportation 79 S. Nimitz Highway Honolulu, HI 96813
Department of Business, Economic Development & Tourism Edwina Tanaka Community Based Development Advisory Council P.O. Box 2359 Honolulu, HI 96804	Department of Land & Natural Resources 3060 Eiwa Street, Room 306 Lihue, Kauai, HI 96766	Mr. Manabu Tagomori Manager-Chief Engineer Department of Land & Natural Resources Division of Water & Land Development P.O. Box 373 Honolulu, HI 96813
Division of Aquatic Resources Department of Land & Natural Resources 3060 Eiwa Street, Room 306 Lihue, Kauai, HI 96766	Director Office of Planning Department of Business, Erconomic Development & Tourism State Office Tower 235 S. Beretania St., 6th Floor Honolulu, HI 96813	District Land Agent Kauai District Office Land Division Lihue, Kauai, HI 96766
Department of Land & Natural Resources Division of Boating & Ocean Recreation Engineering Branch, ATTN: Manny E. 333 Queen St., Suite 300 Honolulu, HI 96813	Office of Hawaiian Affairs 711 Kapiolani Blvd. Suite 500 Honolulu, HI 96813	

6.3 STATE LIBRARIES

Lihue Public Library 4344 Hardy Street Lihue, Kauai, HI 96766	Hanapepe Public Library Hanapepe, Kauai, HI 96716	Kapaa Public Library Kapaa, Kauai, HI 96746
Koloa Public Library/School Library Koloa, Kauai, HI 96756	Waimea Public Library Waimea, Kauai, HI 96796	Director Hawaii State Library 478 South King St. Honolulu, HI 96813
University of Hawaii Hamilton Library 2550 The Mall Honolulu, HI 96822		

6.4 KAUAI COUNTY AGENCIES

Director Department of Planning County of Kauai 4444 Rice Street Lihue, Kauai, Hawaii 96766	Superintendent Division of Parks & Recreation Department of Public Works Lihue, Kauai, HI 96766	Director Office of Economic Development County of Kauai 4444 Rice Street Lihue, Kauai, HI 96766
Manager & Chief Engineer Department of Water County of Kauai 3498 Pualoke Street Lihue, Kauai, HI 96766	Chair Planning Commission County of Kauai 4444 Rice St. Lihue, Kauai, HI 96766	County Engineer Department of Public Works County of Kauai 4444 Rice St., Suite 275 Lihue, Kauai, HI 96766
Director Department of Transportation 4396 Rice St., Suite 103 Lihue, Kauai, HI 96766	Director Office of Economic Development 4280 Rice St. Lihue, Kauai, HI 96766	Ms. Lynn P. McCrory, Member Board of Land & Natural Resources 4th Land District (Kauai) State of Hawaii P.O. Box 3099 Princeville, Kauai, 96722

6.5 PRIVATE AGENCIES AND INDIVIDUALS.

150th ACW SQ (F) Kokee AFS C/O Lester Matsushima 2935 Ohi Ohi Street Lihue, Kauai, HI 96766	Pomaikai Kane C/O Kaiola Canoe Club P.O. Box 3502 Lihue, Kauai, HI 96766	Garden Island Trollers C/O Herman Chong 5338 Luana Street Kapaa, Kauai, HI 96746
Jeff Rahill C/O Pu'uwai Canoe Club 3470 Lawailoa Lane Koloa, Kauai, Hi 96756	Rinky Dink Fishing Club C/O Herbert Keamoai P.O. Box 207 Makaweli, Kauai, HI 96869	Julie Leong C/O Hanalei Civic Canoe Club P.O. Box 814 Hanalei, Kauai, HI 96714
Rainbow Jackpot Fishing C/O James Nakagawa P.O. Box 695 Eleele, Kauai, HI 96705	Pua Carvalho C/O 323 Kamokila Road Kapaa, Kauai, HI 96746	Nelson Togioka C/O Hawaiian Surfing Federation P.O. Box 1194 Waimea, Kauai, HI 96796
Kikiaola Westside Boat Club P.O. Box 986 Waimea, Kauai, HI 96796	Mike Young C/O Wave Riders Against Drugs P.O. Box 1000 Koloa, Kauai, HI 96756	Kikiaola Boat Club Waimea, Kauai, HI 96796
West Kauai Commercial & Sports Fishing Club Waimea, Kauai, HI 96796	Director Kekaha Neighborhood Center Kekaha, Kauai, HI 96752	Director Waimea Neighborhood Center Waimea, Kauai, HI 96796
Kekaha Sugar Company, Ltd. Kekaha, Kauai, Hi 96752	Kikiaola Land Co., Ltd. P.O. Box 367 Waimea, Kauai, HI 96796	Bill Mossman 282 Aikahi Place Kailua, Hawaii 96734
Kauai Business Report ATTN: Jane McClarin 4895 Kikala Road Kalaheo, Kauai 96741	Sierra Club Kaua'i Group of the Hawaii Chapter P.O. Box 3412 Lihu'e, Kaua'i, Hawai'i 96766	Oceanlit Coastal Corporation 1100 Alakea Building 1100 Alakea St., 31st Floor Honolulu, HI 96813
TEOK Investigations P.O. Box 1078 Waimea, Kaua'i, HI 96796	Sierra Club, Hawai'i Chapter P.O. Box 2577 Honolulu, HI 96803	Captain Andy P.O. Box 876 Ele'ele, Kauai, HI
		Sanifill of Hawaii, Inc. P.O. Box 96752, Kekaha, Kauai , HI 96752

6.6 CONGRESSIONAL OFFICIALS

Honorable Daniel K. Akaka United States Senate 720 Hart Senate Office Building Washington,D.C. 20510	Honorable Daniel K. Inouye United States Senate 722 Hart Senate Office Building Washington D.C. 20510	Honorable Neil Abercrombie House of Representatives 1440 Longworth House Office Building Washington D.C. 20515
Honorable Daniel K. Akaka Prince Kuhio Federal Building 300 Ala Moana Blvd, Room 3104 Honolulu, HI 96850	Honorable Daniel K. Inouye Kauai Field Representative 2853-A Mokoi Street Lihue, Kauai, HI 96766	Honorable Neil Abercrombie House of Representatives Prince Kuhio Federal Building 300 Ala Moana Blvd., Room 4104 Honolulu, HI 96850
Honorable Patsy Mink House of Representatives 2135 Rayburn House Office Building Washington D.C. 20515-1102	Honorable Patsy Mink Prince Kuhio Federal Building 300 Ala Moana Blvd., Room 5104 Honolulu, HI 96850	

6.7 COUNTY OF KAUAI OFFICIALS

Honorable Maryanne W. Kusaka Mayor of the County of Kauai 4444 Rice Street, Suite 235 Lihue, Kauai, HI 96766	Ms. Mary Thronas Council Chair Kauai County Council 4396 Rice Street, Suite 101 Lihue, Kauai, HI 96766	Mr. Randal Valenciano Council Vice Chair Kauai County Council 4396 Rice Street, Suite 101 Lihue, Kauai, HI 96766
Ms. Millie Wellington Public Information Officer County of Kauai 4444 Rice St. Lihue, Kauai, HI 96766	Honorable Avery B. Chumbley Hawaii Senate State Capitol, Room 228 415 South Beretania Street Honolulu, HI 96813	Honorable Lehua Fernandes Salling Hawaii Senate State Capitol, Room 213 415 South Beretania Street Honolulu, HI 96813
Honorable Ezra R. Kanoho Hawaii House of Representatives State Capitol, Room 432 415 South Beretania Street Honolulu, HI 96813	Honorable Bertha C. Kawakami Hawaii House of Representatives State Capitol, Room 434 415 South Beretania Street Honolulu, HI 96813	Honorable Hermina Morita Hawaii House of Representatives State Capitol, Room 315 415 South Beretania Street Honolulu, HI 96813
Mr. William "Kaipo" Asing Kauai County Council 4396 Rice Street Lihue, Kauai, HI 96766	Mr. Bryan J. Baptiste Kauai County Council 4396 Rice Street Lihue, Kauai, HI 96766	Mr. Ronald Kouchi Kauai County Council 4396 Rice Street Lihue, Kauai, HI 96766
Mr. James Tehada Kauai County Council 4396 Rice Street Lihue, Kauai, HI 96766	Mr. James Kunane Tokioka Kauai County Council 4396 Rice Street Lihue, Kauai, HI 96766	

CHAPTER 7

REFERENCES USED

U.S. Army Engineer District, Honolulu, 1980. General Design Memorandum and Final Environmental Impact Statement for Kikiaola Light-draft Harbor Waimea, Kauai, Hawaii. Sep. 1980, Honolulu, HI.

Iwamura, R., 1995. Personal communication concerning cost/benefit matters. Nov. 29, 1995, Honolulu, HI.

U.S. Fish and Wildlife Service, 1980. Detailed Report Kikiaola Harbor for Light-draft Vessels Kekaha, Kauai, Hawaii. A report to the CoE under Par. 2(b), Fish and Wildlife Coordination Act. Aug. 8, 1980, Honolulu, HI.

Fullard, James H., 1990. Echolocation survey estimates of the distribution of the Hawaiian Hoary Bat (*Lasiurus cincereus semotus*) on the Island of Kaua'i.

APPENDIX I

ENVIRONMENTAL COMPLIANCE DOCUMENTS

Appendix I
Environmental Compliance Documents
Table of Contents

EVALUATION OF THE EFFECTS OF THE DISCHARGE OF DREDGED OR FILL MATERIAL INTO THE WATERS OF THE UNITED STATES USING THE U.S. ENVIRONMENTAL PROTECTION AGENCY SECTION 404(b)(l) GUIDELINES

KIKIAOLA HARBOR FOR LIGHT-DRAFT VESSELS, KEKAHA, KAUAI, HAWAII

1 June 1998

I. PROJECT DESCRIPTION. (See also Chapter 3, Environmental Assessment)

a. Location: Kikiaola Light Draft Harbor
Kekaha, Island of Kauai

b. General Description: The U.S. Army Engineer District, Honolulu has investigated public concerns and needs associated with the modification of the Kikiaola Light Draft Harbor, which was originally constructed by the State of Hawaii in 1959, and the environmental, social, cultural and economic resources of the area. Four plans have been developed consistent with national and local goals to complete the Kikiaola Light Draft Harbor; the proposed plan and five alternative plans.

1). The Proposed Plan (Alternative 1) would accommodate 45 boats and consists of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater by raising the crest elevation and flattening the seaward slope; modifying 220 feet of the existing west breakwater; removing and constructing an inner east stub breakwater 85 feet long.

2). Alternative Plan 2 would accommodate 45 boats and would consist of dredging an entrance channel 835 feet long; an access channel 230 feet long; a turning basin 115 long and 115 feet wide; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater as in the Proposed Plan; modifying 220 feet of the existing west breakwater; removing and constructing an inner east stub breakwater 85 feet long; and removing 40 feet of the inner stub breakwater.

3). Alternative Plan 3 would accommodate 45 boats and would consist of dredging an entrance channel 820 feet long; an access channel 310 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east

4). Alternative Plan 4 would accommodate about 45 boats and would consist of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater and constructing a new 140 feet outer east stub breakwater; modifying 735 feet of the existing east breakwater as above; modifying 220 feet of the existing west breakwater and removing and constructing an inner east stub breakwater 85 feet long.

5). Alternative Plan 5 would provide berthing for 45 boats. It was developed to utilize the open space between the west and inner stub breakwaters for additional mooring spaces. Plan 5 consists of: removing 150 feet from the existing outer east stub breakwater; raising the east breakwater's crest elevation by four feet from Station 8+70 to Station 9+85 and three feet from Station 2+50 to Station 8+20; flattening the seaward slope of the east breakwater to one vertical on two horizontal from Station 8+70 to Station 9+85; removing and reconstructing an 85-foot long inner east stub breakwater; constructing a 600-foot long extension to the existing west breakwater; dredging a 1,050-foot long entrance channel to a depth of 11 feet and varying in width from 105 to 205 feet with a maneuvering area to facilitate a 90 degree right turn into the access channel.

6). Alternative Plan 6 is very similar to Plan 1 in its overall layout and would accommodate 45 boats. It was developed in response to public input during an information meeting held with users. The plan would consist of dredging an entrance channel 1,050 feet long, 11 feet deep and 105 feet wide; dredging a 620-foot long access channel seven feet deep and 70 feet wide. It also consists of removing 150 feet from the existing outer east stub breakwater; extending the east breakwater by 325 feet with a crest elevation of 12 feet and flattening the seaward slope of that portion of the east breakwater to one vertical on two horizontal; modifying approximately 750 feet of the existing east breakwater by raising the crest elevation to 11 feet, removing the 85-foot long inner east stub breakwater; removing 285 feet of the existing west breakwater and modifying approximately 85 feet of the remaining breakwater.

c. Authority and Purpose: The Kikiaola Light Draft Harbor was authorized by Section 101 of the Rivers and Harbors Act of 1968 (Public Law 90-483). The present proposed plan for a 45-boat harbor is a modification of the original Congressionally authorized project, resulting from a post authorization study completed in 1980. The environmental assessment is prepared under the authority of the National Environmental Policy Act (NEPA) as amended and Engineering Regulation 200-2-2, Procedures for Implementing NEPA. The purpose of the proposed project is to: reduce navigation hazard in the entrance channel; to minimize shoaling in the entrance channel and harbor basin; and to allow adequate and protected berthing.

d. General Descriptions of Dredged or Fill Materials:

	Proposed	Alt. 2	Alternatives Alt. 3	Alt. 4	Alt. 5	Alt. 6
(1) General Characteristics of the Material	Clean basaltic stone (All Alternatives)					
(2) Quantity of Material to be Discharged	28,000 Tons	28,000 Tons	36,000 Tons	35,000 Tons	66,000 Tons	46,000 Tons
(3) Source of the Material		Existing commercial quarries or field stone				

e. Description of the Proposed Discharge Site:

	Proposed	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
(1) Location (see maps page 3 of main GRR)						
(2) Size (acres)	0.17	0.17	0.25	0.33	0.69	0.64
(3) Type of Site	Harbor	Harbor	Harbor	Harbor	Harbor	Harbor
(4) Type (s) of Habitat	Marine	Marine	Marine	Marine	Marine	Marine

(5) Timing and Duration — The project will likely start construction in CY00, and construction will take approximately 16 months.

f. Description of Disposal Method:

(1) Method of Discharge — Smaller stones will be placed by dump-truck, crane and/or front-end loader. Armor units will be placed by crane.

II. Factual Determinations

a. Physical Substrate Determinations:

	Proposed	Alt. 2	Alternatives Alt. 3	Alt. 4	Alt. 5	Alt. 6
(1) Substrate Depth						
(a) Entrance Channel	11 ft	11 ft	9-11 ft	11 ft	9-11 ft	11 ft
(b) Access Channel	7-11 ft	7-11 ft	7-9 ft	7-11 ft	7-9 ft	7-11 ft
(c) Turning Basin	NA	7-9 ft	NA	4-6 ft	NA	NA
(d) Inner stub	0-6 ft	0-6 ft	0-6 ft	0-6 ft	0-6 ft	0-6 ft
(e) Inner east stub	0-2 ft	0-2 ft	0-4 ft	0-2 ft	0- 2 ft	0-2 ft
(f) West Breakwater	6-8 ft	6-8 ft	6-8 ft	6-8 ft	6-8 ft	6-8 ft
(g) Outer east stub	NA	NA	NA	4-5 ft	4-5 ft	4-5 ft
(2) Sediment Type	Basalt-coral beach sand and terrestrial silt and clay					
(3) Dredged/Fill Material Movement	NA	NA	NA	NA	NA	NA
(4) Physical Effects on Benthos	Burial/ removal	Burial/ removal	Burial/ removal	Burial/ removal	Burial/ removal	Burial/ removal
(5) Other Effects	There will be an increase in turbidity, noise, dust and engine exhaust emissions during construction					

(6) Actions Taken to Minimize Impacts — None specific to individual alternatives

General mitigation recommended is as follows:

(a) No construction material will be stockpiled in the marine environment

(b) Fills will be protected from erosion with armor stone as soon after completion as practicable

(c) Breakwaters and revetments will be constructed of large boulders to dissipate wave energy and resist erosion.

(d) All construction-related materials will be placed or stored in ways to avoid or minimize disturbance to the reef.

(e) All construction-related materials will be free of pollutants

(f) Silt curtains will be deployed around dredge sites

(g) No contamination of the marine environment will result from construction activities.

(h) An oil spill contingency plan will be developed for the small boat harbor by the Division of Boating and Ocean Recreation as part of the normal operating procedures of the harbor.

(i) Periodic turtle surveys will be conducted in the harbor area during construction.

(j) Contractors for both the Federal portion and the State of Hawaii portion of the project will be required to conform with county and state air quality and water quality standards, and noise regulations.

b. Water Circulation, Fluctuation and Salinity Determination:

	Proposed	Alt. 2	Alternatives Alt.3	Alt. 4	Alt. 5	Alt.6
(1) Water, Effects on:						
(a) Salinity	No effect	No effect	No effect	No effect	No effect	No effect
(b) Water Chemistry	No effect	No effect	No effect	No effect	No effect	No effect
(c) Clarity	Likely improvement following construction (All Alternatives).					
(d) Color	No effect	No effect	No effect	No effect	No effect	No effect
(e) Odor	No effect	No effect	No effect	No effect	No effect	No effect
(f) Taste	No effect	No effect	No effect	No effect	No effect	No effect
(g) Dissolved Gas	No effect	No effect	No effect	No effect	No effect	No effect
(h) Nutrients	No effect	No effect	No effect	No effect	No effect	No effect
(2) Current Patterns and Circulation						
(a) Current Patterns and Flow	New and modified breakwaters and harbor channel dredging will change current patterns to an unknown degree.					
(b) Velocity	Current velocity will be changed somewhat to an unknown degree.					
(c) Stratification	No effect	No effect	No effect	No effect	No effect	No effect
(d) Hydrologic Regime	No effect	No effect	No effect	No effect	No effect	No effect
(3) Normal Water Level Fluctuations	No effect	No effect	No effect	No effect	No effect	No effect

	Alternatives					
	Proposed	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
(4) Salinity Gradients	No effect	No effect	No effect	No effect	No effect	No effect
(5) Actions That Will be Taken to Minimize Impacts	NA	NA	NA	NA	NA	NA
c. Suspended Particulate/Turbidity Determination						
(1) Expected Changes in Particulate and Turbidity Levels in Vicinity of Disposal Site	Increase during construction, likely decrease following construction for all alternatives					
(2) Effects(degree and duration) on Chemical and Physical Properties of the Water Column						
(a) Light Penetration	Decrease	Decrease	Decrease (During construction only)	Decrease (During construction only)	Decrease	Decrease
(b) Dissolved Oxygen	Decrease	Decrease	Decrease (During construction only)	Decrease (During construction only)	Decrease	Decrease
(c) Toxic Metals & Organics	No effect	No effect	No effect	No effect	No effect	No effect
(d) Pathogens	No effect	No effect	No effect	No effect	No effect	No effect
(e) Aesthetics	No effect	No effect	No effect	No effect	No effect	No effect

	Proposed	Alt. 2	Alternatives Alt. 3	Alt 4	Alt. 5	Alt. 6
(3) Effects on Biota						
(a) Primary Production, Photosynthesis	No effect	No effect	No effect	No effect	No effect	No effect
(b) Suspension/Filter Feeders	Suspension/filter feeders may be stressed in the immediate area of construction.					
(c) Sight Feeders	Sight feeders may avoid the immediate construction area.					
(4) Actions Taken to Minimize Turbidity	Silt containment devices will be deployed around construction area to minimize turbidity (All Alternatives).					

d. Contaminant Determination

The proposed discharge is free of contaminants

e. Aquatic Ecosystem and Organism Determination

The proposed discharge is free of contaminants, so that there will be no toxic effects on the ecosystem or individual organisms; however, the placement of the clean stone and fill material will have physical effects on the aquatic ecosystem as indicated below.

	Proposed	Alt. 2	Alt. 3	Alt 4	Alt. 5	Alt. 6
(1) Effects on Plankton	NA	NA	NA	NA	NA	NA
(2) Effects on Benthos	Benthic organisms will be buried by placement of the stone and coral material; however, the structures will provide hard substrate and vertical habitat for recolonization. The Proposed Action will have less effect than Alts. 3, 4, 5 & 6.					
(3) Effects on Nekton	No effect	No effect	No effect	No effectNo effect		No effect
(4) Effects on Aquatic Food Web	No effect	No effect	No effect	No effect	No effect	No effect

			Alternatives			
	Proposed	Alt. 2	Alt. 3	Alt 4	Alt. 5	Alt. 6
(5) Effect on Special Aquatic Sites						
(a) Sanctuaries and Refuges	NA	NA	NA	NA	NA	NA
(b) Wetlands	NA	NA	NA	NA	NA	NA
(c) Mud Flats	NA	NA	NA	NA	NA	NA
(d) Vegetated Shallows	NA	NA	NA	NA	NA	NA
(e) Coral Reefs	Less than one acre of reef flat (with about 10% coverage by mostly encrusting corals or small colonies) will be buried by the Proposed Action. Alts. 3, 4, 5 & 6 will cover a slightly larger area, but still less than one acre.					
(f) Riffle and Pool Complexes	NA	NA	NA	NA	NA	NA
(6) Endangered and Threatened Species	No effect	No effect	No effect	No effect	No effect	No effect
(7) Other Wildlife	NA	NA	NA	NA	NA	NA
(8) Actions to Minimize Impacts	Actions to minimize impacts of this project involve location, type of material, controlling the material after discharge, method of dispersion, and timing of actions. See EA text for details.					

	Proposed	Alt. 2	Alternatives Alt. 3	Alt 4	Alt. 5	Alt. 6
f. Proposed Disposal Site Determinations						
(1) Mixing Zone Determination	NA	NA	NA	NA	NA	NA
(2) Determination of Compliance with Applicable Water Standards	Project will be in compliance with State of Hawaii water quality standards for Class A waters. A Water Quality Certification under Section 401 of the Clean Water Act will be obtained from the State of Hawaii Department of Health.					
(3) Potential Effects on Human Use Characteristics						
(a) Municipal and Private Water Supply	NA	NA	NA	NA	NA	NA
(b) Recreational and Commercial Fisheries	Improvement to the harbor will enhance commercial and recreational fishing.					
(c) Water Related Recreation	Improvements will allow tour boats to use the harbor, providing various types of recreation in addition to fishing.					
(d) Aesthetics	None	None	None	None	None	None
(e) Parks, National and Historic Monuments, National Seashores, Research Sites, Wilderness Areas, and Similar Preserves	None	None	None	None	None	None

			Alternatives			
	Proposed	Alt. 2	Alt. 3	Alt 4	Alt. 5	Alt. 6
g .Determination of Cumulative Effects on the Aquatic Ecosystem						
	No effect	No effect	No effect	No effect	No effect	No effect
h. Determination of Secondary Effects on the Aquatic Ecosystem						
	No effect	No effect	No effect	No effect	No effect	No effect

FINDINGS OF COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE FOR THE KIKIAOLA HARBOR FOR LIGHT-DRAFT VESSELS

1. No significant adaptations of the guidelines were made relative to this evaluation.

2. The proposed plan and five alternative plans for modifications to the light-draft harbor at this site were evaluated. The environmental effects of all the alternatives would be generally the same as that of the proposed action.

3. The discharge of clean, naturally occurring basalt stone into the nearshore waters at Kikiaola would not degrade water quality or human use of the water. The stone fill material is not suspected of containing contaminants; is not expected to cause any prolonged turbidity problems; and is not expected to degrade the aquatic environment.

4. The Proposed Action will not harm any candidate, proposed or listed endangered or threatened species or their critical habitat.

5. The Proposed Action will modify an existing small boat harbor which was originally constructed by the State of Hawaii in 1959. The project is water dependent and therefore no practicable alternative analysis is required; however, the EA discusses alternatives including a "no discharge" (no action) alternative. The harbor berthing area has been reduced from a 130-boat harbor to a 45-boat harbor, resulting in a reduction in the area of impact. The discharge has been reduced to the absolute minimum that will meet the project objectives.

6. Additional appropriate steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem include locating the project in an area previously disturbed by the existing harbor; using clean stone fill material and fitting the armor stone to reduce the size of the structures.

7. On the basis of this evaluation and the information contained in the Environmental Assessment, the proposed discharge sites are specified as complying with the requirements of the 404(b)(1) guidelines, with the inclusion of appropriate and practicable actions to minimize pollution or adverse effects to the aquatic ecosystem.

Ralph H. Graves
Lieutenant Colonel, Corps of Engineers
District Engineer

STATEMENT OF FINDINGS AND PUBLIC EXPLANATION
IN COMPLIANCE WITH E.O. 11988, FLOOD PLAIN MANAGEMENT
FOR LOCATING THE
KIKIAOLA HARBOR MODIFICATION PROJECT FOR LIGHT-DRAFT VESSELS
AT KEKAHA, ISLAND OF KAUAI, HAWAII, IN THE 100-YEAR FLOOD PLAIN
(1 June 1998)

1. The Kikiaola Harbor for Light-draft Vessels is located between the towns of Kekaha and Waimea, Kauai (Figure 1). According to the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map, Community-Panel Number 150002 0156 D dated September 30, 1995, the proposed project site lies in Zone VE, defined as an area that is inundated by the 100-year coastal flood having a base elevation of 11.0 feet above mean sea level datum, with associated velocity hazards due to wave action.

2. The harbor is considered to be functionally dependent at its location within the 100-year floodplain and cannot perform its intended purpose otherwise.

3. The following facts were considered in evaluating this action.

a. The size of the facility is the minimum that will meet the needs of the community.

b. The coasts of the island of Kauai and other islands in the Hawaiian archipelago are generally all subject to flooding from wave action during large storms, so that it is generally not possible to build or modify a harbor that will not be within a flood zone.

c. The harbor was originally constructed by the State of Hawaii in 1959, and was modified by the State in 1964. The proposed project, originally authorized by the U. S. Congress in 1968 to correct deficiencies and improve the harbor, will be cost shared between the Federal government and the State of Hawaii,.

d. Six alternatives to the proposed action were evaluated, including "No Action", and are briefly discussed below. None of these alternatives involved a different location, outside the floodplain.

(1) The Proposed Plan (Alternative 1) would accommodate 45 boats and consists of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; and removing and reconstructing an inner east stub breakwater 85 feet long.

(2) Alternative Plan 2 would accommodate 45 boats and would consist of dredging an entrance channel 835 feet long; an access channel 115 feet long; a turning basin 115 feet long and 115 feet wide; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; removing and reconstructing an inner east stub breakwater 85 feet long; and removing 40 feet of the inner stub breakwater.

(3) Alternative Plan 3 would accommodate 45 boats and would consist of dredging an entrance channel 820 feet long; an access channel 310 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; and removing 130 feet

from the inner stub breakwater; and constructing a new inner east stub breakwater195 feet long.

(4) Alternative Plan 4 would accommodate 45 boats and would consist of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing west breakwater; removing and reconstructing an inner east stub breakwater 85 feet long; and constructing an outer east stub breakwater 140 feet long.

(5) Alternative Plan 5 would accommodate 45 boats and would consist of dredging a 1,050-foot long entrance channel, removing 150 feet from the existing outer east stub breakwater; raising the east breakwater's crest elevation and flattening the seaward slope; removing and reconstructing an 85-foot long inner east stub breakwater; and constructing a 600-foot long extension to the existing west breakwater.

(6) Alternative Plan 6 is very similar to Plan 1 in its overall layout and would accommodate 45 boats. It was developed in response to public input during an information meeting held with users. Plan 6 consists of dredging a 1050-foot long entrance channel and a 620 foot long access channel; removing 150 feet from the existing outer east stub breakwater; extending the east breakwater by 325 feet and raising the elevation to 11 feet and flattening the seaward slope; removing the 85-foot long inner east stub breakwater; removing 285 feet of the existing west breakwater and modifying approximately 85 feet of the remaining breakwater.

(7) The "No Action" alternative is a nonstructural alternative requiring no modification to the existing Kikiaola Harbor. This action was not considered to be an acceptable or viable solution in mitigating the existing navigational problems and did not meet the community needs and desires.

e. The predicted flood elevation at the selected site is approximately 11.0 feet above mean sea level datum.

f. The harbor protective structures are designed to protect the harbor from waves up to 12 feet high.

4. The design of the facility, as stated in project documents,complies with the general substantive requirements of the National Flood Insurance Program, 44 CFR Section 60.3.

5. The National Flood Insurance Program does not identify for harbor protective structures specific substantive design criteria.

In accordance with Step 5A of the Floodplain Management Guidelines for Implementing E.O. 11988, dated February 10, 1978, the Corps has avoided to the extent practicable direct or indirect development of the floodplain; reduced the risk of flood loss by the design of the facility; minimized the impact of floods on human safety, health and welfare, and has had no significant impact on beneficial floodplain values.

6. A notice of this finding will be published in the State of Hawaii Office of Environmental Quality Control Bulletin.

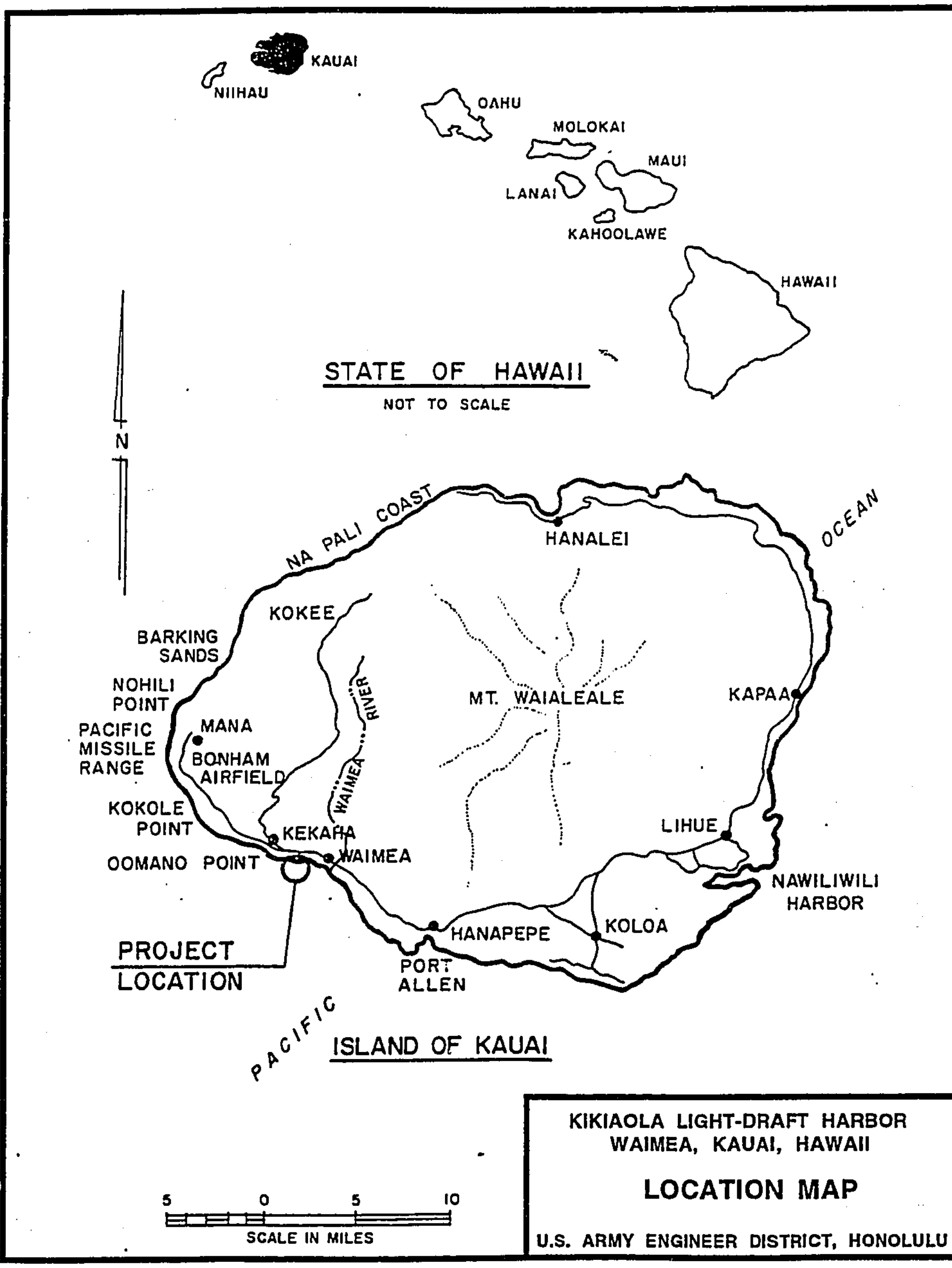
During the evaluation process for this action within a flood hazard zone, a public meeting was held 6 May, 1996, requesting public comment on the proposed action. Few comments were received. There were no comments relating to the construction of the proposed project within the designated 100-year floodplain. In addition a draft Environmental Assessment was circulated to the public and interested governmental agencies, and responses to the comments received are contained in the final Environmental Assessment, Appendix II.

7. The flood hazard zone where the harbor is to be built is identified as areas subject to coastal flooding by wave action. The natural and beneficial values of the project site include the marine resources of the area. The proposed harbor structures are not likely to have a substantial impact on such resources, but there will be some impacts during construction as indicated in the main environmental assessment.

8. The U.S. Army Engineer District, Honolulu staff members Lincoln Gayagas, Timothy Young and William Lennan evaluated this project for compliance with E.O. 11988.

RALPH H. GRAVES
Lieutenant Colonel, USA
District Engineer

Enclosures

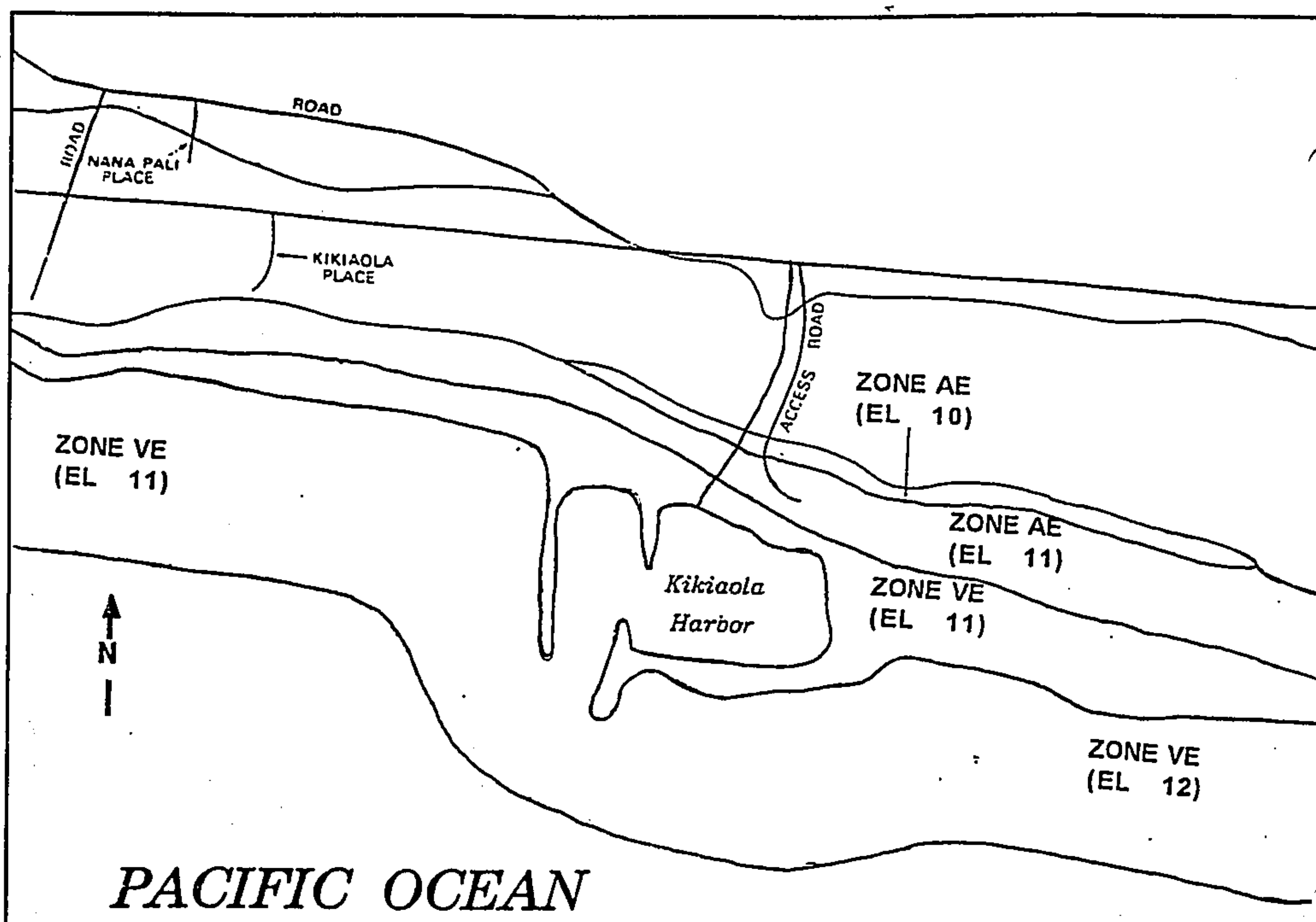


KIKIAOLA LIGHT-DRAFT HARBOR
WAIMEA, KAUAI, HAWAII

LOCATION MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1



ZONE AE Base flood elevations determined.

Zone VE Coastal flood with velocity hazard (wave action); Base flood elevations determined.

From Federal Emergency Management Agency Flood Insurance Rate Map Community-Panel Number 150002 0156D, revised September 30, 1995

KIKIAOLA HARBOR	KEKAHA, KAUAI
FLOODPLAIN	
US ARMY ENGINEER DISTRICT	HONOLULU

FIGURE 2

Public Notice

Public Notice No. CW96-0002 Date: 20 August,1996

Reply to: District Engineer (CEPOD-ET-PP) Respond by: 20 September 1996
U.S. Army Corps of Engineers
Building 230
Ft. Shafter, HI 96858-5440

NOTICE OF U.S. ARMY CORPS OF ENGINEERS COMPLIANCE WITH SECTION 404, CLEAN WATER ACT, SECTION 10 RIVER AND HARBORS ACT OF 1899 AND EXECUTIVE ORDER 11988 AND OUR INTENT TO PERFORM WORK IN THE WATERS IN AND AROUND KIKIAOLA HARBOR FOR LIGHT-DRAFT VESSELS, WAIMEA, KAUAI, HAWAII
CIVIL WORKS AUTHORIZATION NO. CW96-0002

1. APPLICABLE STATUTORY AUTHORITIES: Section 404 of the Clean Water Act (33 U.S.C. 1344); Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 407); .Executive Order 11988; U.S. Water Resources Council Floodplain Management Guidelines for Implementing E.O. 11988; and the Flood Insurance Rate Map for Hawaii County, Kauai, Panel 150002 0156 D, September 30, 1995

2. PROPONENT: U.S. Army Corps of Engineers, Honolulu Engineer District, Building 230, Fort Shafter, Hawaii 96858-5440 and the State of Hawaii Department of Land and Natural Resources, Division of Boating and Ocean Recreation, 333 Queen Street, Room 300, Honolulu, Hawaii 96813

3. PERSON TO CONTACT. Additional information may be obtained from Mr. William B. Lennan, Ecologist, U.S. Army Engineer District, Honolulu Building 230 Fort Shafter, Hawaii 96858-5440 Telephone (808)438-2264

4. LOCATION OF PROPOSED ACTIVITY: Kikiaola Harbor for Light-draft Vessels, Waimea, Kauai, Hawaii.

5. DESCRIPTION OF PROPOSED ACTIVITY: The U. S. Army Corps of Engineers, Honolulu Engineer District, and the State of Hawaii Department of Land and Natural Resources, Division of Boating and Ocean Recreation are proposing to construct improvements to the Kikiaola Harbor for Light-draft Vessels at Waimea, Hawaii (Figure 1). Kikiaola Harbor was origianlly developed by the State of Hawaii in 1959. In 1961 the State constructed the launch ramp, and in 1964 the two stub breakwaters and a short inner breakwater were constructed to reduce surge within the harbor basin. Congress authorized a federal project to modify the State harbor in 1968, and post-authorization studies were initiated in 1978, including an evaluation of environmental impacts required by various laws and regulations enacted since the project was initially authorized. The present proposed plan of improvement is the same as that documented in the General Design Memorandum and Final Environmental Impact Statement (DPR/EIS) in September 1980. The proposed Federal improvements abut a special flood hazard area inundated by the 100-year flood with flood elevations of eleven feet.

The purpose of the harbor improvements is to eliminate the shallow depths in the entrance channel which pose a hazard to vessels using the harbor, particularly during south swell conditions. When the south swell is running, usually during the summer, surf up to 15 feet breaks approximately 1,000 yards off the harbor entrance where the bottom rises in depth from 70-80 feet to about 15 feet. The swell then reforms and breaks again at the channel entrance. Boats attempting to leave the harbor under these conditions must make a "running start." If timing is not right and the outer break begins breaking, boats are forced to turn around and return to the protection of the harbor. Only faster boats with speeds greater than 18-20 knots can attempt exiting the harbor when the south swell is up. For larger, slower boats the harbor is inaccessible during periods of moderate to high south swell which occur with greatest frequency from approximately June to August. This situation is aggravated by the summer Yellow Fin Tuna (*Ahi*) run which usually occurs during this period. Fishing boat owners, who are the principal users, do not want to risk being inadvertently harbor bound due to surf any time during the *Ahi* run.

The proposed design for the Federal portion of the project is for a 105 boat harbor, utilizing the existing general harbor footprint (Figure 2). The Proposed Plan would consist of dredging an entrance channel 725 feet long, 12 feet deep, and 105-205 feet wide; an access channel 320 feet long, 8 feet deep and 105 feet wide; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater by raising the crest and flatening the slope; modifying 220 feet of the existng west breakwater in a similar manner; and removing and reconstructing an inner east stub breakwater 85 feet long.

Primary construction materials would consist of clean basalt stone. The stone material will be obtained from commercial quarries on the island of Kauai.

The State will provide the berthing facilities, wastewater treatment and other shoreside ancillary facilities necessary to support the 105-boat harbor Because detailed plans have not yet been developed, additional environmental documentation may be required for the State of Hawaii portion of the improvements when they have been funded and designed.

The work staging and storage area would be located on State owned land adjacent to the harbor.

The attached figures show the proposed harbor features.

6. OTHER GOVERNMENT AUTHORIZATIONS: The authorization to dredge navigable waters and discharge fill does not obviate the need for the Government and local sponsor, respectively, to obtain other federal, state or local authorizations required by federal, state or local laws. In addition to local building permits, the Corps will submit:

a. A specific request for concurrence with our Coastal Zone Management Program Consistency Determination in the letter of transmittal for the FONSI and EA.

b. An application for Water Quality Certification will be submitted to the State of Hawaii Department of Health concurrent with the request for review of the FONSI and EA.

This action has ben analyzed for compliance with Executive Order 11988. It has been determined that there is no practical alternative to construction of this project in the floodplain. using the guidelines established by the U.S. Water Resources Council. A Statement of Findings and Public Explanation will be included as an appendix to the EA.

7. ENVIRONMENTAL DOCUMENTATION: An Environmental Assessment is being prepared for this action.

8. IMPACTS ON CULTURAL RESOURCES: The proposed project will have no adverse effect on any historic properties or other cultural resources. Coordination with the State of Hawaii Historic Sites office indicates there are no cultural resources in the project area.

9. IMPACTS ON ENDANGERED SPECIES: There are no Federally listed endangered, threatened, candidate or proposed species of terrestrial plants or animals or their critical habitat within the study area. The endangered Hawaiian Bat may occasionally transit or forage in the general harbor area, and the Hawaiian Owl, listed on the State of Hawaii Endangered Species List may also occasionally transit or forage in the area. Neither of these rare terrestrial species nest, breed or roost in the area. By letter dated 13 February, 1996 the U.S. Fish and Wildlife Service concurred in our opinion that the project would not affect listed species under their jurisdiction. In contrast, two rare marine species are common in the area. The federally listed endangered humpback whale is often seen in the area during the "whale season" (December-May annually). Threatened green sea turtles are also likely to be in the area, but the water is very turbid, and algae growth is not lush, so that the area is not a good foraging area.

No blasting is anticipated for the proposed project, therefore no construction related effects are expected to impact threatened or endangered species. The small size of the harbor and the fact that most of the boats are already in the area, makes it unlikely that boat traffic in the area will increase enough to impact either the endangered humpback whale or the threatened green sea turtle. The National Marine Fisheries Service concurred in this opinion by letter dated 1 March 1996. To mitigate possible construction effects on the green turtle, periodic turtle surveys will be conducted in the construction area.

10. EVALUATION FACTORS: The decision whether or not to dredge navigable waters and discharge fill will be based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefit which reasonably may be expected to accrue from the

proposal must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered, including the cumulative effects thereof: among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, flood plain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people. The evaluation will apply the guidelines promulgated by the Administrator, U.S. Environmental Protection Agency, under authority of Section 404 (b)(1) of the Clean Water Act. (40 CFR Part 230)

11. ADDITIONAL INFORMATION TO ASSIST IN EVALUATION: Construction activities will temporarily increase dust and vehicle exhaust emissions in the project area; however, these effects will be temporary and only affect the near vicinity of the project. The Federal portion of the project involves dredging and placing of rocks for the modifications to the protective structures. The State portion of the project will require earth moving and grading for construction of the infrastructure improviments The contractors for both the Federal portion and the State of Hawaii portion of the project will be required to conform with State air, noise and water quality standards. When construction is complete there will be an increase in exhaust emissions from vehicles and boats, but it is expected to be insignificant because of the small number of vehicles and boats involved, and the rapid dispersal caused by the trade winds.

Noise levels will be increased during construction of both the Federal and State portions of the project by the operation of heavy construction equipment. There may be a slight increase in noise after project completion, due to the increased number of boats which will use the harbor. The increase is expected to be very slight because of the small number of boats involved. Noise levels would be compatible with surrounding land uses.

There will be an increase in turbidity during construction; however, it can be controlled by the use of silt containment devices. The placement of rocks for the protective structures will generate only a small temporary increase in the level of turbidity within the harbor, and an insignificant change outside the harbor. Dredging the entrance channel and access channel will generate much more sediment, but it will be controlled by the use of silt containment devices. Upon completion of the State of Hawaii portion of the project, there should be somewhat less turbidity since much of the shoreside area will be landscaped and/or paved, so there will be less sediment in runoff and less dust blowing into the harbor basin.

There will be a loss of about 7 acres of marine habitat from construction of the protective structures and dredging of the entrance and access channels. Most of this area is a sand/silty substrate. A total of about 47,000 cubic yards of material will be dredged and disposed in an upland site, not yet identified. The ungrouted armor stone of the protective structures will provide firm substrate for the more sediment tolerant encrusting corals and those that form small colonies, and it will also provide habitat for reef fish and invertebrates, although the community composition may be different from the present soft bottom community composition. Areas of sand/silt will be recolonized with similar communities after dredging, so that there will actually be very little total habitat lost. Many of the boats expected to be berthed in the harbor are now trailered and use the existing launch ramp. Many of these boats are presently using the local fishery resource, and it is believed that there will be very little change in the level of use of that resource.

Social well-being would be enhanced because of the safer berthing and navigation conditions resulting from harbor improvements.

The unavoidable impacts identified above can be mitigated as follows:

During construction of both the Federal and State of Hawaii portions of the project the construction contractor will be required to adhere to applicable Federal, State of Hawaii and Kauai County air quality and noise regulations. This is a standard requirement in all Corps and State of Hawaii construction contract specifications. For the Federal portion of the project, the contractor will be required to develop an environmental protection plan, which will detail the site and equipment specific measures to be used, based on the construction methods to be used, to comply with the regulations. This requirement for an environmental protection plan is standard in Corps construction contracts. The plan must be approved by the Corps Contracting Officer who is responsible to assure that the contractor's operations do not violate applicable federal, state or local standards.

Turbidity caused by construction of the harbor improvements will be minimized to the maximum extent practicable with existing known methods to control turbidity such as silt curtains, and the Corps will also monitor water quality during construction, and post construction to assure water quality criteria are met.

Construction of the new portions of the breakwaters and revetted moles will provide additional mitigation for the reef flat habitat destroyed, by providing increased vertical habitat.

Fills will be protected from erosion with armor stone as soon after completion as practicable.

Breakwaters and revetments will be constructed of large boulders to dissipate wave energy and resist erosion.

All construction-related materials will be placed or stored in ways to avoid or minimize disturbance to the marine environment.

All construction-related materials will be free of pollutants.

A contingency plan for containing and controlling accidental spills of petroleum products at the construction site will be developed.

The contractor's Environmental Protection Plan, required by the specifications for the construction contract, will include details of how marine resources will be protected from secondary effects of construction. The following items will be included among others in the Environmental Protection Plan:

Lumber or other construction materials treated with creosote or other preservatives substances will not be permitted to contact the water until after at least one week of drying.

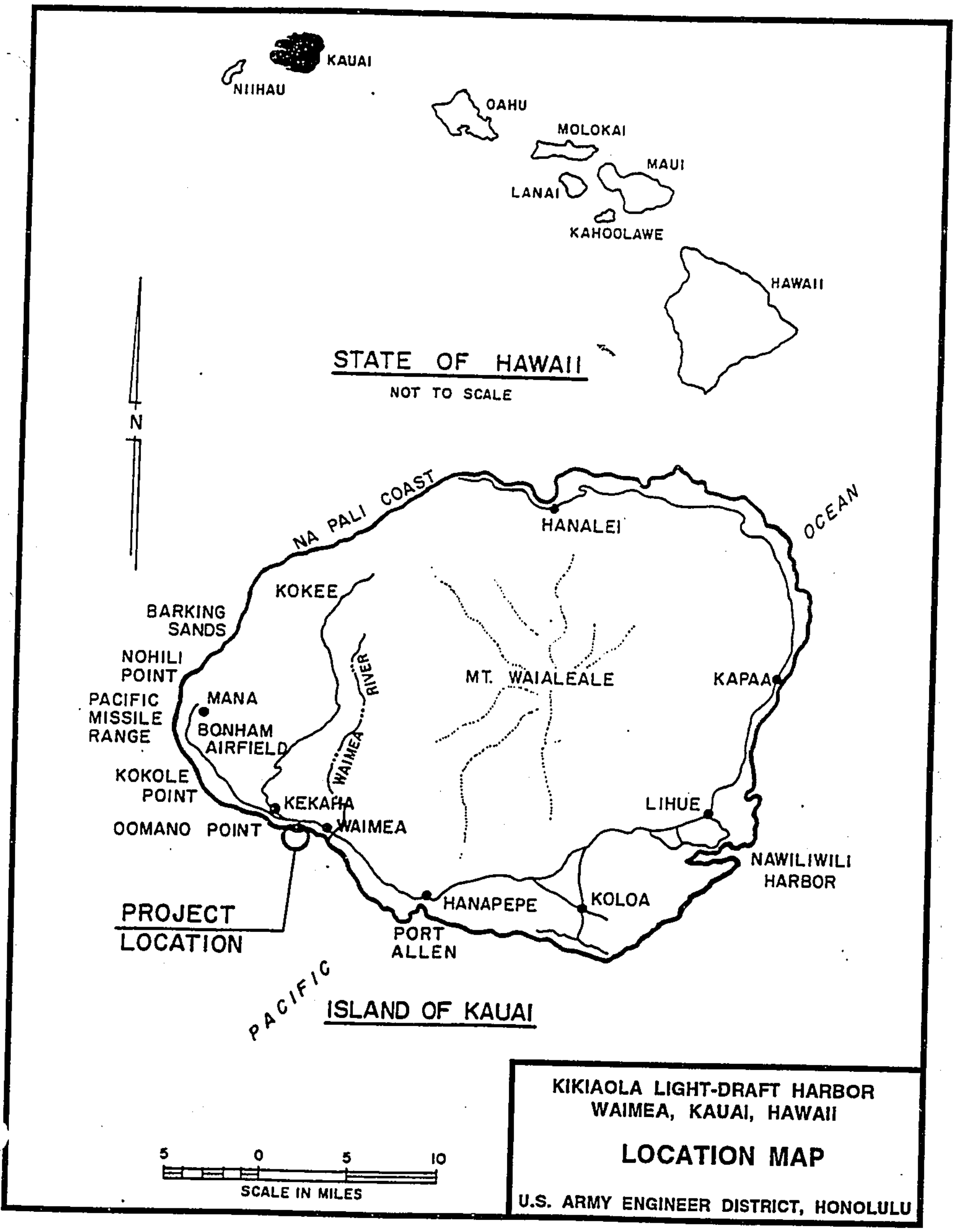
Construction materials, petroleum products, human wastes, debris and landscaping substances (herbicides, fertilizers, pesticides) will not be permitted to fall, flow or leach into the ocean or the drainage ditches which enter the harbor.

12. COMMENTS AND INQUIRIES: The Corps of Engineers is soliciting comments from the public; Federal, State, and local agencies and officials; and other interested parties to consider and evaluate the impacts of the proposed activity on water quality and the public

interest. The Corps will consider comments received to determine whether to discharge, or to modify or condition the discharge for the proposed project. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects and the other public interest factors listed above. Comments are used to determine the need for a public hearing and to determine the overall public interest in the proposed activity and the impacts on water quality. Interested parties may submit in writing any comments that they may have on the proposed activity. Comments should be submitted to the Honolulu District no later than 30 days from the date of this notice. Written comments should be mailed to the address indicated in the letterhead and should make reference to Public Notice No. CW-0002.

13. REQUEST FOR PUBLIC HEARING: Within 30 days from the date of this notice, any person may request, in writing, that the U.S. Army Corps of Engineers, Honolulu District hold a public hearing to consider the effect of the discharge on water quality, the floodplain or other factor of public interest. Requests for public hearings shall state clearly and concisely, the reasons and rationale for such requests.

Attachment
Figures (2 sheets)

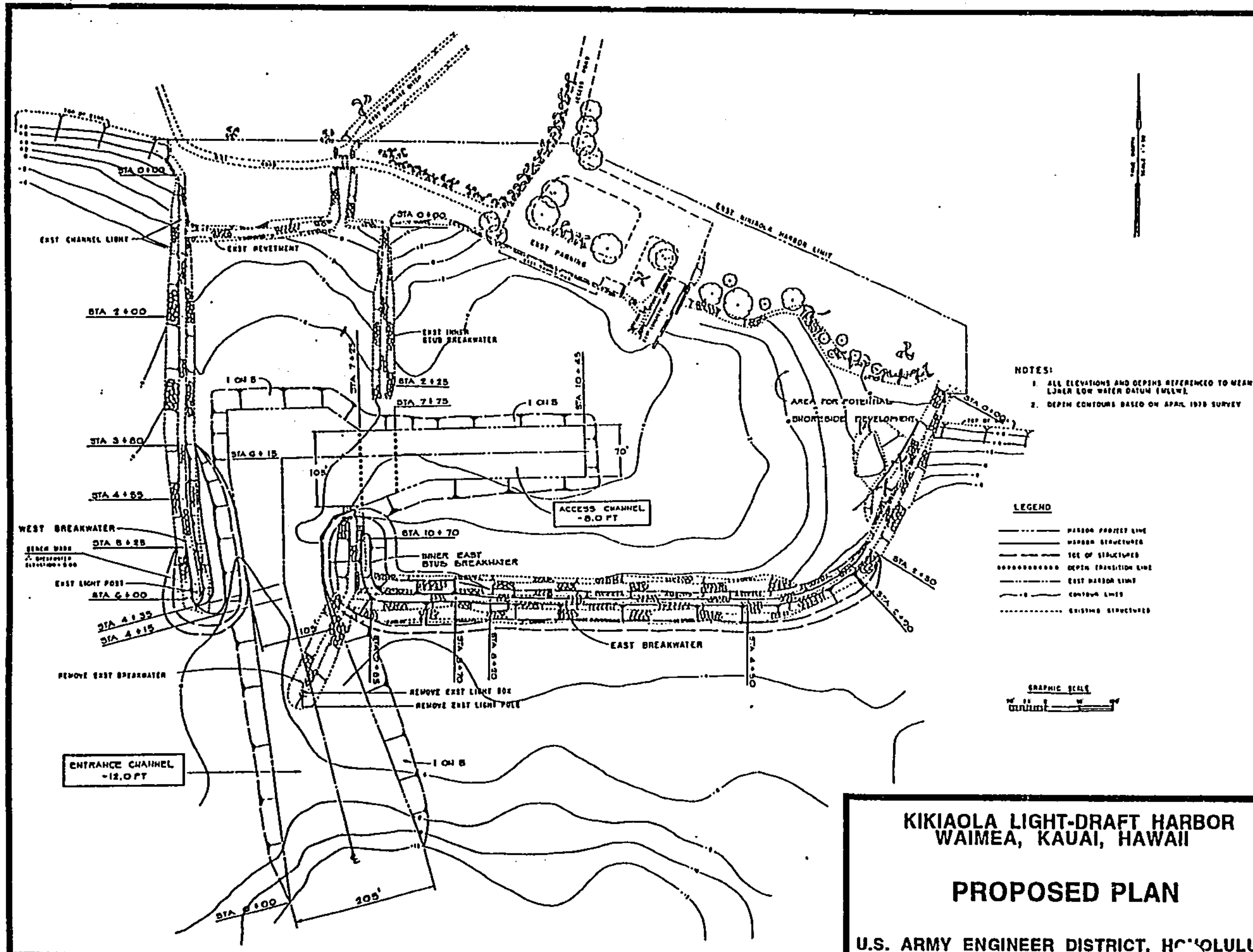


KIKIAOLA LIGHT-DRAFT HARBOR
WAIMEA, KAUAI, HAWAII

LOCATION MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1



KIKIAOLA LIGHT-DRAFT HARBOR
WAIMEA, KAUAI, HAWAII

PROPOSED PLAN

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 2

FINDING OF NO SIGNIFICANT IMPACT
(1 June 1998)

1. **NAME OF PROJECT**: Kikiaola Light-Draft Harbor, Kekaha, Island of Kauai, Hawaii.

2. **PROPONENT ORGANIZATION**: U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

3. **ENVIRONMENTAL ASSESSMENT**: The General Reevaluation Report and Environmental Assessment for the Navigation Improvements, Kikiaola Light-Draft Harbor, dated June 1998 is incorporated by reference.

4. **DESCRIPTION OF PROJECT**: The proposed plan (Alternative 1) would accommodate 45 boats and consists of dredging an entrance channel 700 feet long; an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater, modifying 220 feet of the existing west breakwater, and removing and reconstructing an inner east stub breakwater 85 feet long.

5. **ANTICIPATED ENVIRONMENTAL EFFECTS**:

a. Short-Term Impacts During Construction:

(1) Environmental effects during construction will be negligible. The Corps of Engineers contract specifications will contain environmental protection provisions to avoid, or reduce to insignificance, impacts relating to construction equipment, noise, dust, odor and air emissions, surface and ground water quality pollution, turbidity caused by dredging and construction of breakwater structures, construction danger to nearby personnel and other adverse impacts. No blasting will be required during construction of this project.

b. Long Term Impacts After Construction:

(1) Loss of marine life during dredging and construction of breakwater structures will be mitigated by long term recruitment of organisms to the new structures. In addition, the mitigation measures recommended in the attached Environmental Assessment, Paragraphs 5.6 through 5.8 are hereby adopted and shall be implemented. There will be no effect on threatened or endangered species or cultural resources.

(2) The existing littoral drift cycle at the project site will continue resulting in continued sediment transport of material within and adjacent to the Kikiaola Harbor. As a mitigative measure a sand bypass program will be implemented that minimizes future maintenance dredging but more importantly addresses the existing shoreline erosion problem being encountered along the western shoreline. Sand bypassing will be accomplished mechanically by removing material along the eastern shoreline (Accreted Shoreline) and placing it along the western shoreline (Eroded Shoreline) by dump truck and loader. It is estimated that approximately 16,000 cubic yards of material will be moved every 4.5 years.

(3) The construction of navigation improvements at the existing Kikiaola Harbor may result in a significant impact on localized catch rates of deepwater bottomfish. However, impacts on pelagic and other species are expected to be minimal. In response to the potential impact of overfishing of bottomfish species, the State of Hawaii has developed and is presently in the final stages of establishing a bottomfish management plan. This plan is expected to be implemented well before any changes in vessel activity can be achieved after navigation improvements have been completed at Kikiaola Harbor.

(4) The dredging of the harbor channels and berthing area will impact a small area of the existing reef. With the new entrance channel being dredged to a depth of 11 feet and the existing coral limestone strata at an approximate uniform depth of 11 feet based on past boring log information, we do not anticipate any substantial removal of coral limestone. In addition, the Fish and Wildlife Coordination Act Report dated February 15, 1995 states that the marine environment in and around the harbor is highly degraded by siltation apparently caused by the existing agricultural ditch which empties into the harbor. This condition has remained unchanged over the years and has not been conducive to the propagation and sustained growth of live coral.

(5) The marine environment in and around the harbor will continue to remain highly degraded due to siltation from the existing agricultural ditch. However, due to existing and future land use changes in the Kekaha area during the next few years, sediment load discharge into the harbor is expected to be reduced. During the preparation of plans and specifications, various long-term alternatives such as the implementation of a siltation basin will be investigated.

6. **CONCLUSION**: The Environmental Assessment concluded that the proposed action does not constitute a major federal action having significant effect on the quality of the human environment. Therefore, it is determined that a Federal Environmental Impact Statement is not required.

Ralph H. Graves

RALPH H. GRAVES
Lieutenant Colonel, U.S. Army
District Engineer

Date: 3 June 1998

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services - Pacific Islands Ecoregion
300 Ala Moana Blvd., Room 3108
P.O. Box 50088
Honolulu, Hawaii 96850
Phone: (808) 541-3441
FAX: (808) 541-3470

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Lincoln
Bill -

In Reply Refer To: EAS

NOV 27 1995

Ray H. Jyo
Director of Engineering and Technical Services
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

On October 17, 1995, the U.S. Fish and Wildlife Service (Service) received your October 10, 1995, letter and accompanying information needed to evaluate the presence of federally endangered, threatened, proposed, and candidate species that may be present within the vicinity of your proposed modifications to Kikiaola Light-Draft Harbor, at Waimea, Kauai, Hawaii.

According to the information we have received, the modification will consist of dredging an entrance channel 725 feet long and an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing east breakwater; modifying 220 feet of the existing east breakwater; and removing and reconstructing a section of the inner east stub breakwater 85 feet long.

Our records indicate that the federally endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) may occur within the vicinity of the project area (this record was filed in 1990, and therefore, not known or available for the 1980 report you refer to in your letter). Enclosed is a report on the Hawaiian hoary bat by James Fullard. Because of the possibility of Hawaiian hoary bats occurring within the project area, the Service recommends that an assessment of the project's possible impacts on these bats be conducted. The Service also recommends that the National Marine Fisheries Service be contacted for potential impacts to sea turtles under their jurisdiction.

We appreciate your concern for endangered species. If you have any questions, please contact our Branch Chief for Interagency Cooperation, Ms. Margo Stahl, or Fish and Wildlife Biologist Elizabeth Sharpe at 808/541-3441 (Fax: 808/541-3470).

Sincerely,
for Margo Stahl
Brooks Harper
Field Supervisor
Ecological Services

Enclosure
cc: NMFS/ Gene Nitta

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS ECOREGION
300 ALA MOANA BOULEVARD, ROOM 3108
BOX 50088
HONOLULU, HAWAII 96850
PHONE: (808) 541-3441 FAX: (808) 541-3470

FEB 13 1996

In Reply Refer to: CS

Ray H. Jyo
Director of Engineering and Technical Services
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

The U.S. Fish and Wildlife Service (Service) received two letters from your office, dated December 20, 1995, regarding the Kikiaola Boat Harbor improvement project, near Waimea, Kauai, Hawaii. The project will consist of dredging an entrance channel 725 feet long and an access channel 320 feet long; removing 150 feet of the existing outer east stub breakwater; modifying 735 feet of the existing west breakwater; modifying 220 feet of the existing east breakwater; and removing and reconstructing an 85 foot section of the inner east stub breakwater. The Service prepared a Fish and Wildlife Coordination Act report for this project, which was included in the final Environmental Impact Statement (EIS), issued in 1980.

Fish and Wildlife Coordination Act Report

One of your December 20th letters requested Service concurrence with your belief that the marine environment in the area of Kikiaola Harbor has not changed significantly since 1980, and that an updated Fish and Wildlife Coordination Act (FWCA) report is, therefore, not necessary. Based on a December 5, 1995, site visit by Service biologists, we concur that our 1980 FWCA report does not need to be updated. The marine habitat around the harbor is highly degraded by siltation, apparently caused by an agricultural drainage ditch flowing into the harbor. The proposed harbor project may improve water circulation and flushing at the site. We do, however, recommend that steps to protect green and hawksbill sea turtles and monk seals be taken during construction. These steps should be coordinated between the Corps and the National Marine Fisheries Service. The Service also requests that the Corps require measures to minimize turbidity caused by harbor dredging and construction.

The Service is also concerned that even if water circulation within the harbor is improved, the drainage ditch flowing into the harbor will continue to degrade the marine environment, including sensitive coral reef habitats outside the project area. Continued high rates of siltation will also require more frequent harbor dredging. Therefore, the Service recommends that the U.S. Army Corps of Engineers (Corps) consider long-term methods of reducing the sediment load discharged into the harbor.

Section 7 Issues

The second Corps letter of December 20th requested Service concurrence with the Corps' determination that a formal section 7 consultation is not necessary because the project will not adversely affect endangered or threatened species protected under the U.S. Endangered Species Act (Act). The particular species at issue is the Hawaiian hoary bat (*Lasiurus cinereus semotus*), as discussed in a Service letter to your office, dated November 27, 1995.

The Service concurs that the project, as described in the 1980 EIS, is not likely to adversely affect listed species. Based on our site visit, we have determined that bat roosting habitat and food resources will not be affected by project construction. Therefore, we believe that requirements of section 7 of the Act have been satisfied. Obligations under section 7 of the Act must be reconsidered if (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered, (2) this action is subsequently modified in a manner not previously considered, or (3) a new species is listed or a critical habitat determined that may be affected by the identified action.

We appreciate the opportunity to comment. If you have any questions, please contact Chris Swenson at (808) 541-3441.

Sincerely,

Brooks Harper

Brooks Harper
Field Supervisor
Ecological Services

cc: Gene Nitta, NMFS

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY
GILBERT COLOMA-AGARAN

AQUACULTURE DEVELOPMENT PROGRAM
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HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

November 2, 1995

LOG NO: 15769
DOC NO: 9510SC38

Mr. Ray H. Jyo, P.E., Director
Engineering and Technical Services
Pacific Ocean Division, Corps of Engineers
Department of the Army
Fort Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

SUBJECT: National Historic Preservation Act, Section 106 Compliance - Proposed Maintenance Dredging of Kikiaola Small Boat Harbor, Kikiaola, Waimea District, Kaua'i TMK: 1-2-6:17

Thank you for the opportunity to comment on the proposed maintenance dredging of submerged sections of Kikiaola Small Boat Harbor. Our review is based on historic reports, maps, and aerial photographs maintained at the State Historic Preservation Division; no field inspection was made of the subject parcel.

We have no record of historic sites on this parcel. It seems highly unlikely that significant historic sites are still present in the submerged portions of the harbor, particularly in view of the fact that previous dredging occurred in 1980. Therefore, we believe that the proposed undertaking will have "no effect" on significant historic sites.

Should you have any questions, please feel free to call Sara Collins at 587-0013.

Aloha,

DON HIBBARD, Administrator, and
Deputy State Historic Preservation Officer

SC:amk

2 Director 6

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1. ~~A~~ CEPOD-ET-PP-Action

Original passed to Regulatory

Farley
Bill

EA-I-34

Please contact Mr. Eugene Nitta at 808/973-2987 if you have any questions concerning this consultation.

Sincerely,

Hilda Diaz-Soltero
Regional Director

cc: F/SWO33 - Nitta
F/SWO32 - Naughton
FWS - Stahl

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

FEB 16 1996 F/SWO33:ETN

Ray H. Jyo, P.E.
Director of Engineering
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, HI 96858-5440

Dear Mr. Jyo:

Thank you for your letter regarding the proposed modification to the small boat harbor Kikiaola, Kauai, Hawaii. Endangered humpback whales (Megaptera novaeangliae) may be found offshore of the project site during the winter season and threatened green turtles (Chelonia mydas) appear to be resident in nearshore waters throughout the south coast of Kauai, but none have been observed within the existing small boat harbor. Critical habitat has not been designated or proposed for any listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) in or near the project area. Based on available information I concur with your finding that modifications proposed for the small boat harbor at Kikiaola, Kauai are not likely to adversely affect those species listed above. However, in order to insure that humpback whales or green turtles are not adversely affected by construction activities the following conservation recommendations are provided.

1. One or two surveys immediately prior to the start of construction to confirm the findings of earlier surveys by the U.S. Fish and Wildlife Service and the Corps of Engineers should be conducted. Additional surveys for sea turtles during and post-construction should also be conducted as part of an overall project monitoring plan.

2. To the extent possible, construction activities should be concentrated during the period June through November, to reduce any possible effects from noise or turbidity on humpback whales.

This concludes the informal section 7 consultation process for this proposed project. Consultation must be reinitiated if new information becomes available revealing effects of the project on listed species that were not previously considered, the project is subsequently modified in manner that causes an effect to listed species that was not considered, or if a new species or critical habitat is designated that may be affected by the project.

Rec'd 2/24/97

BENJAMIN J. CAYETANO
GOVERNOR
SEIJI F. NAYA
DIRECTOR
RICK EGGED
DIRECTOR, OFFICE OF PLANNING

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

OFFICE OF PLANNING

235 South Beretania Street, 6th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804

Telephone: (808) 587-2846
Fax: (808) 587-2824

Ref. No. P-6508

February 13, 1997

Mr. Ray H. Jyo, P.E.
Director of Engineering
Department of the Army
Pacific Ocean Division
Corps of Engineers
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency for Kikiaola Light-Draft Harbor Navigation Improvements, Waimea, Kauai

The proposal to construct improvements to the Kikiaola Light-Draft Harbor was previously issued CZM consistency concurrence on February 26, 1981. In response to a follow-up conversation between Mr. Bill Lennan of your planning staff and John Nakagawa of our CZM Program on February 12, 1997, we have determined that the original CZM consistency concurrence is still valid. This determination is based on the understanding that no significant changes to the environmental conditions at the site have occurred and that the scope of the project remains unchanged, as confirmed by Mr. Lennan on February 12, 1997. If any changes are made to the project proposal or if environmental changes are observed, these should be reported to the Office of Planning for CZM review and approval.

CZM consistency concurrence is not an endorsement of the project nor does it convey approval with any other regulations administered by any State or County agency. Thank you for your cooperation in complying with Hawaii's CZM Program. If you have any questions, please call John Nakagawa of our CZM Program at 587-2878.

Sincerely,

RE

Rick Egged
Director
Office of Planning

cc: U.S. Army Corps of Engineers, Operations Branch
U.S. National Marine Fisheries Service, Pacific Area Office
U.S. Fish and Wildlife Service, Pacific Islands Ecoregion
Department of Health, Clean Water Branch
Department of Land & Natural Resources,
Planning & Technical Services Branch
Division of Boating and Ocean Recreation
Department of Transportation, Harbors
Planning Department, County of Kauai

APPENDIX II

COMMENT LETTERS CONCERNING ENVIRONMENTAL MATTERS AND RESPONSES

Appendix II
Comment Letters Concerning
Environmental Matters and Responses
Table of Contents

*Indicates that a response by the Corps was not necessary.

Appendix II
Comment Letters Concerning
Environmental Matters and Responses
Table of Contents (continued)

*Indicates that a response by the Corps was not necessary.

United States Department of the Interior

U.S. GEOLOGICAL SURVEY

WATER RESOURCES DIVISION
677 Ala Moana Boulevard, Suite 415
Honolulu, HI 96813

IN REPLY REFER TO:

June 27, 1997

District Engineer
U.S. Army Engineer District, Honolulu
Attention: CEPOD-ET-PP/T. Young
Building 230
Fort Shafter, Hawaii 96858-5440

Subject: General Reevaluation Report and Environmental Assessment
Navigation Improvements, Kikiaola Light Draft Harbor
Kekaha, Island of Kauai, Hawaii

The staff of the U.S. Geological Survey, Water Resources Division, Hawaii District, has reviewed the General Reevaluation Report and Environmental Assessment, and we have no comments to offer at this time.

Thank you for allowing us to review the report. We are returning it for your future use.

Sincerely,

William Meyer

William Meyer
District Chief

Enc.

07 01 97 16:20 ☎808 438 8316 CEPOD-PA PAO 001

7/1 FAX 841-1581 Tim Young

SIERRA CLUB, HAWAI'I CHAPTER

P.O. Box 2577,
Honolulu, Hawai'i 96803
(808) 538-6616.

June 30, 1997

Mr. Ray Jyo
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, HI 96858-5440

Dear Mr. Jyo,

RE: ENVIRONMENTAL ASSESSMENT FOR IMPROVEMENTS AT KIKIAOLA HARBOR

The Sierra Club, Hawai'i Chapter, has strong objections to your plans for improvements at Kikiaola Harbor, your failure to prepare a complete environmental impact statement and your apparent disregard of state law.

1) Prior to your May 6, 1996 public workshop in Kekaha, I phoned your office to express my concern that the improvement project specifically include a sand bypass component because of the harbor's negative impact on beach processes. I was assured that this issue was being addressed in your plans. I did not feel that I needed to submit written comments because of the assurances that I received. Your general evaluation report suggests that all pertinent comments have been incorporated into the plans. Not true.

2) It is well recognized by scientists, nearby landowners, government officials and community members that the Kikiaola Harbor has disrupted natural beach processes. The Harbor has wrecked havoc with public beaches and private property along the shoreline to the west. How is it that this well documented problem was completely ignored in your general evaluation report and your environmental assessment? For this reason alone, your EA is flawed and should be rejected.

3) An inexpensive sand bypass system would carry sand from the east side of the harbor to the west side, thereby helping to correct the natural beach processes that the harbor disrupted. Such a system would be a win-win solution -- nourishing public beaches, protecting private property and reducing sedimentation in the harbor. Your failure to incorporate this proposal in your project renders your project a controversial project, leaves a major issue unresolved and exacerbates environmental impacts. Because you have failed to include a sand bypass system in your project, a complete environmental impact statement is required.

4) Where will the dredged sand go? Sand of high quality should be placed along the western shore for beach replenishment. It would be a violation of the public trust doctrine to sell high quality sand for construction purposes when it could be used for beach replenishment. An adequate environmental document would fully consider this issue.

5) Your environmental assessment incorrectly suggests that a number of state laws have been fully complied with. In fact, this project will require completion of an environmental impact statement under state law (chapter 343) and a conservation district use permit (since the dredging of submerged lands is a use of conservation district land).

Furthermore, your plans are not consistent with the state's coastal zone management program. By failing to include a sand bypass system to mitigate the adverse impacts of the harbor, your project:

- fails to improve the quality of coastal resources (HRS 205A-2(b)(3)(A));
- fails to protect valuable coastal ecosystems from disruption and fails to minimize adverse impacts on coastal ecosystems (205A-2(b)(4)(A));
- increases the hazard to life and property from erosion (205A-2(b)(6)(A));
- fails to protect beaches for public use and recreation (205A-2(b)(6)(A));
- fails to replace beach resources which have be damaged by development (205A-2(c)(1)(B)(ii)); and
- fails to restore shoreline open space (205A-2(c)(3)(C)).

Sincerely,

David Kimo Frankel
Director

copy: OEQC
DLNR
CZM
Kauai Planning Department
Kauai Times

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF

July 16, 1997

Planning and Operations Division

Mr. David Kimo Frankel, Director
Sierra Club, Hawai'i Chapter
P.O. Box 2577
Honolulu, Hawai'i 96803

Dear Mr. Frankel:

Thank you for your comments on the environmental assessment for navigation improvements at the Kikiaola Light Draft Harbor. We share your concern on the potential impact of the proposed improvements for the existing Kikiaola Harbor on the natural beach processes. To mitigate the potential adverse impacts on coastal resources, a sand bypassing component was incorporated into all alternative plans considered for implementation. As stated in the main report section of the General Reevaluation Report and Environmental Assessment (May 1997), this sand bypassing technique is anticipated to reduce our federal maintenance dredging requirement and enhance the downdrift shoreline through mechanical nourishment.

We inadvertently omitted discussion on sand bypassing in the environmental assessment but will include a statement in the final environmental assessment. Thank you for your continued interest on this project, and we hope we have satisfactorily addressed your concerns.

If there are any further questions regarding this project, please contact Mr. Tim Young of my Planning and Operations Division staff at (808) 438-7013.

Sincerely,

Ralph H. Graves
Lieutenant Colonel, U.S. Army
District Engineer

/

DEPARTMENT OF WATER

County of Kauai

"Water has no Substitute -- Conserve It!"

PP-5
provide cy
for EA

July 11, 1997

Mr. Ray H. Jyo, P.E.
Department of the Army
Pacific Ocean Division
Corps of Engineers
Fort Shafter, HI 96858-5440

Dear Mr. Jyo:

Subject: General Re-Evaluation Report (GRR) and Environmental Assessment (EA) for the Navigation Improvements, Kikiaola Light Draft Harbor, Kekaha, Island of Kauai, Hawaii

We have no objections to the proposed navigation improvements for the Kikiaola Light Draft Harbor. However, water service to the Kikiaola Light Draft Harbor will be limited to the existing water meter serving the harbor.

Requests for additional or larger sized water meter(s) will be dependent on the adequacy of the source, storage and transmission facilities existing at that time.

If you have any questions, please call Keith Aoki at 245-5418.

Sincerely,

E. Y. W. Lau

Ernest Y.W. Lau
Manager and Chief Engineer

KA:et

Waimea82/Army:emi

	OFFICE	ACTION	INFO
2	Dir of Engrg	Tech Svcs	
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	Svcs		
	Tech		

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P.O. BOX 621
HONOLULU, HAWAII 96809

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
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HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT
WATER RESOURCE MANAGEMENT

July 14, 1997

OFFICE		
Dist Engr		
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LD-NAV
REF.: EAUSARMY.RCM

Mr. Ray H. Jyo, P.E.
Director of Engineering
Department of the Army
Pacific Ocean Division
Corps of Engineering
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

SUBJECT: Review : General Evaluation Report and Environmental Assessment for the Navigation Improvements to the Kikiaola Light Harbor
Location: Kekaha, Island of Kauai, Hawaii
TMK : 4th/ 1-2-06: Seaward

Thank you for the opportunity to review and comment on the General Evaluation and Environmental Assessment for the proposed project.

Attached herewith is a copy of our Land Division, Planning and Technical Services' comments pertaining to the subject project.

The Department of Land and Natural Resources has no other comments to offer on the proposed project at this time. Should you have any questions, please contact Nick Vaccaro of the Land Division at 587-0438.

HAWAII: Earth's best !

Aloha,

Dona S. Colemar-Agaran
for MICHAEL D. WILSON

c: Kauai Land Board Member
At Large Land Board Member
Kauai District Land Office

Planning Branch's Comments on General Evaluation Report and Environmental Assessment for Navigation Improvements at Kikiaola Light Draft Harbor

We understand the purpose of the harbor improvements is to eliminate the shallow depths in the entrance channel that pose a hazard to vessels using the harbor, particularly during south swell conditions. The proposed project would dredge the entrance and access channels, remove the existing outer east stub breakwater, modify the east and west breakwaters, and reconstruct the inner east stub breakwater.

Although the subject documentation does not make any reference to State land use designations or any necessary permit requirements, we note the fast land mauka of the harbor (particularly to the east of the harbor) and all the submerged lands affected by this proposed project are in the State Conservation District. Potential impacts to the Conservation District resulting from the project include: destruction of approximately 4.5 acres of hard limestone reef, sand, and silt bottoms and associated benthic organisms; and interruption of the littoral sediment transport system, with resultant downcurrent beach erosion. Since the project consists of a land use within the Conservation District (dredging and placing materials on [submerged] land), it will require an approved Conservation District Use Appliction (CDUA).

The Department of Land and Natural Resources has been moving forward with the development and implementation of a Coastal Erosion Management Plan, and we are interested in the potential affects, both positive and negative, of this harbor improvement project on beach erosion. We note that beach erosion in the vicinity of the harbor has been highlighted in previous environmental studies of the area. Coastal studies have shown that the existing harbor has interrupted sand migration and caused erosion on public beaches and private property along the shoreline to the west. This problem may be corrected by the creation of a sand bypass system that could carry sand from the east side of the harbor to the west side. We believe such a system could nourish and preserve public beaches, protect property and public roads from strom erosion and reduce sedimentation in the harbor.

The reviewed documentation includes a brief, general discussion of a sand bypass system, but provides no specific details. Our Planning Branch will be expecting additional information regarding the sand bypass system and other methods of mitigating potential impacts to Conservation District resources when the CDUA is submitted. Thank you for the opportunity to comment. If there are any questions, please contact Tom Eisen of our Planning Branch at 587-0386.

BENJAMIN J. CAYETANO
GOVERNOR

KAZU HAYASHIDA
DIRECTOR

DEPUTY DIRECTORS
BRIAN K. MINAAI
GLENN M. OKIMOTO

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION
79 SO. NIMITZ HWY. • HONOLULU, HAWAII 96813-4898

IN REPLY REFER TO:

HAR-EP
9851.98

July 15, 1997

Mr. Ray H. Jyo, P. E.
Director of Engineering and Technical Services
Department of the Army
Pacific Ocean Division, Corps of Engineers
Fort Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

Subject: Navigation Improvements Kikiaola Light Draft Harbor

Thank you for providing us the subject report. We support this project as it will add to Kauai's existing harbor facilities and provide the space required by the island's growing population of commercial maritime operators.

Please call Fred Nunes at 587-1887 if you have any questions.

Very truly yours,

Thomas Fujikawa
Chief

	OFFICE	ACTION	INFO
2	Dir of Engrg	Tech Svcs	
1	Deputy		GN
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	Svcs		
	Tech		

4. 07-01-J

PATSY T. MINK
SECOND DISTRICT, HAWAII

WASHINGTON OFFICE:
2135 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-1102
(202) 225-4906
FAX: (202) 225-4987
http://www.house.gov/writerep/

DISTRICT OFFICE:
5104 PRINCE KUHIO FEDERAL BUILDING
P.O. Box 50124
HONOLULU, HI 96850-4977
(808) 541-1986
FAX: (808) 538-0233

BIG ISLAND: (808) 935-3756
MAUI: (808) 242-1818
KAUAI: (808) 245-1951

Congress of the United States
House of Representatives
Washington, DC 20515-1102

COMMITTEE ON THE BUDGET
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OVERSIGHT AND INVESTIGATIONS SUBCOMMITTEE, RANKING DEMOCRAT
COMMITTEE ON GOVERNMENT REFORM AND OVERSIGHT
(on leave)
REGION II WHIP
DEMOCRATIC CAUCUS EDUCATION AGENDA TASK FORCE, CO-CHAIR
CONGRESSIONAL ASIAN PACIFIC CAUCUS, CHAIR

July 16, 1997

18 JUL 1997
HED RHG
DEPTY
SECY
ET

LT. COL. RALPH H. GRAVES
DISTRICT ENGINEER
DEPARTMENT OF THE ARMY
HONOLULU DISTRICT CORPS OF ENGINEERS
FORT SHAFTER HI 96858

Dear Lt. Col. Graves:

Thank you for sending me a copy of the "General Reevaluation Report and Environmental Assessment for the Navigational Improvements, Kikiaola Light Draft Harbor, Kekaha, Island of Kauai, Hawaii."

I deeply appreciate your attention to my information needs regarding projects underway in my Congressional district.

Very truly yours,

Patsy T. Mink

PATSY T. MINK
Member of Congress

	OFFICE	ACTION	INFO
2	Dir of Engrg		
1	Deputy		
	Secretary		
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3	Plng		7/22
	Svcs		
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4 PP-T

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
GILBERT S. COLOMA-AGARAN

July 18, 1997 BOR-E 0040.98

Lt. Col. Ralph H. Graves
District Engineer
U.S. Army Engineer District Honolulu
Bldg. 230, Fort Shafter
Honolulu, Hawaii 96858-5440

Dear Lt. Col. Graves:

Subject: Navigation Improvements, Kikiaola Light Draft Harbor, Kekaha, Kauai

The enclosed memo dated July 13, 1997, from Lynn P. McCrory, Kauai State Board of Land and Natural Resources member, is forwarded for your use and information. Ms. McCrory has requested that she be provided specific information on the subject project. In response to her inquiry we sent her a letter addressing some of the items listed in her memo, as well as a copy of General Reevaluation Report and Environmental Assessment, dated May, 1997. Hopefully, many of the answers to her concerns will be found in the text of this report.

Please address as much of the items listed in her memo as possible, and respond directly to Ms. McCrory with copy to this office. She needs this information to respond to inquiries from the boating and Kekaha communities, as well as other concerned organizations.

Enclosed is a copy of our letter of July 17, 1997, providing some of the information that she requested. Should you have any questions, please call Manuel Emiliano of our Boating Engineering Branch at 587-0122.

Very truly yours,

David E. Parsons
Administrator

Encs.

cc: Lynn P. McCrory
Michael Wilson
Dean Uchida
Jeff Bearman

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
GILBERT S. COLOMA-AGARAN

July 18, 1997

BOR-E 0034.98

MEMORANDUM

TO: Lynn P. McCrory
Kauai BLNR Member

FROM: David E. Parsons
Administrator

SUBJECT: Navigation Improvements, Kikiaola Light Draft Harbor, Kekaha, Kauai

This is in reference to your memo of July 13, 1997, regarding the subject project being planned by the U. S. Army Corps of Engineers. Enclosed for your use and information is a copy of the General Reevaluation Report and Environmental Assessment, dated May, 1997, which was prepared by the Corps of Engineers. Hopefully, many of your questions will be answered in the text of this report. As indicated in the Executive Summary of this report, the General Design Memorandum and Final Environmental Impact Statement were completed in September, 1980, and approved by the Director of Civil Works in September, 1981. This project was put on hold for several years until June, 1991, when a formal request was made to initiate the Preconstruction Engineering and Design (PED) for this project. Federal funding for the PED phase was appropriate for Fiscal Year 1994. As indicated above, this project has a very long history. The Corps of Engineers is now conducting the Feasibility Phase of the PED. A copy of the Office of Planning, DBEDT letter dated February 13, 1997, reaffirming that the original CSM Consistency concurrence is still valid, is enclosed for your information.

The physical features of the project which are intended to improve the navigational operations and safety of Kikiaola Small Boat Harbor are as follows:

1. Modify the existing East Breakwater by raising the crest elevation by four feet from Station 8+70 to 9+85, and by three feet from Station 2+50 to 8+20.

2. Remove the 85 foot end portion of the East Breakwater, and construct a new Inner East Breakwater section.

BOR-E 0034.98

3. Modify 220 feet of the existing West Breakwater by placing armor, underlayer, and bedding stones from Station 3+80 to 6+00.

4. Dredge a new 725 foot long Entrance Channel to a depth of 12 feet and varying in width from 105 to 205 feet.

5. Dredge a new 320 foot long Access Channel to a depth of 8 feet and varying in width from 70 to 205 feet.

The General Navigation Improvement Features will cost $6.404 million, with the Federal Government providing $5,124,000 and the State $1,280,000 for the project.

The information that you requested regarding the "sand bypass system" and "timeframe and components for completion of the proposed project" is contained on pages 24 and 25 of the report and the Project Management Plan shown in Appendix H. A copy of the Sierra Club letter of June 30, 1997, addressed to the Corps of Engineers, regarding concerns of the environmental assessment and specifically the sand bypass component, is enclosed for your information. A copy of the Corps of Engineers' reply to this letter will be sent to you, as soon as it is released. We are also sending a letter to the U. S. Army Corps of Engineers requesting that they also respond to specific items in your July 13, 1997, memo.

In regard to your inquiry regarding any correspondence between DOBOR to and from the community and environmental groups; the Corps of Engineers is handling all of these functions. A public Workshop was conducted by the Corps of Engineers at the Kekaha Neighborhood Center on Monday, May 6, 1996. A copy of the notice is enclosed for your information.

To our knowledge, we do not know of any summary/positional (pros/cons) papers which were prepared by DLNR on this project. The same for any alternative options regarding coastal erosion on neighboring properties, or any correspondence with the County of Kauai which discusses the neighboring properties and seawalls which have been constructed and instructed to be removed. These matters are normally managed by the Land Division of DLNR.

I trust that the information provided will be helpful. Should you have any questions, please call me at 587-1966.

Encs.

cc: Michael D. Wilson
Dean Uchida
Jeff Bearman

FAX MEMORANDUM

PAHIO

TO:	Manuel Emiliano DLNR/DOBOR
FROM:	Lynn P. McCrory Kauai BLNR Member
SUBJECT:	Kikiaola Dredging Project
DATE:	July 13, 1997

fax: 808-587-1977 3 pages

Manuel, today I read with great interest the front page article in our local newspaper (copy follows) regarding the dredging project proposed for the Kikiaola Small Boat Harbor. As I do not have any information on this project, would you please send me the following this week:

- Environmental Assessment;
- Any correspondence between DOBOR to and from the community and environmental groups;
- Any summary/positional (pros/cons) papers which the department has prepared for the project;
- Any alternative options DOBOR has considered regarding the coastal erosion on the neighboring properties believed to be the result of the harbor being in place for the last 40 years;
- Any correspondence with the County of Kauai which discusses the neighboring properties and the seawalls which have been constructed and instructed to be removed;
- Any information you have in regards to the "sand bypass system" proposed by the Sierra Club; and
- Timeframe and components for completion of the proposed project.

It also appears that Jeff Bearman, our local Kauai manager does not have very much information in regards to the project by his quotation in the newspaper. Please send a duplicate of this information to him.

If you have any questions, please do not hesitate to give me a call. Mahalo!

c: Michael Wilson	fax: 808-587-0390	
Dean Uchida	808-587-0455	(for Coastal Erosion Management Plan)
David Parsons	808-587-1977	
Jeff Bearman	246-6678	

A Vacation Ownership Company P.O. Box 3099, Princeville, Kauai, Hawaii 96722 Telephone 808/826/6549 Facsimile 808/826/6715

SUNDAY July 13, 1997

Today's weather

Tradewind showers, sometimes heavy.

[illegible] wins top PRAISE

Page 2-A

[illegible] who last week had been urged by the company to lose weight

Page 6-A

The Garden Islan[d]

Serving Kaua'i and Ni'ihau since 1902 * "A Pulitzer Community Newspaper" * Home Delivery Price 30¢ [illegible]

Both blessing and curse

BECAUSE Kikiaola Small Boat Harbor blocks the migration of sand, the ocean has eroded both beach and land west of the harbor. Above, remnants of a seawall [illegible] on the job and 20 to 30 feet of land has washed into the ocean. Seawalls protect the property of Richard and Anne Brobyn and their neighbors, but waves have swept away sand that is no longer replenished.

[Photos by Dennis Fujimoto]

Kikiaola project up for comment

$6 million plan to dredge harbor, replenish beaches

By LESTER CHANG
Staff Writer

KEKAHA — When the Kikiaola Small Boat Harbor was built in 1959, local fishermen [illegible].

It offered a place to moor their boats and to seek refuge from storms. It was a launch point to the rich fishing grounds of the Kaulakahi Channel.

Nearly 40 years later, the harbor has emerged as a financial burden for the federal, state and county governments, which have to maintain it, and indirectly for nearby property owners, who are losing land to the erosion it causes.

Now the U.S. Army Corps of Engineers and the state recreational boating division have proposed extensive dredging and strengthening of the harbor walls under a plan the agency estimates will cost more than $6 million. The public has until Aug. 7 to comment on the proposal.

Jeff [illegible], who manages the small boat harbors on Kaua'i for the Department of Land and Natural Resources, wonders if the project is necessary, even though

(See Kikiaola on Page 2)

HOT A C[illegible]ING SIGN for a boat harbor, but that's the story at Kik[illegible] where siltation can make for interesting entrances and exits.

Could K[illegible] commu[illegible] buy Kea[illegible]

Public meeting [illegible] on keeping ahu[illegible]

By WILLIAM [illegible]
[illegible]

KEALIA — Can a community group dedicated to preserving farmland organize itself and find a way to raise $19.3 million in three months?

Nothing ventured, nothing gained, Amy Antry would say. Which is why the [illegible] has called a community meeting [illegible] Wednesday with the ultimate goal of eventually purchase of the Kealia ahupua'a [illegible]

[illegible]

"It's an ambitious undertaking," Antry conceded. [illegible]

Bamboo co[illegible] to focus on [illegible]

By SHEILA [illegible]
Staff Writer

LIHUE — Bamboo expert [illegible]

[illegible]

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF

August 1, 1997

Planning and Operations Division

Ms. Lynn P. McCrory, Member
Board of Land and Natural Resources
4th Land District (Kauai)
State of Hawaii
P.O. Box 3099
Princeville, Kauai 96722

Dear Ms. McCrory:

Thank you for your comments on the proposed navigation improvements at the Kikiaola Small Boat Harbor. A copy of your July 13, 1997 FAX memorandum was provided to us by the Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DLNR, DBOR) for additional follow up response. In reference to your memorandum, the following supplemental information, comments and clarification are provided:

- The only correspondence received to date from any community or environmental group is the letter dated June 30, 1997 from the Sierra Club, Hawai'i Chapter. Enclosed is a copy of the U.S. Army Corps of Engineers response.

- The sand bypass system discussed and recommended by the Sierra Club in the Garden Island newspaper on July 13, 1997 would be cost prohibitive and require high maintenance. The sand bypassing method discussed and recommended by the Corps in the General Reevaluation Report essentially fulfills the same objective of moving sand from the east side of the harbor to the west side at a far less cost.

- When all comments on the General Reevaluation Report (GRR) and Environmental Assessment (EA) have been adequately addressed, the report will be forwarded to our headquarters for final approval. We anticipate completion of the plans and specifications for this project by 1998 and award of the construction contract in 1999. The Corps of Engineers has worked closely with the local sponsor (DLNR) in the formulation and preparation of this GRR and EA.

Additional copies of the General Reevaluation Report and Environmental Assessment, prepared in May 1997, have been provided to the Department of Land and Natural Resources, Division of Boating and Ocean Recreation for distribution to special interest groups and individuals.

We hope this supplemental information, as well as the information provided to you previously by the DLNR, DBOR, has satisfactorily addressed your concerns. We look forward to working with you on this project and thank you for your continued interest.

If there are any further questions regarding this project, please contact Mr. Tim Young of my Planning and Operations Division staff at (808) 438-7013.

Sincerely,

Ralph H. Graves
Lieutenant Colonel, U.S. Army
District Engineer

Enclosure

Copy Furnished:

Mr. David Parsons, Administrator
Department of Land and Natural Resources
Division of Boating and Ocean Recreation
State of Hawaii
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

LAWRENCE MIIKE
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801

In reply, please refer to:

July 19, 1997

97-138/epo

District Engineer
U.S. Army Engineer District, Honolulu
Attention: CEPOD-ET-PP/T. Young
Building 230
Fort Shafter, Hawaii 96858-5440

Dear District Engineer:

Subject: GENERAL REEVALUATION REPORT (GRR) AND ENVIRONMENTAL ASSESSMENT (EA)
Navigation Improvements, Kikiaola Light Draft Harbor
Kekaha, Kauai, Hawaii

Thank you for allowing us to review and comment on the subject project. We have the following comments to offer:

Clean Air Branch

Proposed actions in the subject project affecting air quality include all phases of construction activities.

Possible Nuisance Odors from Stockpiling Dredged Material:

The General Reevaluation Report and Environmental Assessment do not address any stockpiling or disposal of dredged material. Stockpiling of dredged material tends to prevent the center portion of the pile from being sun-dried. Odors generated in the center of the pile may be intensified and linger for long periods of time. Due to the nature of the material being removed, there is a significant potential for nuisance odors to be generated, with impacts to nearby residents and thoroughfares. A discussion of odor abatement or prevention should be included in the plan.

Control of Fugitive Dust:

Due to the nature of the project, there is a significant potential for fugitive dust to be generated during the removal of debris and during all phases of the construction activities that would impact nearby residences and nearby thoroughfares. It is suggested that a dust control management plan be developed which identifies and addresses activities that have a significant potential to generate fugitive dust. Implementation of adequate dust control measures during all phases of the project is warranted.

Construction activities must comply with provisions of Hawaii Administrative Rules (HAR), Chapter 11-60.1, "Air Pollution Control," Section 11-60.1-33 on Fugitive Dust. The contractor should provide adequate means to control dust from road areas and during the various phases of construction activities. These means include, but are not limited to:

a. Planning the different phases of construction, focusing on minimizing the amount of dust-generating materials and activities, centralizing material transfer points and on-site vehicular traffic routes, and locating potentially dusty equipment in areas of the least impact;

b. Providing an adequate water source at the site prior to start-up of construction activities;

d. Controlling of dust from any stockpiles, project entrances, and access roads; and

e. Providing adequate dust control measures during weekends, after hours, and prior to daily start-up of construction activities.

If you have any questions regarding these comments, please contact Mr. Calen Miyahara of the Clean Air Branch at 586-4200.

<u>Noise Concerns</u>

Activities associated with the construction phase of the project must comply with the provisions of HAR, Chapter 11-46, "Community Noise Control."

a. The contractor must obtain a noise permit since the noise level from the construction activities are expected to exceed the allowable levels of the regulation as stated in Section 11-46-6(a).

b. Construction equipment and on-site vehicles requiring an exhaust of gas or air must be equipped with mufflers as stated in Section 11-46-6(b)(1)(A).

c. The contractor must comply with the conditional use of the permit as specified in the regulations and conditions issued with the permit as stated in Section 11-46-7(d)(4).

Should there be any questions on these comments, please contact Mr. Jerry Haruno, Environmental Health Program Manager of the Noise, Radiation and Indoor Air Quality Branch at 586-4701.

Sincerely,

BRUCE S. ANDERSON, Ph.D.
Deputy Director for Environmental Health

c: CAB
NR&IAQB

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF

August 1, 1997

Planning and Operations Division

Bruce S. Anderson, Ph.D.
Deputy Director for Environmental Health
Department of Health
State of Hawaii
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

This is in reference to your letter dated July 19, 1997 addressed to the District Engineer. We thank you for your comments on the General Reevaluation Report (GRR) and Environmental Assessment (EA) for Navigation Improvements at the Kikiaola Light Draft Harbor on the island of Kauai. We share your concern on the potential nuisance from odors emanating from a temporary stockpile of dredged material as well as fugitive dust and noise. Our final revised GRR and EA will address and discuss these issues as well as incorporate all other pertinent comments received from government agencies, individuals and special interest groups.

During the preparation of contract plans and specifications, all applicable State, County and Federal requirements will be included in the final contract package. I hope we have satisfactorily addressed your concerns, and we look forward to working with you on this project. Thank you for your continued interest.

If there are any further questions regarding this project, please contact Mr. Tim Young of my Planning and Operations Division staff at (808) 438-7013.

Sincerely,

/s/ Nakasone

Ray H. Jyo, P.E.
Director of Engineering
and Technical Services

TEOK Investigations

mailing address - P.O. Box 1078, Waimea, Kaua'i, HI 96796
street address - 8589 Kaumualii Hwy, Kekaha, Kaua'i, HI 96752
phone/fax - (808) 337-9269; cellular phone - (808) 639-6436
e-mail - teok@aloha.net

FACSIMILE TRANSMISSION
(Page 1 of 3)

TO: Mr. Tim Young **DATE: 29 July 1997**
Army Corps of Engineers
Ft Shafter, HI -- fax no. 841-1581

SUBJECT: Kikiaola Harbor, Kauai

Dear Tim,

I read over the General Reevaluation Report and Environmental Assessment for Navigational Improvements of Kikiaola Harbor, Kauai, and would like to make a few comments.

1. Details of the bathymetry of the Waimea Beach Cell are not well known (someday I will complete a more detailed bathymetric map), but we can at least say the following: a) the beach cell is bounded on the east and west by shallow, submerged rocky headlands that are partly covered with coral/algal growth, b) when sea level was about 300 ft lower 15-18 thousand years ago, the Waimea River extended at least a mile more offshore; today that channel probably is mostly filled with volcanic fluvial sediment, c) a reef-like ledge, subparallel to the shore and about one half mile offshore, extends most of the length of the beach cell and has a relief of about 25-30 feet, with the top of the ledge at a depth of about 35-40 feet, d) volcanic sand from the Waimea River moves westward from the river mouth toward Oomano Point owing to a prevailing longshore current, e) sediment also moves offshore and is lost to the beach cell after it moves seaward of the reef-like ledge, f) very little volcanic sand moves west of the submerged rocky headland at Oomano Point, with most of it moving offshore at that point.

2. As for Kikiaola Harbor itself, we know the following: a) the structure blocks westward movement of volcanic sand in the littoral zone, b) the beach has been accreting at about 2.3 ft/year east of the harbor and eroding at about 2.2 ft/yr west of the harbor, c) the harbor fills with sediment from two sources -- fines (mostly silt and clay) from a drainage ditch entering the basin, and sand transported by wave-generated currents at the seaward entrance. **In general the harbor is a much better settling basin than it is a boat basin.**

3. I think that the Sea Engineering study did a very good job in documenting the rate at which the harbor is being filled with sand from the sea. It did not investigate the sediment infill from the drainage ditch. Has anyone taken and analyzed sediment cores in the harbor to determine the amounts of the various sediments that do fill the harbor? Have you considered moving the drainage ditch so that it does not dump directly into the harbor? Or, do you not consider that a problem?

4. I know that this is a bad time to point this out (actually about 40 years too late), but it seems obvious that a better place for the harbor would have been about one half mile farther west, near Oomano Point. On a natural basis relatively little volcanic sand reaches, or ever did reach, that location, since most of the sand is diverted offshore by the submerged rocky headland. That has been the situation for a very long time, even way before the harbor was constructed. I know that moving the harbor is out of the question, but I just wanted to point this out.

5. But, all of this sedimentology stuff (and your engineering stuff) probably is not the main aspect of the problem that needs to be considered. The big problem is "local attitudes". Local fishermen, etc. have expressed strong dislike of others using their harbor. They especially do not like any commercial tourism use. But this is a public facility, built and maintained (at least once in a while) by everyone's tax dollars. So, my question is -- why should government funds, a lot of government funds, be allocated to maintain a harbor facility that can not easily be used by the general public, both private and commercial? Kauai, especially West Kauai, could use the revenue that would be brought in by commercial (i.e., tourism) use. I could not agree to a $7,000,000+ expenditure on a boat harbor for a bunch of local grumpy old fishermen. Now, I am sure that you don't want to pursue this argument (I know that is not your job), but I think it will be raised at you next "what to do about Kikiaola Harbor" meeting on Kauai -- good luck.

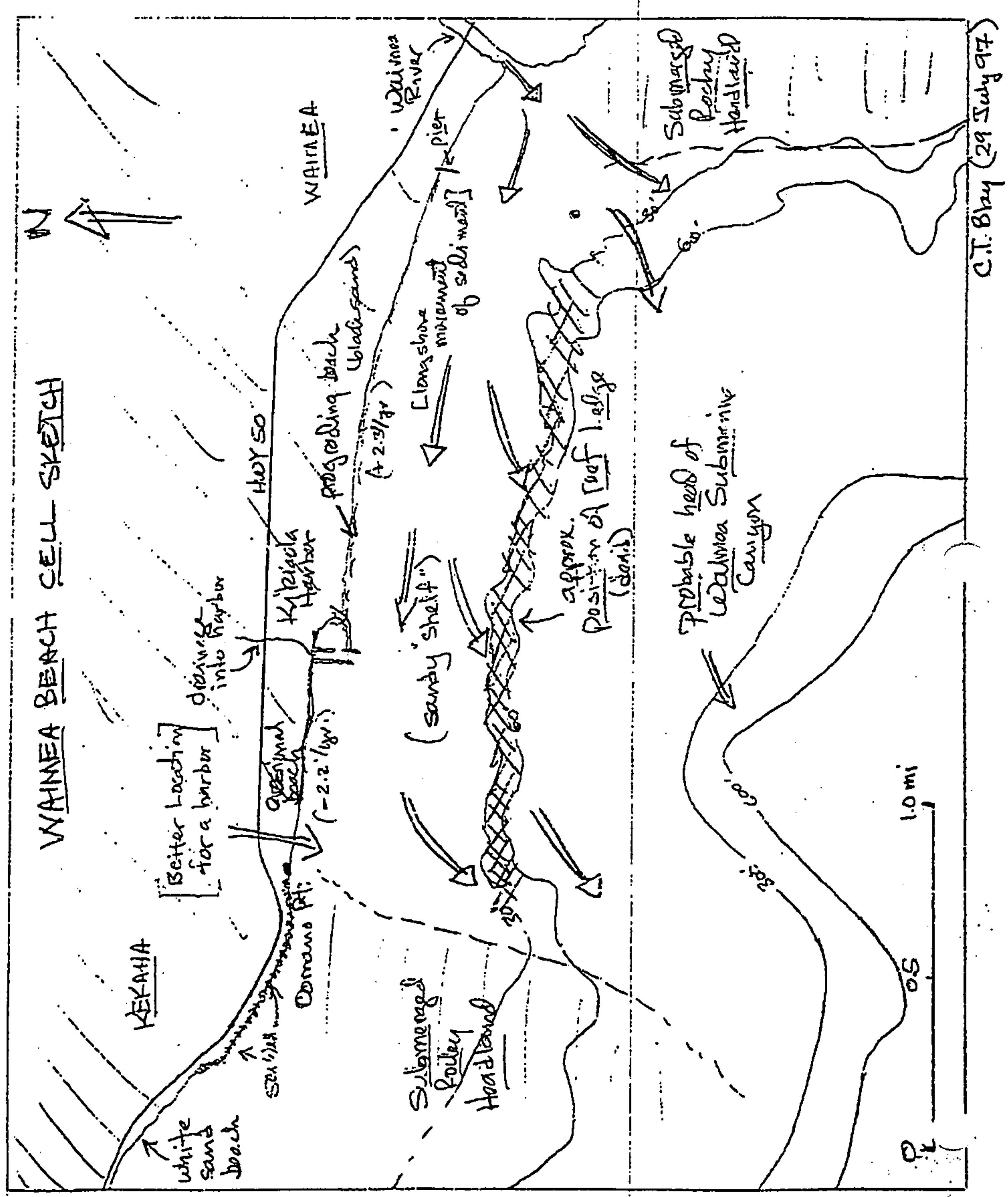
That's about it, Tim. Thanks for sending me a copy of the report. I hope you make it over for the meeting, whenever it might be. I look forward to seeing you.

Best regards,

Chuck Blay

Chuck Blay

attachment: Waimea Beach Cell Sketch Map


WAIMEA BEACH CELL SKETCH
N
WAIMEA
KEKAHA
Waimea River
pier
Submerged Rocky Headland
Submerged Rocky Headland
Longshore movement of sediment
prograding beach (black sand)
(+2.3'/yr)
Kikiaola Harbor
HWY 50
drainage into harbor
Better Location for a harbor
eroding beach
(-2.2'/yr)
Oomano Pt.
seawall
white sand beach
sandy "shelf"
approx. position of reef ledge (dash)
Probable head of Waimea Submarine Canyon
60
30
60'
100'
300'
0
0.5
1.0 mi
C.T. Bley (29 July 97)

MARYANNE W. KUSAKA
MAYOR

DEE M. CROWELL
PLANNING DIRECTOR

IAN K. COSTA
DEPUTY PLANNING DIRECTOR

TELEPHONE (808) 241-6677
FAX (808) 241-6699

PLANNING DEPARTMENT

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1 Deputy		
Secretary		
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~~Dir~~ Constr		
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~~PM&S~~		
3 Plng		
Svcs		
Tech		

4 PP-J

July 30, 1997

Ray H. Jyo, P.E.
Director of Engineering
U. S. Army Engineer District, Honolulu
Attention: CEPOD-ET-PP/T. Young
Building 230
Fort Shafter, HI 96858-5440

Subject: General Revaluation Report and Environmental Assessment
Kikiaola Light Draft Harbor
Kekaha, Kauai, Hawaii

Dear Mr. Jyo:

Thank you for the opportunity to comment on the above identified document. We have met with members of your staff on more than one occasion to discuss the proposed improvements at Kikiaola Harbor. Our primary concern has been, and continues to be, the impacts of the harbor on the shoreline to the west. Since its construction in 1959, the harbor has interrupted the westerly flowing littoral currents that transport sand along the shoreline. This has resulted in accelerated erosion to the west of the harbor, which has threatened property and residences located along Kikiaola beach.

In our discussions with your staff we suggested the incorporation of mitigation measures into the harbor improvements. Your staff related that such measures were being considered. However, the Environmental Assessment (EA) does not discuss the Harbor's impacts on the shoreline to the west. Appendix E of the EA, Sediment Transport at Kikiaola Harbor, indicates that following construction of the harbor, the erosion rate along the shoreline to the west of the harbor increased to approximately 2.3 feet per year. However, the document does not conclude that the harbor is the primary cause of this accelerated erosion.

The harbor has been recognized as a significant factor in causing accelerated shoreline erosion along Kikiaola beach for many years. Page 10 of the June 1991, Aerial Photograph Analysis of Coastal Erosion the islands of Kauai, Molokai, Lanai, Maui and Hawaii, prepared for the Hawaii Coastal Zone Management Program by Makai Ocean Engineering and Sea Engineering, Inc. states:

> "Kikiaola Beach has eroded severely since the construction of the small boat harbor, which interrupted the predominate westward littoral drift."

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Page 26 of the June 1992 Beach Management Plan With Beach Management Districts by Dennis J. Hwang and Dr. Charles H. Fletcher, also prepared for the Hawaii Coastal Zone Management Program, contains the following statement:

> "At Kikiaola Harbor on the south coast, a massive jetty has interrupted the natural littoral drift causing an erosional offset in the coast a mile long and 100 ft wide."

And in his June 7, 1995 letter responding to comments made by the Office of State Planning regarding a rock revetment proposed to be constructed along Kikiaola Beach, Dr. Warren Bucher, Senior Ocean Engineer for Oceanit Coastal Corporation states:

> "There should be a long-term plan for the area that includes addressing the erosion caused by Kikiaola Boat Harbor"

Paragraph one on Page 33 of the EA indicates that sand bypassing is considered to be a viable option to significantly reduce the maintenance dredging requirements within the harbor channel. The aforementioned Appendix E of the EA estimates that the harbor would require maintenance dredging every five years. The study concludes by stating:

> "Alternatively, modifications to the harbor could be designed to incorporate sediment catch basins that enable sand by-passing to the down drift beach."

It should be noted that sand-bypassing would not only reduce the need for maintenance dredging, but also help mitigate the harbor's impacts on the shoreline to the west.

It is recommended that the EA address the current impacts of the harbor which will continue after construction of the proposed improvements, unless mitigation measures are incorporated into the project. Alternative mitigation measures, such as sand by-passing or mechanical transport of sand from the shoreline east of the harbor to the beach to the west, should be discussed in the document. The benefits of reducing shoreline loss along the approximately one mile Kikiaola coast could be included in the project cost/benefit analysis.

The option of disposal of suitable dredged material along the shoreline to the west also should be considered. We had requested that material previously dredged from the harbor be considered for disposal along the shoreline, if some or all of it were found to be suitable (see attached letter).

Thank you for your consideration of these comments. Please contact George Kalisik of my staff at 241-6677 if you have any questions.

Sincerely,

Dee M. Crowell
Planning Director

MARYANNE W. KUSAKA
MAYOR

PLANNING DEPARTMENT

DEE M. CROWELL
PLANNING DIRECTOR
IAN K. COSTA
DEPUTY PLANNING DIRECTOR

TELEPHONE (808) 241-6677
FAX (808) 241-6699

December 5, 1995

Mr. Ray H. Jyo, P. H. , Director
Engineering and Technical Services
Pacific Ocean Division, Corps of Engineers
Department of the Army
Fort Shafter, Hawaii 96858-5440

Subject: Proposed Maintenance Dredging
Kikiaola Small Boat Harbor
General Permit PODCO.OGP 84-3E
Kikiaola, Waimea, Kauai
TMK: 1-2-6:17

Dear Mr. Jyo:

This letter is being sent in response to the proposed maintenance dredging at Kikiaola Small Boat Harbor on Kauai under the above identified General Permit. As you may be aware, the construction of Kikiaola Harbor in the 1950's has been identified as contributing to accelerated coastal erosion on property west of the Harbor. Sediments originating at the Waimea River generally are transported westerly by littoral currents which distribute sand along the Waimea/Kekaha shoreline. Under natural conditions, the deposited sand replenishes the beaches of the area and helps protect mauka lands from coastal erosion. The Harbor interrupts this down current replenishment resulting in accelerated erosion to the west of the Harbor, and accelerated accretion to the east (See the 1991 study Aerial Photograph Analysis of Coastal Erosion on the Islands of Kauai, Molokai, Lanai, Maui and Hawaii, and the 1992 report Beach Management Plan with Beach Management Districts, both prepared for the Office of State Planning).

The County of Kauai Planning Commission is currently reviewing three seawall/revetment projects on property located west of the Harbor. The structures are intended to protect property experiencing coastal erosion caused in part by the effects of the Harbor. However, hardening of the shoreline by the construction of seawalls and revetments has been found to contribute to beach loss makai of the structures, and accelerated erosion down current. Alternatives to seawalls and revetments such as sand

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replenishment have been found to protect beaches and mauka development without the adverse impacts associated with hard solutions.

Offshore dredged material is used throughout the mainland for beach replenishment. The material obtained from the proposed Kikiaola dredging is a potential source of replenishment for the beach area west of the Harbor. We would like to recommend that if the dredged material is found to be suitable, it be used for replenishment of the beach to the west of Kikiaola Harbor. Some of the material being dredged may have been deposited down current on the beaches to the west if not trapped by the Harbor. Use of this material for replenishment would help protect the beach and upland areas by compensating for the Harbor's impacts on natural shoreline processes.

Thank you for your consideration of this recommendation. Please contact George Kalisik of my staff at 241-6677 to further discuss this matter.

Sincerely,

/original signed by/
Dee M. Crowell
Planning Director

c: Manabu Tagomori, DLNR-DOWALD

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY
GILBERT COLOMA-AGARAN

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
ENGINEERING BRANCH
P.O. BOX 373
HONOLULU, HAWAII 96809

JUL 31 1997

Mr. Ray H. Jyo, P.E.
Director of Engineering and
Technical Services
Department of the Army
Pacific Ocean Division
Corps of Engineers
Fort Shafter, Hawaii 96858-5440

Attention: CEPOD-ET-PP/T. Young

Dear Mr. Jyo:

General Reevaluation Report (GRR) and Environmental Assessment (EA) for the Navigation Improvements, Kikiaola Light Draft Harbor (KLDH) Kekaha, Island of Kauai, Hawaii

In reference to your letter of June 20, 1997, we offer the following comments on the subject GRR and EA:

1. Proposed design improvements should be coordinated with Kauai County.
2. Update of emergency evacuation plan for both tsunami and hurricane warning should be coordinated with Kauai County Civil Defense.

Thank you for the opportunity to review the GRR and EA. Should you have any questions, please contact Mr. Dennis Imada of the Project Planning Section at 587-0257.

Sincerely,

Andrew M. Monden

ANDREW M. MONDEN
Chief Engineer

DI:ek
c: Nick Vaccaro, Land Division
Design Section, Engr. Branch

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P.O. BOX 3378
HONOLULU, HAWAII 96801-3378

LAWRENCE MIIKE
DIRECTOR OF HEALTH

In reply, please refer to:
EMD/CWB

OFFICE	ACTION	INFO
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August 1, 1997

C0801EC

Ray H. Jyo, P.E.
Director
Engineering and Technical Services
Planning and Operations Division
Department of the Army
U.S. Army Engineer District, Honolulu
Fort Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

Subject: **Comments on the General Reevaluation Report (GRR) and Environmental Assessment (EA) for the Navigation Improvements, Kikiaola Light Draft Harbor, Kekaha, Island of Kauai, Hawaii**

Thank you for the opportunity to review and comment on the subject GRR and EA. The following information is provided for your attention and action:

1. Kikiaola Harbor is an existing boat harbor and is classified by the Department of Health (Department) as "Class A, Embayment." The designated uses and discharge restrictions are specified in Section 11-54-03 (page 54-8) of Chapter 11-54 of the Hawaii Administrative Rules. Section 2.2.6 (page 7) of the GRR needs to be revised to reflect the correct citations.

2. Based on information provided and the January, 1997 Memorandum of Agreement (MOA) between the Honolulu Engineer District (HED) and the Department's Clean Water Branch (CWB), a Section 401 Water Quality Certification (WQC) is required before the commencement of the project construction. The Department reserves its right to provide further comments during the process of a Section 401 WQC application. Enclosed is a copy of the Section 401 WQC Guidelines and Section 401 WQC Application Form. Please read the instruction and submit your Section 401 WQC application as soon as practicable.

The nature and scope of this project is very similar to those improvements proposed for the Maalaea Harbor project, the Department recommends that you should consider the implementation of similar Best Management Practices, mitigative measures and applicable monitoring practices as proposed in the Maalaea Harbor project.

Should your have any questions, or need additional information, please contact Mr. Edward Chen, Engineering Section of the CWB, at 586-4309.

Sincerely,

Thomas E. Arizumi

THOMAS E. ARIZUMI, P.E., CHIEF
Environmental Management Division

EC:cr

Enclosures: 1. Section 401 WQC Guidelines
2. Section 401 WQC Application Form

c: DHSA, Kauai (w/o encls.)
Chief Sanitarian, Kauai (w/o encls.)

Oceanit Coastal Corporation

coastal engineering services

A subsidiary of Oceanit Laboratories, Inc.

August 1, 1997

District Engineer
U.S. Army Engineer District, Honolulu
Attn: DEPOD-ET-PP/T. Young
Building 230
Fort Shafter, Hawaii 96858-5440

Subject: Draft Environmental Assessment, Kikiaola Light Draft Harbor Navigation Improvements

Dear Sir:

The decision to use sand by-passing at Kikiaola Light Draft Harbor is absolutely correct and long overdue. Sand by-passing is a win-win solution for everyone concerned. Oceanit provided coastal engineering consulting services for beach erosion at a private residence located down-drift of the harbor. As we studied the erosion, it became quite clear that properties along the beach suffer from erosion because the harbor blocks sand from Waimea River that would normally be transported and distributed along the beach. Waimea River is the primary source of sand along this coastline, and the sand is volcanic rather than coral. While some coastal erosion problems are difficult to correct, at Kikiaola the erosion can be substantially reduced or even stopped if sufficient sand is moved from the up-drift side of the harbor and placed on the down-drift side. Sand transfer can be done with construction equipment such as a front loader and dump trucks. Oceanit recommends that sand be moved relatively often, perhaps every six months and not less often than once per year. Waiting intervals of several years could allow erosion to threaten property again in the interim.

Oceanit would be happy to share information on this area with you if needed. Thank you for the opportunity to comment on the proposed project.

Sincerely,

Warren E. Bucher

Warren E. Bucher, Ph.D.
Vice President

WEB/l08017ea.coe

1100 Alakea Building • 1100 Alakea Street, 31st Floor • Honolulu, Hawaii 96813
TELEX: 7431404 • MCI: OCEANIT • TEL: (808) 531-3017 • FAX: (808) 531-3177

BENJAMIN J. CAYETANO
GOVERNOR

GARY GILL
DIRECTOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
235 SOUTH BERETANIA STREET
SUITE 702
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-4186

August 7, 1997

Mr. Michael Wilson, Chair
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Wilson:

Subject: Draft Environmental Assessment for the Kikiaola Light-Draft Harbor Navigation Improvements

This is in response to the review of the subject document. We have the following questions and comments.

1. Recent studies show that the existing harbor has interrupted sand migration and caused the beach to accrete east of the harbor and erode west of the harbor. This problem may be corrected by the creation of a sand bypass system which could carry sand to the west side of the harbor. Scientist and concerned citizens believe that such a sand bypass system would nourish and preserve public beaches, protect property and public roads from storm erosion and reduce sedimentation in the harbor. The project plans include a sand bypass system for maintenance dredging purposes. Please describe in detail the proposed sand bypass system. Include diagrams that clearly illustrate the method and plan. Would the proposed sand bypass system replenish the beach on the west side of the harbor? If not, please justify the reasons for not replenishing the beach on the west side of the harbor.

2. Approximately 53,000 cubic yards of consolidated coralline, sand and silt will be dredged for this project. The dredged material is anticipated to be disposed on lands owned by the Kikiaola Land Company. Please consider using the sand for replenishing the beach on the west side of the harbor.

3. Please describe and evaluate the impacts of future plans by the state to improve infrastructure and berthing facilities within the harbor.

Should you have any questions, please call Jeyan Thirugnanam at 586-4185.

Sincerely,

for Gary Gill
Director

c: Army Corps of Engineers

United States Department of the Interior

FISH AND WILDLIFE SERVICE
PACIFIC ISLANDS ECOREGION
300 ALA MOANA BOULEVARD, ROOM 3108
BOX 50088
HONOLULU, HAWAII 96850
PHONE: (808) 541-3441 FAX: (808) 541-3470

In Reply Refer To: CAW

AUG 8 1997

Lt. Colonel Ralph H. Graves
District Engineer
U.S. Army Engineer District, Honolulu
Attention : CEPOD-ET-PP/T. Young
Building 230
Fort Shafter, Hawaii 96858-5440

Re: Environmental Assessment and Finding of No Significant Impact for Navigation Improvements at Kikiaola Light-Draft Harbor, Kekaha, Island of Kauai, Hawaii.

Dear Lieutenant Colonel Graves:

The U.S. Fish and Wildlife Service (Service) has reviewed the Environmental Assessment (EA) and Finding of No Significant Impact for Navigation Improvements at Kikiaola Light-Draft Harbor, Kekaha, Island of Kauai, Hawaii. The proposed project is sponsored by the U.S. Army Corps of Engineers (Corps) and the Division of Boating and Ocean Recreation of the Hawaii Department of Land and Natural Resources. This letter has been prepared under the authority of and in accordance with provisions of the National Environmental Policy Act of 1969 [42 USC 4321 *et seq.*; 83 Stat. 852], as amended, the Fish and Wildlife Coordination Act of 1934 [16 USC 661 *et seq.*; 48 Stat. 401], as amended, the Endangered Species Act of 1973 [16 USC 1531 *et seq.*; 87 Stat. 884], as amended, and other authorities mandating Department of the Interior concern for environmental values. Based on these authorities, the Service offers the following comments for your consideration.

The proposed project will consist of dredging an entrance channel 725 feet (221 meters) long and an access channel 320 feet (97.5 meters) long; removing 150 feet (46 meters) of the existing outer east stub breakwater; modifying 735 feet (224 meters) of the existing west breakwater; modifying 220 feet (67 meters) of the existing east breakwater; and removing and reconstructing an 85-foot (26-meter) section of the inner east stub breakwater.

Based on a December 5, 1995, site visit by Service biologists, we provided the Corps with information on the existing resources at the proposed project site and conservation measures to avoid impacts to these resources. These conservation measures have been addressed and the following recommendations have been incorporated into the project design and included in the EA:

1. The use of existing upland spoil disposal and quarry sites is encouraged. If new sites are selected, the Service will be given the opportunity to evaluate the environmental effects of the project on fish and wildlife resources at the sites.

2. Field stone, if used, will be acquired from agricultural or existing cleared lands and not from forested lands.

3. Silt curtains will be deployed as necessary to control turbidity.

4. No dredged material will be stockpiled in the marine environment.

5. On land spoil disposal will be conducted behind maintained berms above the influence of the tide, and only clean runoff water from the spoil disposal area will be allowed to reenter waterways.

6. No spoil will be placed in any watercourse or wetland.

7. All permanent spoil disposal areas will be stabilized with vegetative cover or other suitable means to prevent erosion.

8. Terrestrial vegetation at the project site will be restored and erodible embankments will be stabilized immediately following construction.

9. The Service will be notified of any proposed change in project design or construction methodology so that potential impacts to fish and wildlife resources can be evaluated.

We believe that with the incorporation of these conservation measures into the proposed project design, the proposed project will not result in significant impacts to any Federal trust resource under our jurisdiction. Therefore, the Service will support a Finding of No Significant Impact determination for the proposed project.

The Service appreciates the opportunity to comment. If you have questions regarding these comments, please contact Fish and Wildlife Biologist Christine Willis at 808/541-3441.

Sincerely,

Donald Palawski

FOR Brooks Harper
Field Supervisor
Ecological Services

cc: NMFS-PAO, Honolulu
USEPA-Region IX, San Francisco
DAR, Hawaii
CZMP, Hawaii
CWB, Hawaii

KIKALOA WESTSIDE BOAT CLUB
P.O. BOX 986
WAIMEA, HI 96796

AUGUST 19, 1997

TIM YOUNG (PROJ. MNGR)

PER YOUR REQUEST TO PROVIDE A WRITTEN RESPONSE TO THE VARIOUS HARBOR PLANS DISCUSSED IN OUR MAY 1997 MEETING AT KIKIAOLA SMALL BOAT HARBOR, THE FOLLOWING COMMENTS NOT ONLY REPRESENT FEEDBACK FROM THE CLUB MEMBERSHIP (APPROX 70), BUT ALSO INCLUDED OTHER HARBOR USERS, COMMERCIAL FISHERMEN / RECREATIONAL USERS / COMMERCIAL SIGHTSEEING TOUR BOATS.

OF ALL THE PLANS DISCUSSED, PLAN 1 WAS THE UNANIMOUS CHOICE FOR ANY FUTURE CHANGES OR IMPROVEMENTS AT KIKIAOLA SMALL BOAT HARBOR.

THE IMPORTANCE OF THIS SMALL BOAT HARBOR NEEDS TO BE STRESSED. KIKIAOLA SMALL BOAT HARBOR HAS MORE THEN FULFILLED ITS ORIGINAL PRIMARY PURPOSES, PROVIDING A PUBLIC RECREATIONAL BOATING FACILITY AND PROMOTING THE FISHING INDUSTRY.

IT HAS ALSO PROVIDED OUR ISLAND COMMUNITY, OCEAN ACCESS FOR THE MILITARY, COMMERCIAL AND PRIVATE SECTOR. EXAMPLES — FIRE DEPT. OCEAN RESCUE / VISITING SHIPS SHUTTLE CRAFT / MILITARY SHIPS SHUTTLE CRAFT (BARKING SANDS PMRF EXERCISES / DOCARE STATE MARINE ENFORCEMENT DEPT.

KIKIAOLA WESTSIDE
BOAT CLUB

KIKIALOA WESTSIDE BOAT CLUB
P.O. BOX 986
WAIMEA, HI 96796

EXAMPLES CONTINUED –

ISLAND ECONOMIC RESOURCES SHUTTLE LOCATION FOR FILM CREW SUPPORT VESSELS (LATEST MOVIE 6DAY 7NIGHT WITH HARRISON FORD)

KAUAI SCHOOLS SYSTEMS EDUCATIONAL OCEAN TOURS / ONE OF ONLY 2 LEGAL ISLAND ACCESS HARBORS FOR JET SKIS.

IF PLAN 1 IS INITIATED IT WOULD ENHANCE THE ORIGINAL PRIMARY GOAL OF KIKIAOLA SMALL BOAT HARBOR, BY MAKING IT A SAFER HARBOR FOR ALL ITS COMMUNITY USERS.

SINCERELY,

PHILIP J. FILL
K.W.B.C. PRES.
808-337-1995 H
639-8970 CEL.
P.O. BOX 807
KEKAHA, HI
96752

KIKIAOLA WESTSIDE
BOAT CLUB

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
GILBERT S. COLOMA-AGARAN

8 OCT 1997
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October 6, 1997

BOR-E 0285.98

Lt. Col. Ralph H. Graves
District Engineer
U.S. Army Engineer District Honolulu
Bldg. 230, Fort Shafter
Honolulu, Hawaii 96858-5440

Dear Lt. Col. Graves:

Subject: Navigation Improvements, Kikiaola Light Draft Harbor, Kekaha, Kauai

We have received several inquiries from the Kekaha Community regarding several environmental concerns of the subject project. We feel that several of these concerns merit consideration. Accordingly, we request that the following items be included in the scope of work and conditions of the project:

1. That no blasting be permitted in dredging the harbor entrance and turning basin.

2. That sand deposits located outside of the eastern portion of the existing breakwater, be removed and transported beyond the western portion of the existing breakwater, and be used as sand replenishment to the adjacent beaches. As a follow on separate action, the Boating Division will develop and implement a sand bypass program to remove sand from outside of the eastern portion of the existing breakwater, and transport this sand beyond the western portion of the existing breakwater, and replenish the adjacent beaches on an annual basis.

3. That the reef area affected by the proposed navigation improvements be surveyed and if live coral heads are discovered, that a coral transplant program be developed and implemented to identify, remove, stock pile and transplant affected live coral heads, similar to the program developed for Kawaihae SBH.

BOR-E 0285.98

Your efforts are greatly appreciated. Should you have any questions, please call Manuel Emiliano of our Boating Engineering Branch at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator

SIERRA CLUB
Kaua'i Group of the Hawai'i Chapter
Post Office Box 3412
Lihu'e, Kaua'i, Hawai'i 96766

District Engineer
U.S. Army Engineer District, Honolulu
Attn: CEPOD-ET-PP/T Young
Bldg. 230
Fort Shafter, HI 96858-5440

Dear Sir:

Re: Kikiaola Light Draft Harbor
Waimea, Kauai

On Aug. 3rd I wrote a letter to Manuel Emiliano of the DLNR regarding the Kikiaola Harbor. The letter and numerous post cards from others never reached their destination as the OEQC bulletin "The Environmental Notice" had an incorrect address. When I spoke to Mr. Emiliano about the matter he suggested that this time I should include a letter to you when I re-send the Aug. 3rd letter. I wrote:

The Kauai Group of The Sierra Club seeks to mitigate the impact on the reef and the surrounding coastal areas of the Kikiaola Harbor project. We object to the proposal as written and would like the following elements implemented.

1. The 4.5 acres of reef to be left undisturbed as the reef is a natural protector of the shoreline.

2. A sand bypass system be an integral part of the design to protect the adjacent beaches from further erosion caused by the present harbor. Sea walls have had to be constructed as a result which have caused greater destruction of the nearby beaches. A coastal sand bypass system is necessary to prevent sand sedimentation which would necessitate future dredging. Reliance upon external transporting of sand by truck is both impractical and ineffective. Funding

for maintenance - may not be available so the prohibitive cost of continual trucking is clearly not a viable option.

Please give these requests careful consideration

Thank you,

Judy Dalton
Conservation Co-Chair
Kauai Group, Sierra Club

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF

October 10, 1997

Planning and Operations Division

Ms. Judy Dalton, Conservation Co-Chair
Sierra Club
Kaua'i Group of the Hawai'i Chapter
Post Office Box 3412
Lihu'e, Kaua'i, Hawaii 96766

Dear Ms. Dalton:

Thank you for your comments on the General Reevaluation Report and Environmental Assessment for Navigation Improvements at the Kikiaola Light Draft Harbor. We share your concern for the potential environmental impacts from the proposed harbor improvements and have taken every available measure to address and mitigate these issues.

The proposed recommended plan follows specific planning criteria set forth by the Corps' Planning Guidance for civil works projects and is consistent with the national planning objective. The national planning objective, as defined by the "Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies" of the U.S. Water Resources Council, is to contribute to the national economic development (NED) consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements.

The recommended plan will follow the basic footprint of the existing harbor. Navigation improvements, which include the dredging of an entrance and access channel and berthing area, will impact approximately 4.5 acres of limestone, and sand and silt bottoms. Based on data obtained from previous subsurface investigations no blasting is anticipated during dredging operations.

As stated in the Fish and Wildlife Coordination Report, the proposed modifications should not have any significant, long-term, adverse impacts on fish and wildlife resources.

The degradation of nearshore water quality is largely due to sediment deposition from the adjacent agricultural ditch that empties into the harbor. Although these turbid waters do not support reef-building organisms, a relatively diverse and abundant benthic and intertidal marine fauna exists. To preclude potential impacts to offshore coral reefs in the vicinity, construction control measures such as movable silt curtains will be deployed during dredging operations to confine turbidity to the construction area. The deepening of the entrance and access channel may improve water circulation and clarity, which could result in colonization of new species thereby enhancing overall species diversity.

The potential impacts of our navigation improvements at Kikiaola Harbor on adjacent shoreline areas were considered during our plan formulation. A littoral drift study was conducted in August 1996 to determine the general characteristics of the offshore sediment transport. In addition, other previous reports were reviewed and evaluated to determine the best approach to mitigating the ongoing shoreline erosion. Shoreline erosion continues along the coastline west of the harbor and accretion along the eastern side since the construction of the original harbor in 1959. In recent years, the eastern shoreline seems to have stabilized and additional accretion may be bypassing this area and continuing along the predominant westerly drift.

Our evaluation of the study area suggests that sand bypassing may reduce coastal erosion along the western shoreline if sufficient sand is placed from the updrift side to the downdrift side of Kikiaola Harbor. Sand bypassing may also allow accretion to continue along the eastern shoreline thereby preventing appreciable sediment transport into the entrance and access channel and berthing area. Sand bypassing would be accomplished by removing material along the eastern shoreline above the high water mark and placing it along the western shoreline by dump truck and loader. Other mechanical means were considered such as utilization of pumps. However, due to the high initial investment of between $2.0 million to $5.0 million for planning, design and construction, the annual maintenance cost, aesthetic and noise impacts to the surrounding area and impacts to the marine environment, this idea was dropped from further consideration. The development and funding of a sand bypass program is currently being investigated and evaluated by the Corps of Engineers and the Department of Land and Natural

Resources, Boating and Ocean Recreation Division for potential implementation.

If there are any further questions regarding this project, please contact Mr. Tim Young of my Planning and Operations Division staff at (808) 438-7013.

Sincerely,

for Ray H. Jyo, P.E.
Director of Engineering
and Technical Services

Copy Furnished:

Admiral Gehring
Department of Land and Natural Resources
Division of Boating and Ocean Recreation
333 Queen Street, Suite 300
Honolulu, Hawaii 96813

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Science Center Honolulu Laboratory
2570 Dole St. • Honolulu, Hawaii 96822-2396
(808)943-1221 • Fax: (808)943-1290

December 18, 1997 F/SWC2
Kauai2:SGP

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Mr. Ray H. Jyo, P.E.
Director of Engineering & Technical Services
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

Our staff has reviewed the information on the Kekaha (Kikiola) project, and has provided the attached information and assessment of potential impacts on fishery populations from this project. This response represents the scientific assessment of the National Marine Fisheries Service, Honolulu Laboratory and should not be viewed as an endorsement of the project as a whole nor concurrence with any permitting or similar requirements.

Although commercial fishing boats operating out of Kekaha catch a significant number of deepwater bottomfish, our scientists believe that effective implementation of the State's proposed area closures will adequately protect those species. However, there may be a significant impact from this project on the localized catch rates (catch per day fishing) of these species that would affect the fishing experience. Impacts of the project on pelagic and other species are expected to be minimal.

Because the project is most likely to affect main Hawaiian Islands bottomfish, I recommend you also contact Mr. William Devick, Hawaii Division of Aquatic Resources, for their assessment of the situation. I have copied our response to him, as well as to Ms. Kitty Simonds, Executive Director of the Western Pacific Regional Fishery Management Council which is responsible for recommendations concerning Federal fisheries regulations in the Hawaii exclusive economic zone. Finally, I have copied our response to Dr. Charles Karnella of our Pacific Islands Area Office in Honolulu which is responsible for reviewing Environmental Impact Statements.

Please feel free to call us if you have any questions. Dr. Sam Pooley was responsible for compiling our response (808-943-1216).

Sincerely yours,

R. Michael Laurs

R. Michael Laurs
Director, Honolulu Laboratory

Attachment

cc: W. Devick
K. Simonds
C. Karnella

NMFS Honolulu Laboratory
2570 Dole Street
Honolulu, HI 96822
(808) 943-1216
FAX 932-1290

December 18, 1997

Fishery impacts of the Corps of Engineers Kekaha, Kauai harbors project

Kekaha is a small-boat harbor on the southwestern coast of the island of Kauai. We have compiled commercial catch reports data from the Hawaii Division of Aquatic Resources (HDAR). These reports are required of all fishermen who sell any of their fish, and they represent the most comprehensive data source on landings by small-boat fishermen in Hawaii.[1] The data from these reports provide the baseline information for our assessment of potential fishery impacts.

Hawaii commercial catch report data for the calendar year 1996 are compiled as might apply to the Corps of Engineers small boat harbor project at Kekaha on Kauai.

Data are summarized by:

- Kauai fishing "area", meaning the HDAR statistical fishing area codes around Kauai, Niihau, and Kaula
- Kauai boats (boats landing at Kauai ports).

The fishing statistical areas are illustrated on an attached map from HDAR.

Summaries were also prepared for Kekaha/Kikiola boats (port = 631), i.e., catch which was identified as landed at this port. This does not represent all of the activity by vessels which launch at Kekaha. Fishing vessels frequently take some of their trips from one port (e.g., Kekaha) and some of their trips from other ports.

The first table provides overall summaries of pounds caught, ex vessel revenue, number of boats reporting landings and number of trips for the 1996 calendar year.

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[1] There are limitations with these data, including under-reporting by commercially licensed fishermen, unlicensed commercial fishermen, and lack of coverage of recreational fishermen.

The **third table** provides Kauai area landings by home port.

The **fourth table** provides species landings (pounds caught): MHI (excluding longline and aku boats), Kauai area, and Kekaha boats.

The **fifth table** provides landings (pounds caught) by gear for the Kekaha boats.

> In some cases sub-totals do not add-up and totals do not add across tables because for some summaries longline and aku boats landings were not excluded. However their combined total of Kauai area landings was only 3,607 pounds (0.5% of the Kauai area total).

Based on the information contained in these tables, as well as the on-going investigations of our Fish Biology & Ecology Investigation and our Stock Assessment Investigation, the following is our Laboratory's assessment of the fishery population impacts which would be generated by doubling the fishing effort out of Kekaha (and maintaining the same level of fishing activity from other Kauai ports).

A. General impacts

1. Doubled, the Kekaha boats' landings would amount to only about 4% of the State's total commercial landings, but would amount to 27% of Kauai's commercial landings. None of the federally managed species are managed on the basis of local populations on one side of Kauai or even on the basis of separate populations on individual islands, although the latter may be hypothesized. If any population is currently overfished in waters around Kauai, then 27% of the landings would represent a substantial contribution to that overfishing.

2. If no local Kauai populations exist or are currently overfished, then it is not very likely that a localized increase in exploitation of 13.8% in fishing areas around Kauai could create a problem, or cause a detectable impact on catch rates.

B. Pelagic impacts (tunas, billfish, mahimahi, etc.)

1. I Kekaha boat landings doubled, this would still amount to only about 4% of the State's total commercial pelagic landings, and about 26% of Kauai's commercial landings. None of the pelagic species have biologically-distinct populations on one side of Kauai or separate populations on individual islands. The expected increase would have no impact on pelagic stocks. It is conceivable that a 20-fold or greater increase in trips by the Kekaha boats, resulting in a 40% or greater increase in the state's commercial pelagic fishing effort might have a perceivable negative effect on localized catch rates (catch per day fished), but it would not affect the biological productivity of the stocks (i.e. total catches by all vessels combined would not decline).

the biological productivity of the stocks (i.e. total catches by all vessels combined would not decline).

2. The biggest percentages of statewide commercial catches of pelagics by the Kekaha boats were around 5% for sailfish, ono, other pelagics (8%) and other tuna. A doubling to 10-16% of statewide harvest would not have a significant impact on the statewide catch rates for any of the pelagic species. It is conceivable but unlikely that the 20-30% increase in Kauai commercial harvests that might result for some species could have a negative effect on localized catch rates, for those species. Impacts would be more likely if the Kekaha boat increases were enough to double the Kauai catch of some species. Again, total catches would not decline because the productivity of the stocks would not be affected.

C. Impacts on Insular Species (bottomfish, reef fish, lobsters, etc.)

The greatest potential for impacts would be on the species where one might hypothesize localized populations in waters around separate islands such as for onaga and ehu (red snappers) where the Kekaha boat catch already represents more than half of the total commercial catch for Kauai. In these cases a twofold increase in fishing effort could be very significant if these species are overfished.

1. Biological Impact

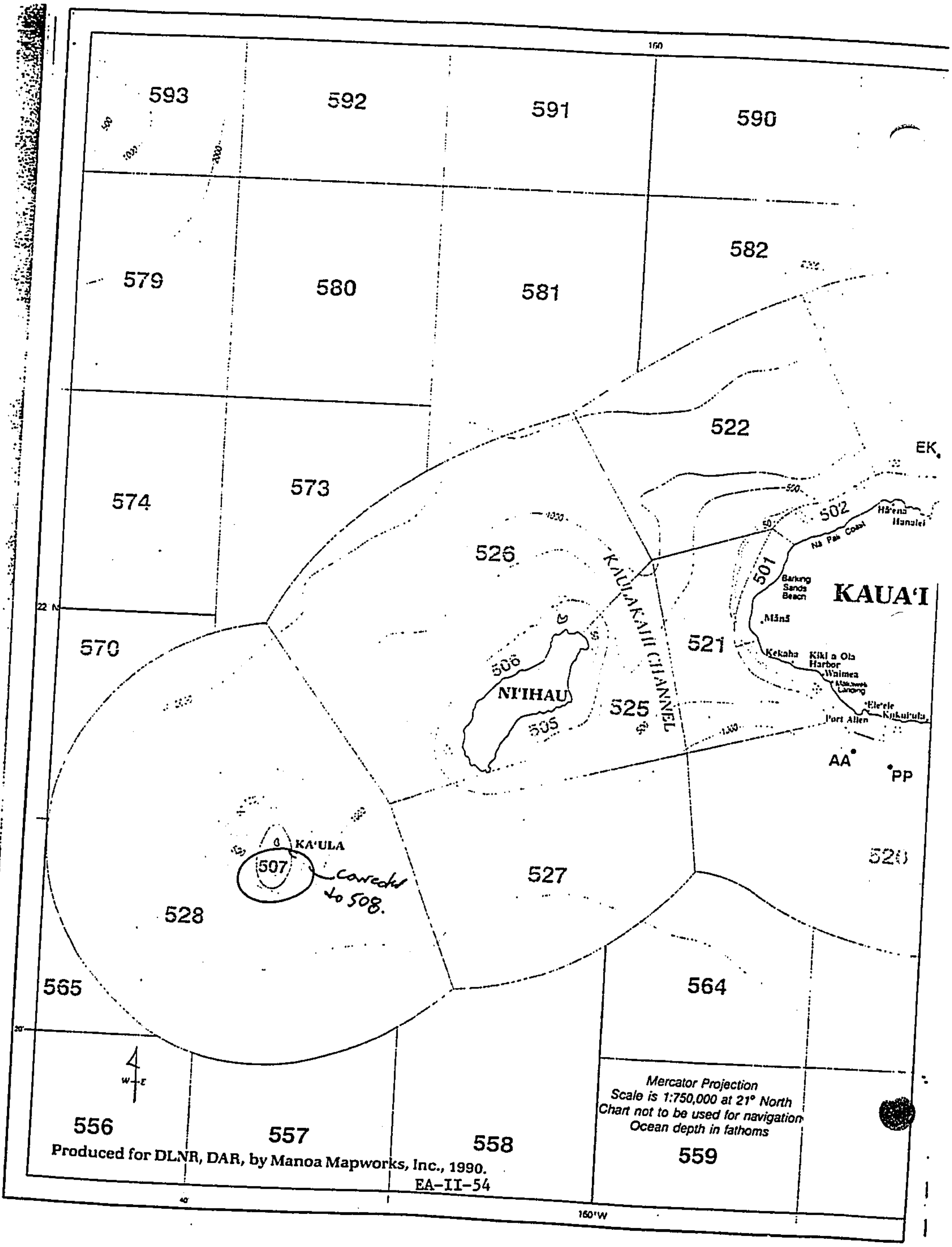
Of the bottomfish species (snappers, groupers, and jacks), onaga and ehu have been listed as recruitment overfished for the Main Hawaiian Islands, a condition that has existed for a number of years. These species are major components of the Kekaha/Kikiola bottomfish catch (24% and 18%, respectively). As such, any further fishing mortality placed on these species would be considered detrimental to the stock. The State of Hawaii, however, is in the final stages of establishing a bottomfish management plan which should be in place well before any change in vessel activity could be achieved after dredging the Kikiola Harbor. The plan centers around closing 20% of the habitat of onaga and ehu to fishing and thereby protecting 20% of the breeding population. With this plan in place, an increase in effort outside of the closed areas may slow population recovery but would not jeopardize the State's management actions to recover these stocks from recruitment overfishing.

2. Localized affects

Catch per unit effort (cpue), on the other hand, will be affected by both the State's management plan and any increased bottomfishing effort due to increased Kikiola vessel activity. With implementation of the State plan alone, Main Hawaiian Island fishermen should expect to experience a short-term 20% reduction in catch per unit effort since 20% of the exploitable population will be within the closed areas. If effort is not increased, longer-term cpue should improve as the spawning stock biomass increases within the closed areas. It is difficult to anticipate the change in cpue experienced by any one fisherman as it will depend on how much of his fishing has been conducted in areas that are closed and how much new effort is place on his fishing grounds by either increased fishing trips or by trips translocated to his area that were previously conducted in the now closed areas. Although, the actual locations of the closed areas are yet to be determined, those suggested for the Kauai/Niihau/Kaula Rock region are in blocks 502 and 504 which are not major bottomfishing zones. This being true, cpue reduction due to closed areas should not approach the 20% level for Kekaha/Kikiola vessels. On the other hand, Area 501 is a major onaga fishing area and with 79.3% of the catch (of all species) in this area taken by Kekaha/Kikiola boats. A doubling of effort on this local scale would, certainly, significantly lower cpue levels for those vessels involved and a 20% reduction would not be an unreasonable result.

Attachments
- HDAR Kauai map
- Tables

Hawaii Division of Aquatic Resources charts of fishing areas



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Scale is 1:750,000 at 21° North
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Ocean depth in fathoms
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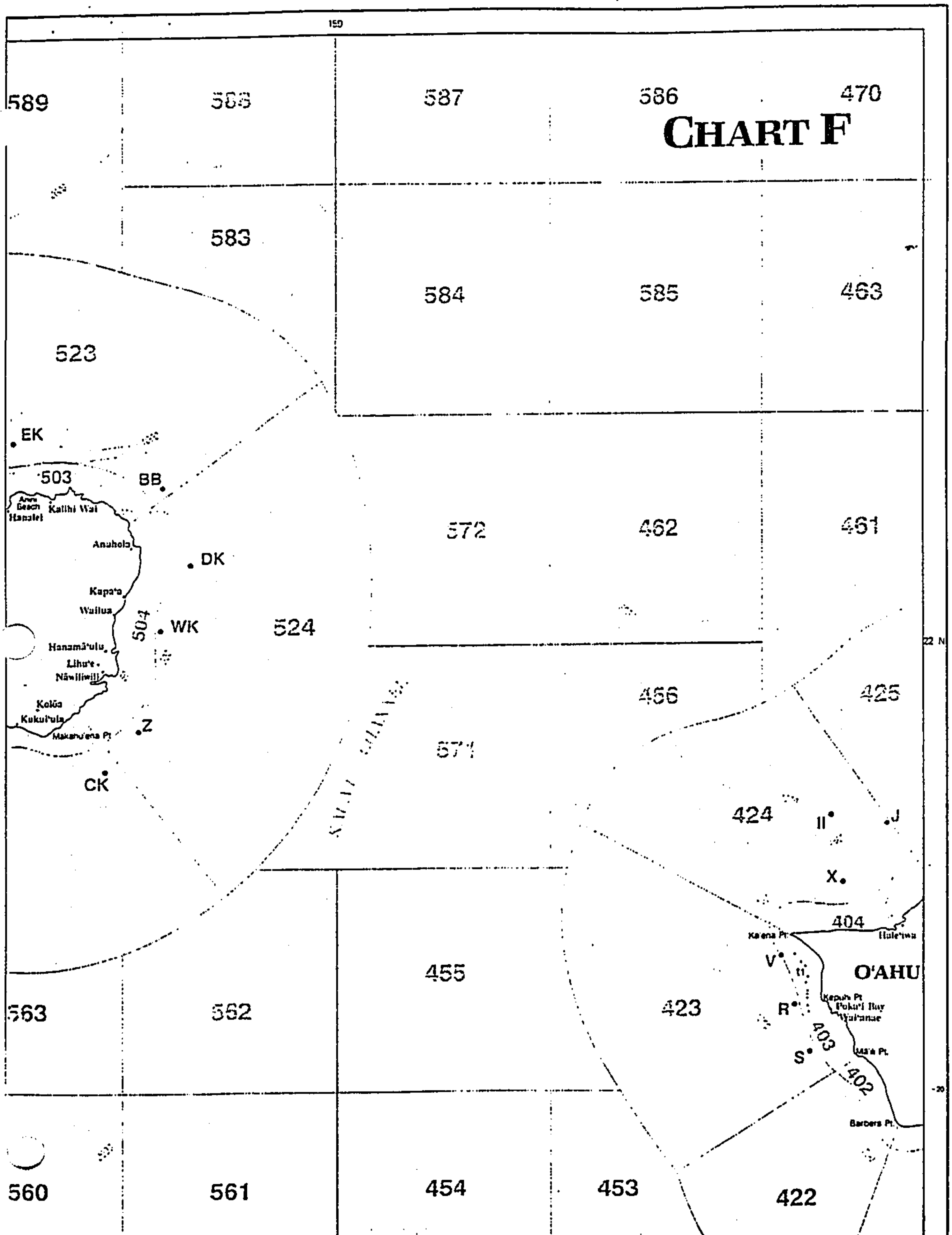
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Kauai fishery analysis, 1996 Hawaii commercial catch report data

Table 1: **Overall summaries of landings from Kauai fishing areas and by Kauai fishing boats.**

	Pounds Caught	Revenue	Boats	Trips
All Statewide boats -- Kauai fishing areas	1,011,993	2,042,588	323	7,141
Niihau-Kaula fishing areas	192,391	461,487	61	514
Statewide fishing areas -- Kauai boats[1]	854,746	1,806,796	305	7,101
Kekaha/ Kikiola boats (Port #631)	134,824	297,529	67	900
			Percent total Kauai fishing area pounds	
Kauai area by Kauai boats	830,745	1,750,500	82.1%	
Kauai area by Kekaha/Kikiola boats	134,824	297,529	13.3%	
Kauai area by non-Kauai boats	181,248	292,087	17.9%	
Non-Kauai area by Kauai boats	24,001	56,296	12.5%	
Non-Kauai area by Kekaha/Kikiola boats	0	0		

Data: HDARMAIN.dbf (9/15/97 date)

\kau2.tab

1 "Boats" are defined as any HDAR license holder reporting landings in a particular port.

Kauai fishery analysis, 1996 Hawaii commercial catch report data

Table 1: **Overall summaries of landings from Kauai fishing areas and by Kauai fishing boats.**

	Pounds Caught	Revenue	Boats	Trips
All Statewide boats -- Kauai fishing areas	1,011,993	2,042,588	323	7,141
Niihau-Kaula fishing areas	192,391	461,487	61	514
Statewide fishing areas -- Kauai boats[1]	854,746	1,806,796	305	7,101
Kekaha/ Kikiola boats (Port #631)	134,824	297,529	67	900

			Percent total Kauai fishing area pounds
Kauai area by Kauai boats	830,745	1,750,500	82.1%
Kauai area by Kekaha/Kikiola boats	134,824	297,529	13.3%
Kauai area by non-Kauai boats	181,248	292,087	17.9%
Non-Kauai area by Kauai boats	24,001	56,296	12.5%
Non-Kauai area by Kekaha/Kikiola boats	0	0	

Data: HDARMAIN.dbf (9/15/97 date)

\kau2.tab

1 "Boats" are defined as any HDAR license holder reporting landings in a particular port.

Table 2: Kekaha/Kikiola boats (license holders recording landings at Port #631 in 1996)

Fishing Area	Pounds Caught	Revenue	Boats	Trips
Total	134,824	297,529	67	900
501	10,167	15,579	21	125
508[2]	15,974	38,198	5	56
520	25,083	55,916	25	159
521	28,300	48,069	28	272
All Other[3]	55,300	139,767	nes	288

[2] Area 508 does not appear on the attached map: it is the same as area 507 on the map, i.e., the area around Kaula.

[3] Some areas are not specified individually because the number of license-holders (boats) landing from that area was too small under confidentiality criteria.

Table 3: Kauai area landings by home port

	Pounds Caught All Boats[4]	Pounds Caught Kekaha/ Kikiola Boats	Pounds Caught Non-Kekaha/ Kikiola Boats	Percent Total Kauai Area Pounds by Kekaha/ Kikiola boats
Total Kauai Area	1,011,993	134,824	877,169	13.3%
501	12,822	10,167	2,655	79.3%
508	44,907	15,974	28,933	35.6%
520	276,375	25,083	251,292	9.1%
521	33,959	28,300	5,659	83.3%
528	52,683	23,257	29,426	44.1%
All Other	591,247	32,043	559,204	5.4%

4 "All Boats" meaning license holders reporting landings at <u>any</u> Hawaii port.

Table 4: Species landings[5]

SPECIES	Total MHI Pounds Caught	Kauai Area Pounds Caught (boats from all islands)	Kekaha/ Kikiola boats – Pounds Caught	Percent Kekaha/ Kikiola boat landings of Total MHI Pounds	Percent Kekaha/ Kikiola boats of Kauai Pounds
Pelagics: marlins, tunas, other pelagics					
striped marlin	106,475	13,748	750	0.7%	5.5%
blue marlin	821,989	59,103	4,684	0.6%	7.9%
broadbill (swordfish)	11,227	434	57	0.5%	13.1%
sailfish	1,323	203	65	4.9%	32.0%
other billfish	33,996	1,604		0.0%	0.0%
mahimahi	452,378	45,886	4,753	1.1%	10.4%
ono (wahoo)	326,839	71,960	17,028	5.2%	23.7%
other pelagics	7,783	3,810	635	8.2%	16.7%
aku (skipjack tuna)	468,089	59,416	13,852	3.0%	23.3%
yellowfin tuna	1,858,046	432,087	47,902	2.6%	11.1%
bigeye tuna	14,551	495	161	1.1%	32.5%
albacore	388,594	4,911	79	0.0%	1.6%
other tuna	10,510	4,701	544	5.2%	11.6%
Total Pelagics	**4,501,800**	**698,358**	**90,510**	**2.0%**	**13.0%**

-- continued on following page --

5 MHI fishing statistical areas. Excludes longline and aku boat landings.

SPECIES	Total MHI Pounds Caught	Kauai Area Pounds Caught (boats from all islands)	Kekaha/ Kikiola boats – Pounds Caught	Percent Kekaha/ Kikiola boat landings of Total MHI Pounds	Percent Kekaha/ Kikiola boats of Kauai Pounds
— continued from previous page —					
Bottomfish: snappers, groupers, jacks					
opakapaka	137,456	4,415	944	0.7%	21.4%
onaga	65,995	6,735	4,776	7.2%	70.9%
ehu	27,697	6,395	3,625	13.1%	56.7%
hapuupuu	10,836	2,874	905	8.4%	31.5%
butaguchi	3,066	1,678	155	5.1%	9.2%
uku	51,708	10,296	4,265	8.2%	41.4%
ulua	4,845	1,754	78	1.6%	4.4%
other bmus	76,659	9,165	2,534	3.3%	27.6%
other bottomfish	43,021	15,795	2,455	5.7%	15.5%
Total Bottomfish	**421,283**	**59,107**	**19,737**	**4.7%**	**33.4%**
Other species					
other crustaceans	26,141	4,775	2,050	7.8%	42.9%
tako (octopus)	19,258	68	37	0.2%	54.4%
squid	4,261	2,627	110	2.6%	4.2%
akule	395,257	179,600	8,852	2.2%	4.9%
opelu	380,533	12,032	9,944	2.6%	82.6%
all other	300,218	20,630	3,584	1.2%	17.4%
Total Other	**1,125,668**	**219,732**	**24,577**	**2.2%**	**11.2%**
Total All Species	**6,048,751**	**977,197**	**134,824**	**2.2%**	**13.8%**

Table 5: Kekaha/ Kikiola landings by gear

Port	GEAR	Boats	POUNDS
631	3 Bottom handline	23	18,254
631	4 Inshore handline	30	19,991
631	6 Trolling	55	76,813
631	8 Ikashibi (tuna handline)	4	1,301
631	9 Paluahi (tuna handline)	5	2,329
631	35 Pelagic handline	12	9,816
631	40 Kona crab net	9	1,948
631	All Other	nes	4,372
631	Total	67	134,824

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.1 ECONOMIC ANALYSIS

APPENDIX A

Navigation Improvements at Kikiaola Harbor
General Reevaluation Report and Environmental Assessment
Appendix A - Economic Analysis

1. Background.

The purpose of this economic analysis is to reevaluate the benefits attributable to improving the conditions at the Kikiaola small boat harbor. The original general design memorandum and final environmental impact statement were completed in September 1980. In that report, five plans were evaluated and an NED alternative selected. Since that time, conditions at the harbor have changed and so have the policies regarding benefit calculations. This reevaluation measures the impact of the five original plans as well as a new sixth alternative on present harbor users. It is conducted in accordance with current Corps regulations as presented in the "Planning Guidance Notebook" ER 1105-2-100.

2. Benefit Calculations.

2.1. General.

This economic analysis measures the benefits from enhanced commercial and recreational boating opportunities provided by an improved small boat harbor at Kikiaola. These benefits are measured by comparing harbor use under without- and with-project conditions. Increases in harbor use, reductions in user operating costs, and decreases in boat damages attributable to the proposed plan can be counted as benefits. Benefits and costs are measured at an October 1997 price level and annualized over the 50-year project life using a prescribed discount rate. That discount rate is currently at 7-3/8 percent.

The benefit calculations are based on information gathered through interviews and surveys of boaters interested in Kikiaola harbor. Interviews were conducted with the four commercial passenger tour companies with permits to operate out of Kikiaola to gain some insight into their current practices. They were also asked to estimate the impacts that modifying Kikiaola harbor might have on their operations. Similar interviews were conducted with some of the boaters on past and current waiting lists for mooring spots in the harbor.

In addition to the interviews, a survey was sent out to over 800 registered boaters on Kauai to help identify other users of Kikiaola harbor and their frequency of use. Responses were received from 149 boaters. Table 1 lists the respondents, their vessel sizes, and the annual number of trips they currently take out of Kikiaola harbor and plan to take once the improvements are in place.

TABLE 1.
KIKIAOLA HARBOR USER SURVEY RESULTS
VESSEL CHARACTERISTICS AND NUMBER OF TRIPS

	Vessel Characteristics				Number of Trips	
Survey Number	Length (feet)	Draft (feet)	Beam (feet)	Age (years)	Without Project	With Project
1	28.5	4.5	10	8	37	37
2	20	1.5	7	13	127	120
3	12.5	0.5	5	5	43	49
4	17	1	6	20	30	54
5	19		7.5		52	52
6	26	3	9	9	240	240
7	14	2	6	14	0	2
8	18	3	6	12	0	4
9	26		10	20	30	
10	29	3	9	20	0	96
11	26	4.25	8.5	13	48	48
12	14	1	4.5	1	26	26
13	20	3	8	3	48	
14	31	4	9	10	0	120
15	19	3	7	10	3	3
16	16	1.5	5	3	9	12
17	20	2	5.6	2	60	
18	18	3	6	22		
19	12			3	18	22
20	20	2	8	15	5	20
21	25		10	10	0	6
22	25	2.5	8	15	24	180
23	25	3	8	15	3	24
24	16.5	3	6	25	17	17
25	17	0.67	6	16	64	64
26	22	1.5	8	10	7	
27	21	1.5	8	14	10	42
28	27	3.5		20	23	
29	13	6	2	10	0	6
30	22		6	15	63	69
31	17	2	5	21	0	5
32	24	2	8	12	175	175
33	19	2	8	10	21	21
34	13	1.25	4.7	5	0	30
35	14	1	5	2	25	32

TABLE 1.
KIKIAOLA HARBOR USER SURVEY RESULTS
VESSEL CHARACTERISTICS AND NUMBER OF TRIPS
(Cont.)

	Vessel Characteristics				Number of Trips	
Survey Number	Length (feet)	Draft (feet)	Beam (feet)	Age (years)	Without Project	With Project
36	21.6	3	6		8	
37	18	3	7.9	4	4	126
38	17		5	26	8	14
39						
40	16	3	4	4		
41	17	2	6	7	0	24
42	12	2	6	2	30	30
43	10	2	4	15	0	11
44	12	3	5	10	24	
45	15	2	5	5	0	60
46	14	2.5	4	10	25	48
47	18.5	1	8	16	84	120
48	12	5	8		33	49
49	18.5	1.8	8.5	3	2	
50	18	2	6	6	26	36
51	11	1	5	6	26	
52	16		7.5	4.5		
53	16	0.5	8	2	68	104
54	20	2	6	12	36	36
55	25	2	9	1	36	36
56	17	2	6	25	72	72
57	45	2	10			
58	25	3	8	14	40	60
59	17.5	10	6.67	1	13	16
60	18	3	6	2	12	12
61	19	2	8	5	0	10
62	15	1	6	5	0	24
63	20	3.5	7.83	13	60	
64	12	1	4	1	48	48
65	21	1.5	8	1	48	48
66	17	2.5	7	20	72	72
67	18	2	6	5	53	48
68	21	4.5	8	13	44	
69	25	3	8	10		
70	19.6	3	8	12		

TABLE 1.
KIKIAOLA HARBOR USER SURVEY RESULTS
VESSEL CHARACTERISTICS AND NUMBER OF TRIPS
(Cont.)

	Vessel Characteristics				Number of Trips	
Survey Number	Length (feet)	Draft (feet)	Beam (feet)	Age (years)	Without Project	With Project
71	19	2	6	19	48	
72	13.5				40	96
73	12	1	4	7	11	29
74	25	6	8		0	24
75	23.5	3	8	26	1	60
76	14	0.83	6	1		
77	13	1	5	3		
78	22	2	8	4	6	33
79	25	2	9	20	5	48
80	19	1	7	15	96	96
81	16	1	6	15	79	65
82	21	2.5	8	6	48	54
83	12	0.5	5	7		
84	20	4	8	10	24	
85	19	3	7			
86	14		6	12	46	60
87	25	3.5	8	2	25	48
88	25		3	15	36	57
89	24	3	8	15		
90	18				60	120
91	27	5	9	20	0	10
92	31	3	9	1	120	120
93	12	2		4		
94	17	3	2.17	5	140	120
95	24	2	8	20	0	23
96	28	3	9	2	0	20
97	19	2	6	9	18	
98	13	2	6	25	0	6
99	24	2	8	10	1	
100	22.67	2.17	8.75	7	0	71
101	22	2	8.5	4	52	80
102	31	3	9	5		
103	24	3.5	9	15	0	48
104	20	1.5	6	21	0	12
105	13	0.5	5.42	19	25	28

TABLE 1.
KIKIAOLA HARBOR USER SURVEY RESULTS
VESSEL CHARACTERISTICS AND NUMBER OF TRIPS
(Cont.)

	Vessel Characteristics				Number of Trips	
Survey Number	Length (feet)	Draft (feet)	Beam (feet)	Age (years)	Without Project	With Project
106	19.5	2.5	7	10	72	
107	27	5	8	6		
108	11.5	1	5	4	48	48
109	19.17	4		24	21	120
110	28	4	9	14	36	36
111	15	2	5	4	36	36
112	12.5				61	
113	24	3	8	20	35	72
114	16.67	0.5	4	18	20	
115	20	4	9.5	2	6	
116	13.67	1.5	4.5	18	28	
117	17			12	0	2
118	22	3.5	8	23	76	144
119	19	4	7	15	236	240
120	26	4	8	18	166	166
121	19	3	18	1	137	159
122	38	5.5	13	15	0	312
123	22	2	5	12	39	39
124	18	2.5	7	20	34	60
125	19	2	8	10	72	72
126	16	1	6	7	32	28
127	24	3	8	15	17	17
128	17.5	2		22	30	28
129	18	1.5				
130	16	1	6	14	0	14
131	14	2	5	14	60	
132	14	1	6	10	24	24
133	25	3	8	18	24	
134	28	3.67	9	14	240	275
135	23	2	8	16	42	
136	20	3	7	14	52	
137	27	2	10	8	0	19
138	24	3	9	15	120	120
139	21	3	8	15	0	215
140	27	2	10	6	0	0

TABLE 1.
KIKIAOLA HARBOR USER SURVEY RESULTS
VESSEL CHARACTERISTICS AND NUMBER OF TRIPS
(Cont.)

	Vessel Characteristics				Number of Trips	
Survey Number	Length (feet)	Draft (feet)	Beam (feet)	Age (years)	Without Project	With Project
141	21	1.5	8	10	0	
142	16	1.5	5	25		
143	25	3	9	12	0	48
144	30	3	9.83	6	96	48
145	14	1	6	15	3	
146	17	3	6	10	0	48
147	22	2	7	20	72	
148	27	3	9.5	8	144	144
149	30	2	12	20	12	

In addition to the types of vessels and the number of trips, the survey also asked about the purpose of the trips taken from Kikiaola harbor. The majority of respondents listed commercial fishing, sport fishing, subsistence fishing, or recreation as their main reasons for launching from Kikiaola harbor. Table 2 displays the trip purposes for individual respondents. An "X" in a particular category indicates that the vessel is launched from Kikiaola harbor for that purpose.

TABLE 2.
KIKIAOLA HARBOR USER SURVEY RESULTS
TRIP PURPOSE

	Trip Purpose				
Survey Number	Commercial Fishing	Sport Fishing	Subsistence Fishing	Recreation	Other
1	X				
2	X				
3		X			
4			X		
5			X		
6	X				
7	X				
8		X			
9		X			

TABLE 2.
KIKIAOLA HARBOR USER SURVEY RESULTS
TRIP PURPOSE

	Trip Purpose				
Survey Number	Commercial Fishing	Sport Fishing	Subsistence Fishing	Recreation	Other
10			X		
11	X				
12		X			
13	X				
14	X				
15				X	
16			X		
17		X			
18					
19		X			
20		X			
21		X	X		
22	X				
23		X	X		
24			X		
25					X
26					
27	X	X	X	X	
28			X		
29				X	
30	X				
31	X		X		
32	X				
33		X			
34					
35		X		X	
36					
37	X				
38					
39				X	
40		X		X	
41				X	
42		X	X	X	
43			X		
44				X	
45		X	X	X	
46		X			
47	X			X	

TABLE 2.
KIKIAOLA HARBOR USER SURVEY RESULTS
TRIP PURPOSE

	Trip Purpose				
Survey Number	Commercial Fishing	Sport Fishing	Subsistence Fishing	Recreation	Other
48		X			
49					
50	X		X		
51		X			
52					
53		X			
54				X	
55	X				
56			X		
57					
58	X				
59	X	X	X		
60		X			
61	X		X	X	
52	X	X	X	X	X
63	X			X	
64		X			
65		X		X	
66		X			
67		X			
68			X		
69					
70					
71		X			
72		X			
73			X		
74		X			
75		X		X	
76					
77					
78	X				
79	X			X	
80		X			
81		X		X	
82	X				
83		X	X		
84	X		X		
85					

TABLE 2.
KIKIAOLA HARBOR USER SURVEY RESULTS
TRIP PURPOSE

Survey Number	Trip Purpose				
	Commercial Fishing	Sport Fishing	Subsistence Fishing	Recreation	Other
86			X		
87	X				
88	X				
89					
90		X		X	
91	X				
92	X				
93					
94			X		
95				X	
96	X				
97		X			
98		X			
99	X			X	
100	X				
101	X	X	X		
102	X				
103	X				
104		X			
105			X		
106	X	X			
107					
108			X		
109		X			
110	X				
111				X	
112		X			
113	X	X	X		
114		X			
115	X				
116		X			
117					X
118	X				
119	X				
120	X				
121	X		X		
122					X
123					X

TABLE 2.
KIKIAOLA HARBOR USER SURVEY RESULTS
TRIP PURPOSE

	Trip Purpose				
Survey Number	Commercial Fishing	Sport Fishing	Subsistence Fishing	Recreation	Other
124		X			
125		X	X	X	
126	X			X	
127		X			
128		X		X	
129					
130				X	
131		X			
132		X			
133		X			
134	X				
135		X		X	
136			X		
137			X		
138	X				
139	X		X		
140					
141					
142		X		X	
143	X		X		
144		X		X	
145			X		
146			X		
147	X	X	X	X	
148	X		X		
149	X		X		

2.2. Without-project Conditions.

Currently, boaters launching at Kikiaola must contend with the shallow depths in the entrance channel and harbor basin. The inadequate depths produce steep swells and breaking waves in the entrance channel several times a year. This makes it extremely hazardous for boaters trying to enter or exit the harbor. It is not unusual for boaters to cancel their trips during these periods of high surf. Waves breaking over the east breakwater exacerbate the agitation in the harbor and cause surge problems in the berthing area as well. Many frequent users of the harbor have sustained damages to their boats because of the surge and shallow depth. The shallow depth is also responsible for the underutilization of the harbor basin. There are only six mooring spots in the berthing area occupied by three commercial vessels and three recreational craft. Many of the boaters launching from Kikiaola harbor trailer their vessels to and from the facility. These conditions at Kikiaola harbor are not expected to change substantially during the study period and are taken as the without-project conditions.

There were five applicants on the waiting list for mooring spots in Kikiaola harbor as of April 1997. Of the five, three intend to run commercial passenger operations from their mooring spots. The number of applicants on the waiting list is not expected to change significantly over the study period under without-project conditions.

2.3. With-project Conditions.

Deepening the entrance and access channels and modifying the breakwaters will alleviate the navigation hazards that now plague Kikiaola harbor. Under with-project conditions, waves will no longer break in the entrance channel. There will be fewer instances of severe surge in the harbor basin or waves overtopping the breakwater. The planned modifications will greatly enhance Kikiaola's appeal as a launching facility for both commercial and recreational vessels.

In addition to Corps modifications, the state is also planning to dredge other areas of the harbor and develop slips for vessels of various sizes. Despite the short waiting list, it is anticipated that the slips will be filled by a combination of commercial operators and recreational boaters.

The current number of applicants on the waiting list is not indicative of this facility's popularity as a launch site. Kikiaola is the closest harbor to the productive fishing grounds found along Kauai's western coast and the nearby island of Niihau. Kikiaola is also the closest harbor to Kauai's Na Pali coast which is a major visitor attraction. The number of applicants has diminished over time because no improvements to the harbor have been made recently. Many boaters are no longer willing to pay the yearly waiting list fee. Employees of the Department of Land and Natural Resources maintain the waiting list for mooring spots in Kikiaola harbor. They expect the applications for mooring spots to dramatically increase once improvements to the harbor begin. They are confident that there will be at least 100 applicants on the waiting list for slips in an improved Kikiaola harbor.

The following sections discuss the benefits generated by an improved Kikiaola harbor.

2.4. Ongoing Commercial Operations.

Several ongoing commercial passenger operations would benefit from improvements to Kikiaola harbor. The vessels for these operations are moored in the harbor or moored somewhere else along the coast. By providing better facilities an improved harbor will increase the efficiency of these tour operators and their net revenues.

The benefits for these improvements are derived from interviews with the commercial tour operators done in 1995 and updated in 1997. In 1995, these operators normally conducted one or two tours a day, five to seven days a week, depending on the weather and season. They had one or two boats each ranging between 22 and 55 feet in length. Passengers were charged between $65 and $110 for tours that lasted from two and a half to six hours. Between six and 49 passengers went out each tour on average and operating costs ranged from about $200 to $1,200 per tour. The effects on these commercial passenger tour businesses of improving Kikiaola harbor are based on these figures.

2.4.1. Increased Net Revenue Benefits.

The harbor's inadequate facilities make it difficult or impossible to conduct tours several times a year. Operators report canceling tours between five and 21 days annually due to the unstable conditions in the harbor. The total revenue lost each year is computed by, first, multiplying the average number of passengers per tour by the fee charged per passenger. The result is a revenue figure per tour. The operating cost per tour is subtracted from the revenue to get the net revenue per tour. This is multiplied by the number of canceled tours to get the total lost net revenue per boat per year. This is done for all the affected boats and the results are summed. The total lost net revenue caused by current conditions at Kikiaola equals about $47,000 at a 1997 price level during a typical year. Under without-project conditions, this situation is expected to continue with the unsafe conditions at Kikiaola interfering with tour boat operations.

The proposed modifications will improve the conditions under which commercial boaters operate. Waves will no longer break in the entrance channel and the surge in the harbor will diminish. The hazards of taking on and discharging passengers in the berthing area will be greatly reduced. It is estimated that 90 percent of the trips canceled under without-project conditions will not need to be canceled under with-project conditions. The net revenue generated by commercial passenger operations will then increase by $47,000 x 0.9 = $42,300.

The mooring fee for a slip in Kikiaola will also increase after the modifications are completed. The state now charges $2.00 per foot length per month in fees for a mooring spot for a commercial craft. The fee for a slip is $5.60 per foot length per month. These fees have not changed for several years and are assumed to be constant for this study. It is also assumed that the currently moored commercial vessel at Kikiaola will get a slip in the improved facility and pay higher mooring fees. The commercial vessel moored at Kikiaola is 38 feet long. The mooring fees will increase from 38 feet x $2.00 per foot per month x 12 months = $912 a year to 38 feet x $5.60 per foot per month x 12 months = $2,554 a year. The annual increase in mooring fees is $2,554 - $912 = $1,642 at a 1997 price level.

The increase in mooring fees is subtracted from the increase in net revenue to get the benefit attributable to the project. In this case, the benefit for increased net revenue is $42,300 - $1,642 = $40,658 or about $41,000.

2.4.2. Increased Efficiency Benefits.

Another tour operator interested in moving into Kikiaola currently moors a 55-foot catamaran at Kukuiula harbor which is along Kauai's southern coast. Everyday between May and October the catamaran launches from Kukuiula and heads west approximately six ocean miles to Port Allen to pick up passengers. Once the passengers are on board, the boat continues west past Kikiaola harbor to the Na Pali coast. At the end of the day, passengers are brought back to Port Allen and the catamaran returns to Kukuiula. *This operator will improve the overall efficiency of his commercial passenger* operation by launching out of Kikiaola harbor.

Traveling the distance between Kukuiula harbor and Port Allen adds about $100 a day to the operating cost of the catamaran. During the 20-week Na Pali coast tour season, the catamaran makes the trip from Kukuiula harbor to Port Allen everyday. The cost of making those trips is 20 weeks x 7 days per week x $100 per day = $14,000. This cost will be avoided by moving the catamaran to Kikiaola once the conditions in the harbor are corrected. This $14,000 in savings can be counted as a benefit of the project.

The cost associated with the segment of the Na Pali coast tours between Port Allen and Kikiaola harbor can also be avoided once the harbor modifications are completed. Traveling the distance between Port Allen and Kikiaola harbor adds about $200 per trip to the operating cost of the catamaran. Launching the catamaran from Kikiaola will reduce the cost of each trip by reducing the distance of each trip. The operator will be able to eliminate traveling between Port Allen and Kikiaola harbor which are approximately 10 ocean miles apart. Avoiding that part of the tour will eliminate $200 in operating costs per trip. The operator currently takes about 200 trips to the Na Pali coast during the 20 weeks between May and October. The savings in operating cost generated by launching from Kikiaola is 200 trips x $200 per trip = $40,000 a year.

In addition to lowering the operating costs of each trip, launching out of Kikiaola harbor will reduce the time it takes to complete each trip. At present, the Na Pali coast tours take five and a half hours from start to finish. The tour operator conducts these tours seven days a week between May and October. In May, September, and October there is only enough daylight to conduct one tour a day. In June, July, and August there is enough daylight to conduct two tours a day. The operator conducts afternoon tours in addition to the regular morning tours five days a week during those months. Having to pick up and discharge passengers from Port Allen instead of Kikiaola harbor adds about 20 miles and between 30 and 60 minutes to each trip. The tour operator will be able to run tours that last between four and a half and five hours launching out of Kikiaola. This will give the operator enough time to run two tours a day during the entire 20-week period.

The tour operator is confident that there is sufficient demand to have 40 passengers on those second tours during May, September, and October. At $95 per person, the increased revenue is 40 passengers x $95 per passenger = $3,800 per tour. The operating cost per tour launching out of Kikiaola will be $1,100 - $200 = $900. The total net revenue is then $3,800 - $900 = $2,900 per tour. By conducting a second tour five days a week during the months of May, September, and October in addition to the tours currently offered in June, July, and August, there will be an additional 8 weeks x 5 trips per week = 40 trips every year. The increase in net revenue from the additional trips is then 40 additional trips x $2,900 per trip = $116,000.

The catamaran does not currently operate out of Kikiaola harbor for several reasons. The harbor's shallow depth, which restricts the number of available mooring spots, and hazardous conditions during periods of high surf prevent the catamaran from using Kikiaola. Mooring at Kukuiula and picking up and discharging passengers at Port Allen is clearly a second best alternative. The improved Kikiaola harbor will have adequate depth and provide enough protection to make it a safe launching facility.

Along with increased revenues, the operator moving into Kikiaola will experience mooring fee increases as well. The state charges the catamaran operator $2.00 per foot per month to moor in its present location. The yearly fee for the 55-foot vessel is 55 feet x $2.00 per foot x 12 months = $1,320. The mooring fee will be $5.60 per foot length for a slip at Kikiaola harbor. The associated yearly fee is 55 feet x $5.60 per foot x 12 months = $3,696. The mooring fees paid to the state by the operator will increase by $3,696 - $1,320 = $2,376 annually in 1997 dollars.

The benefits generated by improving Kikiaola harbor is the reduction in operating costs and the increase in net revenues attributable to the improvements less the increases in mooring costs. In this case the benefits equal $14,000 + $40,000 + $116,000 - $2,376 = $167,624 or about $168,000.

2.5. Future Commercial Passenger Operations.

Correcting the conditions at Kikiaola harbor would not only improve the efficiency of present tour operations, it would also encourage others to enter the market. There are two boaters that have indicated a desire to start commercial passenger operations at Kikiaola. They are either on the current waiting list for mooring spots in the harbor or have been on past waiting lists.

The obstacle for these prospective tour operators is the lack of mooring spots in the harbor. An improved Kikiaola harbor will have more mooring spots and will be able to accommodate additional tour businesses. The two future operators have indicated they will conduct Na Pali coast tours once they get mooring spots. These tours will be conducted in a 24-foot boat and a 30-foot boat. Tours will be offered once a day, six days a week, by one operator and once a day, everyday, by the other operator. They plan to offer tours all year around like the tour operator that launches out of Kikiaola now. They are expecting to carry six passengers and 16 passengers per trip respectively. Tours will take between four and five hours to complete. Together they will take about 7,000 passengers to the Na Pali coast every year.

The benefits for new commercial vessels are calculated by measuring the value of the activity they provide to the users. In this case, the users are the passengers going on the Na Pali coast tours. The benefits are calculated using techniques to value recreational activities and are considered recreational benefits.

The Corps has three methods of calculating recreational benefits. This study utilizes the Unit Day Value (UDV) method. The UDV method assigns a value to the recreational experience of the user based on a point system. Points are assigned to the activity and to the various characteristics of the facility and totaled. The Kikiaola small boat harbor has been assigned the following points:

(a) Recreational Experience (0-30) - 23 points. Tours to the Na Pali coast offer a unique outdoor experience that is often the highlight for visitors staying on Kauai. There are also opportunities for whale watching and snorkeling during these tours.

(b) Availability of Opportunity (0-18) - 3 points. Tours can be run out of Port Allen which is about 10 road miles east of Kikiaola. Other tours are launched out of Hanalei along the northern coast of Kauai. It takes about an hour by car to reach the Hanalei site from Kikiaola.

(c) Carrying Capacity (0-24) - 8 points. The improved harbor will provide the necessary facilities for operators to conduct their tours.

(d) Accessibility (0-18) - 10 points. There is fair access to the harbor and fair access within the harbor.

(e) Environmental (0-20) - 6 points. The improved harbor will not exceed the limits of the existing harbor. There will be relatively minor additional impacts on the surrounding environment after the improvements are completed.

Total Points: 23 + 3 + 8 + 10 + 6 = 50.

According to Corps guidance EGM 97-3, there are general hunting and fishing and recreational values and specialized hunting and fishing and recreational values. The specialized hunting and fishing and recreational values are applicable for Kikiaola harbor. The Na Pali coast offers unique opportunities for sightseeing, whale watching, and snorkeling. The untouched natural beauty, clear water, and abundant sea life of the Na Pali coast provide for a unique high-quality experience. For these reasons, the 50 points are assigned a value of $15.12 from the "Specialized Recreation Values Other Than Fishing & Hunting" in the EGM 97-3.

The two future commercial passenger operations on the waiting list will accommodate about 7,000 passengers a year on their tours to the Na Pali coast. The recreational value of $15.12 is assigned to these passengers for a total recreational value of 7,000 passengers x $15.12 per passenger = $105,840 or about $106,000 annually in 1997 dollars.

This estimate assumes that there is sufficient demand for additional Na Pali coast tours. Interviews with present operators indicate that this is reasonable. Na Pali coast tours are very popular with visitors to Kauai. It is not difficult to book passengers on these tours. Several operators report that during high demand periods it is not unusual to turn away as many people as they take on their tours. Several boaters are looking to expand their operations to accommodate more passengers. There appears to be sufficient demand to support additional Na Pali coast tours. The constraint to expansion is the availability of an acceptable launch facility.

2.6. Trailered Commercial Fishing Boats.

Kikiaola harbor is a popular facility from which to launch commercial fishing boats all year round. It is the closest facility to the productive fishing grounds along the western coast of Kauai and around Niihau. This includes the areas near Barking Sands, Kaula Island, and Lehua Island. When certain fish species are running in the area the harbor is overcrowded with trailered commercial fishing boat activity. Under with-project conditions, the popularity of Kikiaola harbor as a launching site for commercial fishing boats is expected to increase.

The information to calculate the commercial fishing benefits generated by improving Kikiaola harbor comes from several sources. Commercial fishermen on Kauai provided responses to a survey on their habits. These responses were supplemented with an interview of a boater familiar with commercial fishing in the area. Further data was gathered from the files of the State Department of Land and Natural Resources Division of Aquatic Resources (DLNR) and from a study done by the National Marine Fisheries Service (NMFS).

There were 50 survey responses from commercial fishermen that use Kikiaola harbor now or plan to use it once it is improved. The responses show that commercial fishing boats launching from Kikiaola harbor range in length from 14 to 28.5 feet. These vessels have drafts between one foot and four and a half feet and beams ranging from three feet to 10 feet. On average, there are one-person crews aboard these vessels.

Of the 50 survey responses, 37 responses are attributed to full-time fishermen, while the remaining 13 responses are from part-time fishermen. It is assumed that full-time fishermen go out an average of three and a half days per trip. They engage in deep bottom hand-line fishing, trolling, and hand-lining for pelagic species. Fishing trips for part-time fishermen last about a day. Their methods of fishing include inshore hand-lining, rod and reel, knife (opihi), spear-fishing, and netting. Commercial fishermen use all of the methods mentioned to some extent depending on the time of year and the type of fish being sought. The distinction made here is based on the observation that full-time fishermen tend to do more deep-sea fishing while part-time fishermen are more apt to do near-shore fishing.

Whether deep-sea fishing or near-shore fishing, survey responses from commercial fishermen indicated that many either use Kikiaola and Port Allen as their launch sites or Port Allen exclusively. Port Allen is the next most convenient launch site for fishermen heading for the fishing grounds off the western coast of Kauai. The most common reason given for not using Kikiaola harbor even though it is closer to those fishing grounds is its shallow depth and rough conditions during certain times of the year. Some fishermen will check the conditions at Kikiaola harbor first before going to Port Allen, while others go directly to Port Allen.

The number of trips presently taken from Kikiaola harbor by part-time and full-time commercial fishermen range from four trips a year to 240 trips annually. These fishermen also use Port Allen when the conditions at Kikiaola are marginal. Once Kikiaola harbor is improved, survey responses indicate that the current harbor users will transfer the trips they now take from Port Allen back to Kikiaola harbor. These fishermen are expected to take between five and 275 trips a year from the harbor under with-project conditions. In addition, an improved facility will attract commercial fishermen that do not use Kikiaola now. Under with-project conditions, these fishermen anticipate transferring between three and 108 trips a year that currently originate from Port Allen to Kikiaola harbor. The savings in operating costs generated by these transfers can be counted as benefits of the project.

Along with the fishing trips transferred from Port Allen, an improved Kikiaola harbor will also prompt fishermen to take more trips each year. Survey responses indicate that full-time fishermen will take 262 new trips after Kikiaola is improved. Part-time fishermen will take an estimated 451 new trips. The increase in net revenue generated by these 713 trips can be counted as benefits of the project.

Before the commercial fishing benefits generated from an improved Kikiaola harbor can be calculated, the impacts on the nearby fishing grounds of having more fishing trips from Kikiaola harbor was determined. Like other areas around the main Hawaiian Islands, the waters off Kauai's western coast are susceptible to overfishing. The additional fishing trips that will be taken represent a sizable increase in the usage of these fishing grounds and could lead to declines in the catch per unit effort of the fishermen. Any reductions in catch per unit effort will negatively affect the benefits from increased net revenue to commercial fishermen.

A study by the NMFS indicates that the estimated increase in commercial fishing trips under with-project conditions may lead to the overfishing of some species. This in turn will cause a decrease in the catch per unit effort for some of the fishermen. The NMFS study investigated the habits of fishermen currently launching from Kikiaola. The study listed the catch of these commercial fishermen by location as delineated by the DLNR statistical fishing areas. The catch by these commercial fishermen were also reported by species and grouped into pelagics, bottomfish, and other species. Combining their knowledge of the fish resources off Kauai's western coast and the current fishing pressure on those resources, the NMFS was able to estimate the impacts of the additional fishing trips.

The study concluded that pelagic species will not be affected by the estimated increase in fishing trips from Kikiaola harbor. There will be no impact on the catch per unit effort. The catch from bottom fishing, however, will be impacted by the increase in fishing trips out of Kikiaola harbor. The NMFS study identified one area in particular that will be significantly affected. This area is located within two miles of the coast of the western tip of Kauai and is heavily fished for onaga which is a species of bottom fish. This species is already overexploited in the waters around the main Hawaiian Islands. The NMFS study concluded that it is not unreasonable for the increased fishing trips from Kikiaola harbor under with-project conditions to cause catch per unit effort to decline by 20 percent in the affected area.

The benefits generated by the increased number of trips taken from Kikiaola was adjusted to take into account this reduction in catch per unit effort. According to the data from the DLNR, the trips to the affected area currently make up about 14 percent of all the trips from Kikiaola harbor. These are the fishing trips that will experience a decrease in catch per unit effort. It is assumed that the portion of the total trips going into the affected area under with-project conditions is also 14 percent. Furthermore, because of its proximity to the coast, it is assumed that only part-time fishermen will go to the affected area.

The value of marine life landed commercially at Kikiaola was obtained for a three-year period from the DLNR. The value of fish caught per trip was calculated from this data. Full-time fishermen are estimated to catch an average of $336 worth of fish per day at a 1995 price level. For a three and a half day trip, the average catch is then 3.5 days x $336 per day = $1,176. Part-time fishermen bring in an estimated $223 worth of fish per one-day trip. These values represent the revenue earned by commercial fishermen under without-project conditions.

The revenue under with-project conditions will be impacted by the anticipated increase in the usage of the harbor by commercial fishermen once Kikiaola is improved. The revenue for the part-time fishermen going to the area susceptible to overfishing will be reduced by 20 percent to reflect the reduction in catch per unit effort as discussed earlier. The revenue for these fishermen will be $223 x 0.8 = $178 per trip. The revenue for full-time fishermen will remain the same under with-project conditions at $1,176 per trip. The revenue for the part-time fishermen that go to the areas less susceptible to overfishing likewise remain the same at $223 per trip.

The operating expenses associated with full-time and part-time commercial operations were also calculated. Full-time fishermen spend about $208 per trip on fuel depending on the type of fuel. They spend an additional $135 on ice and incidentals and $100 for repair and replacement of equipment per trip. The total cost per trip for a full-time fisherman is then $208 + $135 + $100 = $443. Part-time fishermen have much lower operating costs. They spend about $10 for fuel and another $20 for incidentals for a total of about $30 per trip.

Net revenue calculations for the fishermen using Kikiaola harbor are based on the previously calculated revenue and cost figures adjusted to a 1997 price level. Full-time fishermen are assigned net revenues of $1,176 - $443 = $733 x 1.036 = $759 per trip. Part-time fishermen are assigned net revenues of $223 - $30 = $193 x 1.036 = $200 per trip or $178 - $30 = $148 x 1.036 = $153 per trip if they fish in the affected area. On an hourly basis, full-time fishermen make about $759 per trip/84 hours per trip = $9.04 per hour. Likewise, part-time fishermen make $200 per trip/24 hours per trip = $8.33 per hour or $153 per trip/24 hours per trip = $6.37 per hour. Benefit calculations are based on these net revenue and hourly rate figures.

Under without-project conditions, commercial fishermen either cannot use Kikiaola harbor several times a year or choose not to use it because it is too rough. The proposed improvements will greatly reduce the navigational hazards faced by the commercial fishermen already launching from Kikiaola. These fishermen will be able to take more fishing trips from the improved harbor. Survey responses show that the safer facility will also entice boaters to launch from Kikiaola that have not done so in the past. Project benefits can be derived from the intensified use of Kikiaola harbor by these commercial fishermen.

Port Allen is the closest alternative facility to Kikiaola. Commercial fishermen often launch from Port Allen when there is too much surge action at Kikiaola. Assuming that fishermen travel to the same fishing grounds, additional costs are incurred whenever fishermen launch from Port Allen. Survey respondents report that 59 trips by full-time fishermen must be taken from Port Allen during a typical year because of the surge problem at Kikiaola. Also, 244 trips by part-time fishermen are similarly affected.

Launching from Port Allen adds two hours to the trip to and from the fishing grounds and uses up another 20 gallons of gas on average. The ER 1105-2-100 states that the added time it takes to get to the fishing ground is valued at one-third the fisherman's wage rate. The hourly rate for a full-time fisherman is $9.04 and gasoline is sold for about $1.64 per gallon. The added cost of launching from Port Allen is (2 hours x $9.04/3 per hour) + (20 gallons x $1.64 per gallon) = $38.83 per trip. The total annual added cost is then 59 trips per year x $38.83 per trip = $2,291. Of the total trips by full- and part-time fishermen, 303 trips x .14 = 42 trips will be to the area susceptible to overfishing. These are assumed to be trips by part-time fishermen. These fishermen make $6.37 per hour and pay $1.64 per gallon for gas. The annual added cost for their trips out of Port Allen is (2 hours x $6.37/3 per hour) + (20 gallons x $1.64 per gallon) = $37.04 per trip x 42 trips = $1,556. The remaining 202 part-time fishing trips have added annual costs from launching out of Port Allen of (2 hours x $8.33/3 per our) + (20 gallons x $1.64) = $38.35 per trip x 202 trips = $7,747.

The proposed improvements to Kikiaola harbor will reduce the surge problem and the need to launch from Port Allen. It is estimated that 90 percent of the trips launched from Port Allen under without-project conditions will be launched from Kikiaola harbor under with-project conditions. This, in turn, will reduce the costs associated with launching from Port Allen. This savings can be counted as a benefit of the project and equals $2,291 + $1,556 + $7,747 = $11,594 x 0.9 = $10,435 or about $10,000 a year.

Benefits will also be generated by commercial fishermen that do not launch out of the present harbor, but will launch out of an improved Kikiaola harbor. It is assumed that these fishermen now launch out of Port Allen when fishing off the western coast of Kauai. Switching launch sites will save these fishermen time and reduce their operating cost. These savings can be counted as project benefits.

It has been estimated from survey responses that 120 trips a year by full-time fishermen and 131 trips a year by part-time fishermen will be transferred from Port Allen to Kikiaola under with-project conditions. Of the total 251 trips that will be transferred, 251 trips x .14 percent = 35 trips will be to the affected area. The estimated savings of the transfer is $38.83 per trip for full-time fishermen, $37.04 per trip for part-time fishermen going to the affected area, and $38.35 for other part-time fishermen. The annual savings for moving to Kikiaola is equal to 120 trips a year x $38.83 per trip = $4,660 for full-time fishermen. Part-time fishermen taking trips to the affected area are expected to transfer 35 trips from Port Allen to an improved Kikiaola harbor. The total savings for these part-time fishermen equal 35 trips per year x $37.04 per trip = $1,297 a year. The savings for the remaining part-time fishing trips equals $38.35 per trip x 96 trips = $3,682.

The savings to these commercial fishermen for transferring their fishing trips to an improved Kikiaola harbor can be counted as benefits. The annual benefit for the new full-time and part-time commercial fishermen using Kikiaola harbor is $4,660 + $1,297 + $3,682 = $9,639 or about $10,000 a year.

As discussed earlier, an improved Kikiaola harbor will encourage fishermen to go out on more fishing trips than they do now. Survey results indicate that commercial fishermen will go out on 713 more fishing trips once Kikiaola is improved. Of the 713 additional fishing trips from Kikiaola harbor, 713 trips x .14 = 99.8 or about 100 trips will be to the area susceptible to overfishing. These fishermen will experience a 20 percent decrease in their net revenues because of reductions in their catch per unit effort. The net revenue for these part-time fishermen will be $153 per trip. The net revenues for the part-time and full-time commercial fishermen going to other fishing areas are $200 per trip and $759 per trip, respectively, as estimated earlier. The benefit from an increase in the total net revenue to commercial fishermen is then ($153 per trip x 100 trips/year) + ($200 per trip x 351 trips/year) + ($759 per trip x 262 trips/year) = $284,358 or about $284,000 per year.

The total benefit for commercial fishermen from reduced operating costs and increased net revenues is $10,000 + $10,000 + $284,000 = $304,000 at a 1997 price level.

2.7. Recreational Benefits.

Kikiaola is a popular harbor with recreational users as well as commercial operators. According to the survey, Kikiaola is frequently used by recreational boaters and those fishing for sport or consumption. The surveys also reveal that these harbor users are affected by the insufficient depth and surge problems in a similar manner as the commercial users. Likewise, recreational use is expected to increase after the improvements to Kikiaola have been completed.

Survey results indicate that recreational boating at Kikiaola harbor will increase by 87 trips. The value of a non-fishing recreational trip was estimated in Section 2.5 of this appendix at $15.12 per person per trip. Assuming one person per trip, the value of the increased *non-fishing* recreational use is 87 trips x $15.12 per trip = $1,315 at a 1997 price level.

Fishing trips from Kikiaola harbor for sport and consumption will also increase under with-project conditions. These trips are also valued using the UDV method from the ER 1105-2-100. For fishing trips, a dollar value from the "Specialized Fishing & Hunting Values" category is assigned to each person. Using the UDV method of computing recreational values, Kikiaola harbor was assigned 50 points which corresponds to a recreational value of $21.26 per person fishing. There will be an increase of 1,084 fishing trips according to the completed surveys. The value of this increase in recreational fishing at a 1997 price level is 1,084 trips x $21.26 per trip = $23,046 assuming one person per trip.

The total benefit for increased recreation is the sum of the values for non-fishing recreation and recreational fishing. The total attributable to an improved Kikiaola is $1,315 + $23,046 = $24,361 or about $24,000.

3. Benefit Summary.

Table 3 lists the commercial and recreational navigation benefits by category and benefit type for the six alternatives.

TABLE 3.
COMMERCIAL AND RECREATIONAL NAVIGATION BENEFITS

Category	Benefits ($)	
	Commercial	Recreational
Increased Net Revenue	41,000	--------
Increased Efficiency	168,000	--------
New Commercial	--------	106,000
Trailered Commercial Fishing	304,000	--------
Recreational	--------	24,000
TOTALS BY BENEFIT TYPE	513,000	130,000

Based on the information in Table 3, the average annual commercial and recreational navigation benefits from improving Kikiaola harbor total $643,000. The benefits accruing to ongoing commercial passenger operations and trailered commercial fishing vessels are considered high priority benefits. They make up 80 percent of the navigation benefits generated by this project. Benefits for new commercial vessels and recreational boating are considered recreation and make up 20 percent of the navigation benefits.

It is the comparison of the average annual benefits found in Table 3 with the average annual costs discussed in the next section that determines the National Economic Development (NED) alternative.

4. Cost.

There are six alternatives being considered in this analysis. Detailed descriptions of these plans can be found in the main report. Table 4 lists the various costs involved in constructing and maintaining these improvements to Kikiaola harbor and the average annual costs associated with each alternative.

TABLE 4.
PROJECT COSTS
($000)

	Alternatives					
	1	2	3	4	5	6
Project First Cost	5,749	5,954	6,087	6,334	8,734	7,366
Interest During Constr.	282	292	356	391	567	408
Investment Cost	6,031	6,246	6,443	6,725	9,301	7,774
Amortized Invest. Cost	458	474	489	511	706	590
Annual O & M	71	70	75	74	69	69
TOTAL AVE. ANN. COST	529	544	564	584	775	659

The project first costs of the different alternatives include the cost of all the materials and services that will go into improving the harbor. The interest during construction is based on the project first cost and is calculated using the prescribed discount rate of 7-3/8 percent and a 16-month construction period for alternatives 1 and 2. Alternative 3 has a construction period of 19 months while Alternative 4 has a 20-month construction period. Alternative 5 will take 21 months to construct and Alternative 6 will take 18 months to build. The investment cost is the sum of the project first cost and the interest during construction. This investment cost is multiplied by the capital recovery factor for a 50-year project life at a discount rate of 7-3/8 percent which is 0.07591 to estimate the amortized investment cost. The average operation and maintenance cost is added to the amortized investment cost to get the total average annual cost of each alternative.

5. Benefit-cost ratios.

It is a comparison of a plan's total average annual benefits and total average annual cost that determines its economic viability from a federal standpoint. The federal government will consider participating in the construction of the alternatives with benefit-cost ratios greater than one. The option with the highest net benefits is chosen as the recommended alternative from among the plans with benefit-cost ratios greater than one. Table 5 shows the average annual benefits, the average annual costs, the benefit-cost ratios and the net benefits of the six alternatives considered in this analysis.

TABLE 5.
PROJECT ECONOMICS

	Alternatives					
	1	2	3	4	5	6
Ave. Ann. Benefits ($000)	643	643	643	643	643	643
Ave. Ann. Costs ($000)	529	544	564	584	775	659
Benefit-Cost Ratios	1.22	1.18	1.14	1.10	0.83	0.98
Net Benefits ($000)	114	99	79	59	(132)	(16)

6. National Economic Development (NED) Alternative.

According to the information in Table 5, Alternative 1 has a benefit-cost ratio greater than one and the highest net benefits. As such, it is the NED alternative and the recommended plan.

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.2 DESIGN ANALYSIS

APPENDIX B

APPENDIX B
DESIGN ANALYSIS AND REEVALUATION

1. WAVE EXPOSURE AND REFRACTION ANALYSIS.

a. Kikiaola Harbor is exposed to deep water waves approaching from S 45° E clockwise to N 82° W (Figure 1). The harbor is directly exposed to wave attack from the south and indirectly exposed from the north. The indirect exposure from the north can produce large waves as a result of north Pacific storm waves. However, these waves refract around the western tip of Kauai before reaching the project area. The wave attack from the south is more likely to produce maximum wave conditions. A detailed computer-aided refraction analysis was performed for wave attacks from the southern exposure regime. Results of the refraction analysis were used to locate wave energy convergence zones near the harbor and determine critical wave crest alignment at the proposed entrance channel. Critical wave crest alignment is used in wave diffraction analysis is discussed in this appendix.

b. Examination of the southern exposure regime indicated a range of possible deep water wave attacks from S 23° E to due south. Wave refraction analyses were performed for waves approaching from S 23° E, S 11.5° E, and due south with periods ranging from 8 to 16 seconds. A computer program from the US Army Engineer Waterways Experiment Station (WES) was employed in a two-step analysis to perform these refraction diagrams. Step one of the analysis carried wave rays from deep water to a depth of 70 feet. Step two carried wave rays from a depth of 70 feet to the harbor area.

c. Results of step one indicated that deepwater waves approaching from S 23° E, S 11.5° E, and due south could affect Kikiaola Harbor. Waves from due south, however, appear to be most likely to cause critical wave attacks because of higher refraction coefficients. Table 1 shows average refraction coefficients and approach directions for the various wave periods.

d. Wave rays with the highest refraction coefficients and directions likely to affect the harbor were transferred to a larger grid scale for step two analysis. To insure adequate coverage and account for possible discrepancies, each transferred ray was replaced by 3 sets of 7 to 10 rays each. Approach directions for the 3 sets were based on the direction of the ray from step one. Directions of the 3 sets were 2 degrees apart with the center direction being that of the transferred ray.

Table 1. Wave Refraction Data for Kikiaola Harbor

DEEPWATER WAVE APPROACH	WAVE PERIOD (SECONDS)	AVERAGE REFRACTION COEFFICIENT	WAVE APPROACH AT 6' CONTOUR (DEGREES)
S 23^{o} E	8	0.98	160
	10	0.99	159
	12	0.97	160
	14	0.98	159
	16	0.93	160
S 11.5^{o} E	8	0.99	170
	10	0.97	169
	12	0.97	170
	14	0.95	169
	16	0.90	166
Due South	8	0.99	177
	10	0.97	176
	12	1.00	177
	14	0.98	174
	16	0.99	177

e. Results of the refraction analysis indicate that large southern swell waves, especially those approaching from due south with 12-second periods, are the critical waves affecting the harbor. The refraction diagram (Figure 2) shows that the proposed entrance channel is located in an area of wave divergence and for this reason it is situated in the most desirable location.

2. WAVE DIFFRACTION ANALYSIS.

a. Theoretical wave diffraction analyses (Figures 3 to 6) were conducted for the four plans. Incident wave direction was determined from the refraction analysis described previously. Angle of approach at the entrance channel mouth was determined to be from S 3^{o} E. Diffraction analyses were performed in accordance with procedures, techniques, and diagrams described in the Coastal Engineering Research Center (CERC) Shore Protection Manual (SPM).

b. The theoretical wave incident to the breakwater opening at the channel mouth is assumed to be a broken wave of 9.8 feet, based on an average depth of 12.5 feet and a slope of m = 0.0. A breakwater opening, leading into the harbor basin, produces a secondary diffraction effect. Lines of equal diffraction coefficient are plotted and labeled on the diffraction diagrams. Wave height at any point within the entrance channel is determined by multiplying the diffraction coefficient by the incident wave height.

Wave height in the harbor basin area is computed by multiplying the incident wave height, H_b, by the diffraction coefficient, K, in the entrance channel and the diffraction coefficient, K, in the harbor basin:

$$H_b \times K = \text{Wave Height}_{\text{Channel}} \times K = \text{Wave Height}_{\text{Basin}}.$$

3. <u>STILLWATER LEVEL</u>. The stillwater level (SWL) is defined as the level of water above the elevation datum plane when no waves are present. Components of the SWL are astronomical tide level (S_a), wave setup (S_w), atmospheric pressure induced level (S_p), and storm surge (S_s). Stillwater level components in the original report were calculated as follows:

a. <u>Astronomical tide level</u> (S_a): Maximum astronomical tide expected is estimated to be about 0.4 foot above the mean higher high water level of 1.6 feet. Total astronomical tide level is 1.6' + 0.4' = 2.0 feet.

b. <u>Wave Setup</u> (S_w): Wave setup is estimated from calculated theoretical values being that the location of the primary protective structure is not in the area of maximum wave setup. For engineering calculations, a value of 0.5 foot is used for S_w.

c. <u>Atmospheric Pressure Induced Level</u> (S_p): The following storm parameters were used in calculating S_p to be 0.5 foot:

- A 1-inch central pressure drop of mercury (Hg)
- A 20-mile radius of maximum wind
- A distance of 35 miles to the storm center.

d. <u>Storm Surge</u> (S_s): Storm surge is estimated rather than calculated because of difficulty in assessing values for complex hydrographic conditions. The estimated storm surge of 0.5 foot is used.

Therefore:

$$\begin{aligned} SWL &= S_a + S_w + S_p + S_s \\ &= 2.0' + 0.5' + 0.5' + 0.5' \\ &= 3.5 \text{ feet} \end{aligned}$$

However, recent hurricane vulnerability reports (Sea Engineering, 1986 and 1993) refine the information available for this area and provide a more realistic scenario for storm conditions. The typical wave setup and storm surge modeled in the studies resulted in a stillwater level of 6.25'. This SWL was used to size the armor stone.

4. CHANNELS AND TURNING BASIN DESIGN.

a. Design Vessel. The entrance channel, turning basin, and access channel are designed to provide safe navigation for vessels up to lengths of 45 feet, 14-foot beam, and 5-foot draft. These dimensions are characteristic of fishing boats which are the largest vessels anticipated to use the harbor. The most recent user survey indicated the original assumptions for the design vessel are still valid.

b. Entrance Channel Design. The minimum width and depth of the entrance channel were computed as follows:

◦ Minimum Width = 6 x Design Vessel Beam x 1.15 to allow for navigation through waves
= 6 x 14' x 1.15
= 96.6' say 100 feet

The original design called for a channel width of 105 feet; this width shall be retained.

◦ Depth:

Draft	= 5 feet
Bottom Clearance and Squat	= 2 feet
Wave Allowance	= 4 feet
Total Channel Depth	= 11 feet

Although the minimum entrance channel width is 105 feet, a flared entrance channel width of 205 feet at the seaward end is provided. A flared entrance channel will provide additional navigation safety, dissipate wave energy, and cause less wave disturbance at the channel mouth.

c. Turning Basin Design. The length, width, and depth of the turning basin were computed as follows:

◦ Minimum Width and Length = 2.5 x Design Vessel Length
= 2.5 x 45 feet
= 112.5 feet; USE: 115 feet

◦ Depth:

Draft	= 5 feet

Bottom Clearance and Squat	= 2 feet
Wave Allowance	= 2 feet
Total Basin Depth	= 9 feet

d. Access Channel Design. The width and depth of the access channel were computed as follows:

° Minimum Width = 5 x Design Vessel Beam
= 5 x 14 feet
= 70 feet

° Depth:

Draft	= 5 feet
Bottom Clearance and Squat	= 1 feet
Wave Allowance	= 1 feet
Total Basin Depth	= 7 feet

5. DESIGN WAVE HEIGHT.

a. Breakwater design is based on depth-controlled breaking wave criteria which determines the maximum wave height to which the structure might be subjected. The design wave height is based on depth at the structure toe, wave period, and slope (m) seaward of the structure toe.

b. The original report design wave heights computed for the east and west breakwater heads, inner and outer east stub breakwaters, and used for the diffraction analyses were based on average depth across the channel mouth:

Channel:	12 feet (depth) + 3.5 feet (SWL) = 15.5 feet
Adjacent Area:	6 feet (depth) + 3.5 feet (SWL) = 9.5 feet
Average Depth:	$\frac{15.5 \text{ feet} + 9.5 \text{ feet}}{2}$ = 12.5 feet (d_s)

Therefore, for constant channel depth, m (slope) = 0.0 and from SPM, Figure 7-4:

$$\frac{H_b \text{ (Design Wave Height)}}{d_s \text{ (depth)}} = 0.78$$

Design Wave Height = 12.5 feet x 0.78
= 9.8 feet

Using updated criteria and information results in a Design Wave Height of 11.5 feet.

c. The design wave height for the east breakwater trunk was computed on depth at the structure toe, d_s, of 7 feet, 12-second wave period, and slope of m = 0.006. From SPM, Figure 7-2:

$$\frac{H_b \text{ (Design Wave Height)}}{d_s \text{ (depth)}} = 0.83$$

$$\text{Design Wave Height} = 7.0 \text{ feet} \times 0.83 = 5.8 \text{ feet}$$

Again, using updated criteria and information results in a Design Wave Height of 8.0 feet.

d. Table 2 summarizes the design wave heights obtained for the applicable structures.

Table 2. Design Wave Heights

Structure	Design Wave Height (Feet)
East and West Breakwater Heads	11.5
East Breakwater, Trunk	8.0
Inner and Outer East Stub Breakwaters	11.5

6. DESIGN FACTORS.

a. Armor Layer Design. The CERC SPM design formulas were used to determine the weight of the stones and the thickness of the stone layers. Table 3 shows the design factors used in computing the armor layer design.

Table 3. Design Factors for Kikiaola Harbor

Structure	Unit Weight of Armor Stone (W_r)	Specific Gravity of Armor Stone (S_r)	Stability Coefficient (K_D)	Side Slope Cot θ	Layer Thickness (n)	Layer Coefficient (K_Δ)	Design Wave Height (H_b)
East Breakwater Head	156 lbs/ft^3	2.44	2.8	1:2	1 and 2	1.00	11.5 feet
East Breakwater Trunk	156 lbs/ft^3	2.44	2.0	1:1.5	1	1.00	8.0 feet
Inner & Outer East Stub Breakwaters	156 lbs/ft^3	2.44	2.8	1:2	2	1.00	11.5 feet

b. East Breakwater Design. Armor stone size and armor layer thickness for the east breakwater head section were computed as follows:

- Armor Stone size:

$$W = \frac{W_r H_b^3}{K_D (S_r - 1)^3 \cot \theta}$$

$$= 7.12 \text{ tons}$$

° Range of Armor Stone Size: .75W to 1.25W = 5.5 - 9.0 tons

° Armor Layer Thickness (two layers):

$$= nk_\Delta \left(\frac{W}{W_r}\right)^{1/3}$$

$$= 8.6 \text{ feet}$$

One Layer = 4.3 feet

Armor stone size and armor layer thickness for the east breakwater trunk section were computed in a similar way. Table 4 shows the results of the computations.

Table 4. Stone Weight and Layer Thickness for East Breakwater

	Armor Layer		Underlayer		Bedding Layer	
Station	Weight (Tons)	Layer Thickness (ft)	Weight (pounds)	Layer Thickness (ft)	Stone Weight (pounds)	Layer Thickness (feet)
2+50 to 8+20 (Trunk)	3.5 - 6.0	3.85	NA	NA	Spalls to 200	2.5
8+70 to 9+85 (Head)	5.5 - 9.0	9.0	700-1200	4.5	Spalls to 200	2.5

c. Wave Runup and Crest Elevation. In the original report wave runup and resulting crest elevation for the trunk head sections of the east breakwater were based on CERC report number CETA 79-1, "Wave Runup on Rough Slopes." The computed runup for the head section resulted in a crest elevation of 13.3. The computed runup for the trunk section resulted in a crest elevation of 10.8 feet.

The flared entrance channel and flat dredged side slope (1V on 5H) will dissipate wave energy and reduce wave height at the channel mouth. Therefore, allowing for minor overtopping during the most severe wave conditions, crest elevation for the head section was set at +12 feet MLLW. The crest elevation for the trunk section was set at +11.0 feet MLLW. Subsequent analysis of the runup and wave transmission using ACES showed the set crest elevation was optimal.

d. West Breakwater Head Design. The original report recommended a modest increase in armor stone size, but required a significant modification of the existing breakwater. Subsequent analysis indicated simply resetting the existing armor stone and ensuring a keyed and fitted armor layer would significantly reduce construction costs while maintaining the protective nature of the structure. Crest elevation shall remain at the existing elevation of +8 feet MLLW. Overtopping of the structure will occur during storm wave conditions.

e. Inner and Outer East Stub Breakwaters Design. Computations for armor stone size and armor layer thickness are similar to the east breakwater head section. Table 6 shows the results of the computation.

Table 5. Stone Weight and Layer Thickness for Inner and Outer East Stub Breakwaters

	Armor Layer		Underlayer		Bedding Layer	
Station	Design Stone Weight (ton)	Layer Thickness (feet)	Design Stone Weight (lbs)	Design Layer Thickness (feet)	Stone Weight (lbs)	Layer Thickness (feet)
INNER						
9+85 to 10+70 1/	5.5-9.0	9.0	700-1200	3.85	Spalls to 200	2.5
9+85 to 11+80 2/	5.5-9.0	9.0	700-1200	3.85	Spalls to 200	2.5
OUTER						
0+00 to 1+40 3/	5.5-9.0	9.0	700-1200	3.85	Spalls to 200	2.5

1/ Plans 1, 2, and 4
2/ Plan 3
3/ Plan 4

Computed wave runup results for the two stub breakwaters is similar to the east breakwater head. The incident wave approaches the two stub breakwaters at an angle of 90 degrees between the wave crest and breakwater. The striking wave runs along the structure, increasing the effective surface area available for wave energy dissipation and decreasing the wave runup. Although the wave runup resulted in a crest elevation of 13.3 feet, the crest elevations for the two stub breakwaters were set at +12 feet MLLW, allowing for minor overtopping.

7. SEDIMENT STUDY.

a. The ocean bottom off Kikiaola Harbor consists of sand channels and deposits, interspersed with coral reef segments. The offshore sand deposit is located approximately 200 feet from the tip of the outer east stub breakwater. An engineering investigation was conducted to measure alongshore sediment transport. Sediment traps were placed offshore from the harbor area (Figure 7). One set of traps, trap set 1, was emplaced in the sand deposit just seaward of the proposed entrance channel alignment.

b. Each trap set consisted of two traps running parallel to the coast - one facing east and the other facing west. The trap set would therefore catch littoral drift moving in either direction and the absolute sum of measurements would total gross alongshore transport. It should be noted that gross alongshore transport is different from net alongshore transport. Net alongshore transport is the difference between east and west littoral drifts.

c. Study results showed that sand filled sediment traps to normal capacity each time they were emplaced. Study results also showed great movement of sediments in the sand deposit area. This was determined by measurement of gross alongshore transport taken during the two-hour trap emplacement. A gross transport rate of 0.357 cubic yard per day per foot of width was measured. Assuming that gross alongshore transport is approximately the same throughout the surf zone, but limited primarily to the 400-foot wide sand deposit area in the channel vicinity, the yearly gross transport (in both directions) would be 52,000 cubic yards. This estimate is based on a very brief two-hour measurement.

d. During the course of the investigation, sediment traps were not set shoreward of the sand deposit, as breaking waves prevented boat and divers from operating the area. However, two sediment traps, trap set 3, were placed at the seaward end of the harbor entrance to estimate the rate of sediment transport into the harbor. The measured transport rate was 0.0026 cubic yard per foot width per day. For the 200-foot wide opening, the yearly transport would be approximately 190 cubic yards per year.

e. Based on the sediment study results that indicated that there is a highly active littoral movement zone offshore of the harbor, it is estimated that approximately 13,000 cubic yards of material would be dredged every 5 years. High maintenance dredging requirements were based on removing 4 feet of shoaled material in the entrance channel (seaward end to channel mouth), 2 feet in the inner channel and 1 foot in the access channel.

8. <u>CURRENTS</u>. Measurements taken during the sediment study indicate that the surface currents in the vicinity of Kikiaola Harbor are predominantly wind driven. Surface drogues released near the harbor entrance moved in response to the prevailing wind. Turbid water from the harbor or from dredging operations can be expected to move approximately downwind. Due to the reflection of the tradewinds around the island, the downwind direction during tradewind conditions would be predominantly alongshore. During Kona winds, the downwind direction would be predominantly onshore.

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.3 GEOLOGY, FOUNDATIONS AND MATERIALS

APPENDIX C

APPENDIX C

GEOLOGY, FOUNDATIONS AND MATERIALS

REGIONAL GEOLOGY

1. Kauai consists of a single, large, shield volcano built from the sea floor by many thousands of thin flows of lava basalt (Reference 5). Toward the end of growth of the shield about five million years ago (Reference 9) the volcano summit collapsed to form a broad, well-defined central depression (caldera). The town of Lihue is located on the southeast edge of this huge depression. The high mountains Kawaikini and Waialeale on the west side are erosional remnants of the crater rim of the original shield volcano. The huge depression was bordered by less depressed fault blocks, some of which merged imperceptibly with the outer slopes of the volcano. Volcanic activity about one million years ago gradually filled the depression burying piles and ridges of talus along the foot of the boundary cliffs.

SITE GEOLOGY

2. The light-draft vessel harbor at Kikiaola is located on a uniformly straight, low and wide beach that extends for 2.7 miles from Waimea River, to the west, to Oomano Point at Kekaha. The land away from the harbor is a flat, alluvial terrace (or platform), 10 to 15 feet in elevation above sea level, one mile in width and underlain by both alluvial and marine sediments. On the outer or seaward edge of the terrace there is a low beach with calcareous sand dune ridges. At the inner edge, the spurs of lava flows (Waimea Canyon Volcanic Series) are truncated by an ancient sea cliff. The sea covered the terrace in ancient times and deposited a series of calcareous sandstone and sandy limestone benches and reefs. The rock benches and reefs have been removed by erosion (at least down to -12 feet MLLW) over most of the harbor. Remnants of the ancient reefs were found in previous borings and seen in a drainage ditch that empties into the harbor just west of the center groin structure. The composition and gradation of the calcareous sandstone in the ditch is similar to the material found in the black beach sand today, showing that erosional and depositional processes have been the same along this part of the coast for several hundred thousands of years. The sandstone is tightly cemented and requires a jackhammer and considerable effort to excavate. The beach along this section of the Kauai coast is sand, consisting of 60 to 75 percent fine grained pieces of basalt and olivine, and 25 to 40 percent of calcareous skeletal material from shallow water marine plants and animals. Black colored basalt pieces predominate and when wet the sand has a uniform, black appearance. When dry it is black with white specks much like salt and pepper. The material ranges in average size from medium grained sand (1 millimeter) to silt (0.03 millimeter). The detrital basalt sand comes from the Waimea River and mixes with small pieces of limestone rock from coral reef deposits found southeast of the Waimea River and 2,000 feet northwest of Oomano Point, opposite the cemetery at Kekaha. All grains coarser than silt are subrounded to rounded reflecting the ease with which basalt and coral limestone abrade in the surf zone. There is a strong westward current flowing nearshore that moves the sand along the beach (and in shallow water) so that there is a gradual decrease westward in the percentage of basalt components and an

increase in calcareous grains. No appreciable change or variation in size of sand grains was noticed in the 14,000 feet of beach.

SEISMICITY

3. The record of earthquake activity in the Hawaiian Islands indicates much variation in frequency and intensity from location to location. The greatest seismic activity has been observed on the Island of Hawaii which is subjected to frequent and occasionally severe earthquakes. The other major islands experience earthquakes less frequently and generally of lower intensity than the Island of Hawaii.

4. The earthquakes that are frequent on the Island of Hawaii are for the most part related to the volcanic activity. Several severe earthquakes have been recorded and indeed have caused extensive damage and loss of life both from collapse of structures and from tsunamis.

5. In recent years, attention has been given to the seismic events generated by tectonic activity along the Molokai Fracture Zone. The zone of faults lies roughly east-west and transects the chain of principal islands about midway (in the area of Molokai). Actually, a fracture zone consisting of a multitude of faults extends from north of Kauai to south of the Island of Hawaii. These faults run in various directions but generally trend east-west.

6. The possibility of destructive earthquakes originating in this fracture zone has resulted in the upgrading of Kauai from a Zone 0 to a higher classification. The 1991 Uniform Building Code designates Kauai in a seismic Zone 1 from a scale of Zones 0 to 4 with 4 being the highest. An examination of the seismic history of Kauai indicates that the possibility of earthquake damage should be considered. The April 2, 1868 earthquake, centered south of the Island of Hawaii, was probably the most severe recorded in the islands and has been estimated at 7 to 8 on the Modified Mercalli Scale. This event was felt in Kauai, however, no structural damage was reported.

7. The earthquake occurring on February 19, 1871 was a strong event and was associated with tectonic movements in the fault zones between Oahu and the Island of Hawaii. This event caused severe damage to Maui and Molokai, which were located near the epicenter. This earthquake was felt in Kauai and the movement lasted thirty to forty seconds. No serious damage was reported.

8. A report published by the Hawaii Institute of Geophysics (Reference 3) contained the recommendations for upgrading Kauai from Zone 0 to Zone 1. This recommendation was based on historical data for numerous earthquakes in the islands and an evaluation of the possibility of severe earthquake occurrence along the Molokai Fracture Zone.

SUBSURFACE INVESTIGATIONS

9. Eleven borings (B-1 to B 11) were taken by the Government in March 1965 in connection with an earlier study on Kikiaola Harbor. Supplemental subsurface investigations (B-12 to B-21) were performed during May-June 1980 to confirm preliminary design assumptions in terms of stable cut and fill slopes, potential for settlement and the level of effort required in excavating the entrance channel, turning basin and access channel. The location and logs of explorations are shown on Figures C-1, C-2 and C-3 of this appendix.

LABORATORY TESTING

I0. Routine laboratory tests were performed on samples obtained from the subsurface investigations to determine characteristics of the in-situ materials and develop soil parameters for design. Results of laboratory tests are shown on Table C-1.

SUBSURFACE CONDITIONS

11. A black colored basalt-coral beach sand averaging between 2 and 8 feet in thickness is found in the existing harbor. Red terrestrial silt and clay, washed in by the drainage ditches, overlies the sand in about half the harbor area nearest the beach. The silt and clay measures 1 to 3 feet in thickness. At elevations between 9 and 13 feet below mean lower low water level there is a layer of reef rock 0.3 to 8.5 feet thick, which may be the ancient fringing reef surface formed before deposition of the basalt-coral sands. The subgrade for the breakwater modifications consists mainly of sand-silt mixtures and some terrestrial silt.

DESIGN CONSIDERATIONS

12. Dredgeability. The material to be excavated consists mainly of basalt-coral beach sand and terrestrial silt and clay. Removal of approximately 30,000 cubic yards of material will required for construction of the harbor's entrance and access channel. The existing materials can be readily removed with an ordinary clamshell dredge.

13. Breakwater Toe Protection. The toe of the modified breakwater structures will be imbedded below the anticipated depth of scour. A 3-foot thick bedding layer will be provided beneath and 5 feet beyond the toe to serve as a filter blanket to prevent foundation materials from migrating through the armor layers and causing the breakwater to settle.

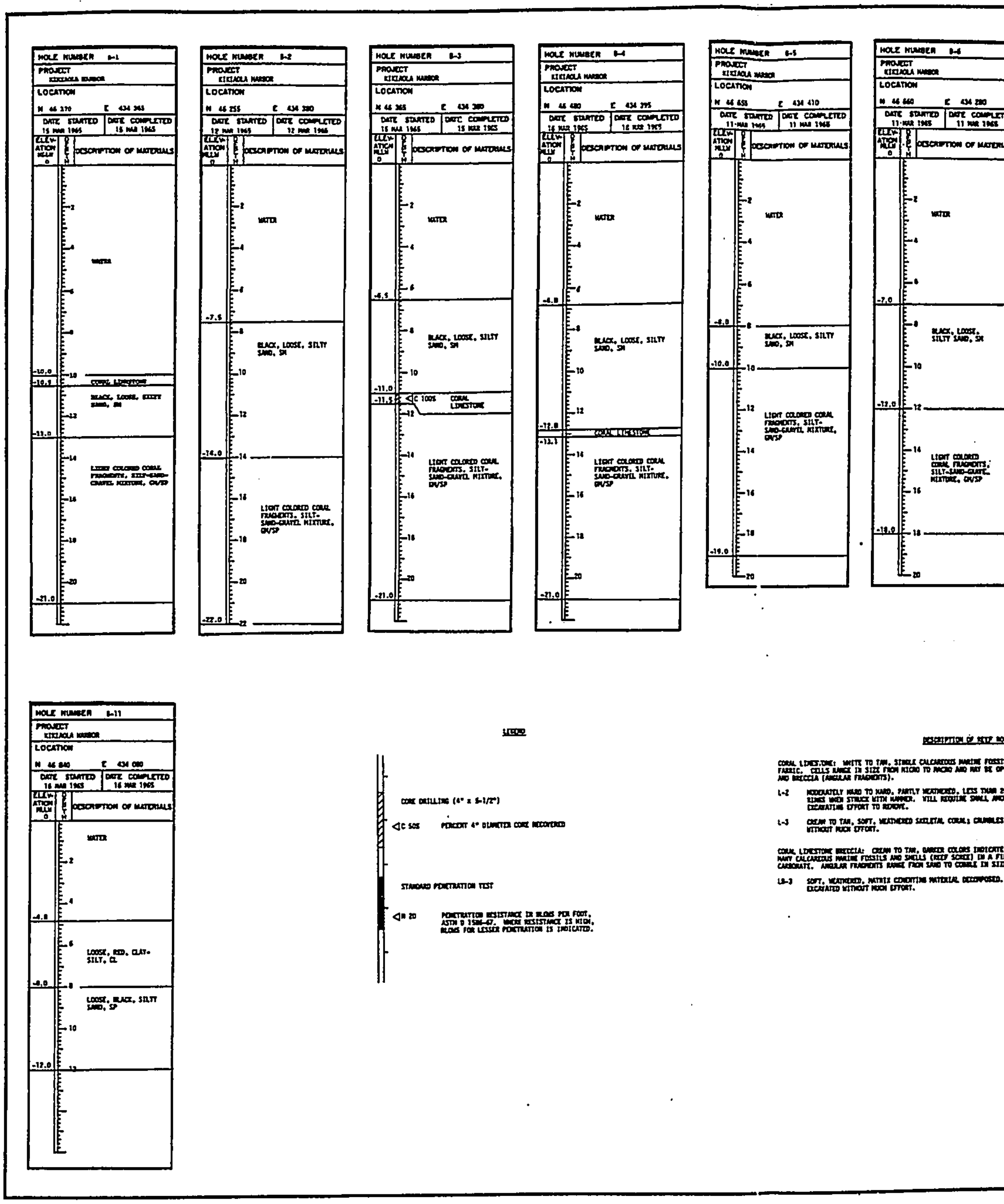
14. Excavation Slopes. Based on slope stability analyses and assuming a very loose silty sand foundation, excavation slopes of 1V on 5H are stable for the entrance and access channel. To preclude slope failures as a result of surcharge loads from adjacent breakwater structures, a minimum berm width of 25 feet will be maintained between the top of excavation and the toe of all breakwater structures.

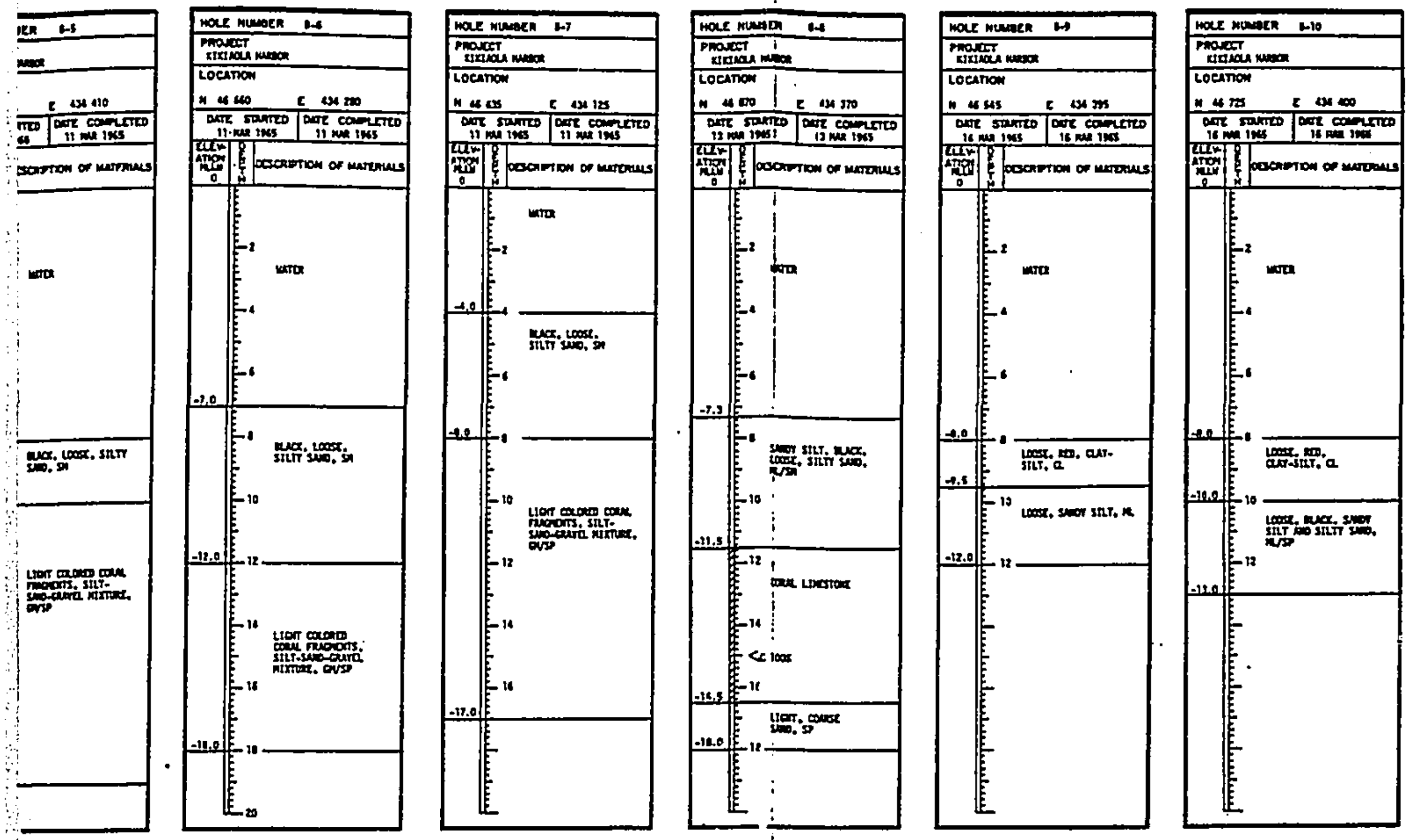
15. Breakwater Slopes. Slope stability analyses assuming a very loose silty sand foundation were also performed for the head and trunk sections of the east breakwater. Side slopes of 1V on

TABLE C-1: SUMMARY OF SUBSURFACE INVESTIGATION TEST DATA

BORING NO./ SAMPLE NO.	SOIL CLASS	MLLW ELEVATION (FT)	CUMULATIVE % PASSING												SPECIFIC GRAVITY	WATER CONTENT %	NATURAL DRY DENSITY PCF
			1-1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200			
12-1A	SP-SM	4.0-7.0		100	87	85	84	79	75	70	58	47	27	12	2.80	31.1	94
14-4	SM	19.8-22.8	100	98	93	85	78	68	60	52	42	30	24	17		24.8	
14-5	SP-SM	0.0- 3.0					100	98	94	87	63	31	17	7		26.6	
15-1	SP-SM	2.8-5.8	100	95	88	81	77	72	68	65	60	50	22	11		25.8	
15-4	SM	11.6-14.6	100	98	98	96	94	88	80	72	61	48.3	36	30	2.76	23.4	105
16-1	SP-SM	4.0-7.0	100	96	83	68	63	56	50	44	37	30	16	10	2.70	15.7	119
16-2	SP-SM	7.0-10.0	91	91	81	70	67	61	56	49	42	35	20	11		17.6	
17-1	SP-SM	0.0-1.0	100	94	86	82	76	64	51	42	32	26	20	12		22.4	
17-2	SW-SM	1.5-4.5	100	95	90	82	73	57	43	33	27	23	17	12	2.66	15.6	118
18-1	SP-SM	0.0-3.0	100	92	87	81	75	61	49	40	35	28	19	12		18.7	
18-2	GM	3.0-6.0	100	78	67	62	56	44	36	29	24	20	17	13		20.9	
19-1A	SP-SM	1.0-2.5					100	98	96	93	86	69	36	8	3.01	26.0	106
19-1B	SM	2.5-4.0			100	96	95	85	73	59	46	37	29	18		17.0	
20-1	GP-GM	2.0-4.0	100	93	82	68	64	51	41	35	32	29	21	12	2.47	28.3	91
21-1A	SP-SM	3.5-5.0					100	99	99	98	96	33	16	7		20.3	
21-1B	GM	5.0-6.5	100	75	73	69	65	57	51	44	41	37	26	16		20.8	

C-4


HOLE NUMBER B-1
PROJECT KIKIAOLA HARBOR
LOCATION N 46 270 E 434 365
DATE STARTED 15 MAR 1965
DATE COMPLETED 15 MAR 1965
ELEVATION MLLW
DEPTH
DESCRIPTION OF MATERIALS
WATER
CORAL LIMESTONE
BLACK, LOOSE, SILTY SAND, SM
LIGHT COLORED CORAL FRAGMENTS, SILT-SAND-GRAVEL MIXTURE, GW/SP
HOLE NUMBER B-2
PROJECT KIKIAOLA HARBOR
LOCATION N 46 255 E 434 380
DATE STARTED 12 MAR 1965
DATE COMPLETED 12 MAR 1965
WATER
BLACK, LOOSE, SILTY SAND, SM
LIGHT COLORED CORAL FRAGMENTS, SILT-SAND-GRAVEL MIXTURE, GW/SP
HOLE NUMBER B-3
PROJECT KIKIAOLA HARBOR
LOCATION N 46 365 E 434 380
DATE STARTED 15 MAR 1965
DATE COMPLETED 15 MAR 1965
WATER
BLACK, LOOSE, SILTY SAND, SM
C 100% CORAL LIMESTONE
LIGHT COLORED CORAL FRAGMENTS, SILT-SAND-GRAVEL MIXTURE, GW/SP
HOLE NUMBER B-4
PROJECT KIKIAOLA HARBOR
LOCATION
WATER
BLACK, LOOSE, SILTY SAND, SM
CORAL LIMESTONE
LIGHT COLORED CORAL FRAGMENTS, SILT-SAND-GRAVEL MIXTURE, GW/SP
HOLE NUMBER B-5
PROJECT KIKIAOLA HARBOR
LOCATION
WATER
BLACK, LOOSE, SILTY SAND, SM
LIGHT COLORED CORAL FRAGMENTS, SILT-SAND-GRAVEL MIXTURE, GW/SP
HOLE NUMBER B-6
PROJECT KIKIAOLA HARBOR
LOCATION
WATER
BLACK, LOOSE, SILTY SAND, SM
LIGHT COLORED CORAL FRAGMENTS, SILT-SAND-GRAVEL MIXTURE, GW/SP
HOLE NUMBER B-11
PROJECT KIKIAOLA HARBOR
LOCATION
WATER
LOOSE, RED, CLAY-SILT, CL
LOOSE, BLACK, SILTY SAND, SP
LEGEND
CORE DRILLING (4" x 5-1/2")
C 50% PERCENT 4" DIAMETER CORE RECOVERED
STANDARD PENETRATION TEST
N 20 PENETRATION RESISTANCE IN BLOWS PER FOOT, ASTM D 1586-67. WHERE RESISTANCE IS HIGH, BLOWS FOR LESSER PENETRATION IS INDICATED.
DESCRIPTION OF REEF ROCK
CORAL LIMESTONE: WHITE TO TAN, SINGLE CALCAREOUS MARINE FOSSIL FABRIC. CELLS RANGE IN SIZE FROM MICRO TO MACRO AND MAY BE OPEN AND BRECCIA (ANGULAR FRAGMENTS).
L-2 MODERATELY HARD TO HARD, PARTLY WEATHERED. LESS THAN 20% RINGS WHEN STRUCK WITH HAMMER. WILL REQUIRE SMALL AMOUNT EXCAVATING EFFORT TO REMOVE.
L-3 CREAM TO TAN, SOFT, WEATHERED SKELETAL CORAL; CRUMBLES WITHOUT MUCH EFFORT.
CORAL LIMESTONE BRECCIA: CREAM TO TAN, DARKER COLORS INDICATE MANY CALCAREOUS MARINE FOSSILS AND SHELLS (REEF SCREE) IN A FINE CARBONATE. ANGULAR FRAGMENTS RANGE FROM SAND TO COBBLE IN SIZE.
LB-3 SOFT, WEATHERED, MATRIX CEMENTING MATERIAL DECOMPOSED. EXCAVATED WITHOUT MUCH EFFORT.



NOTES TO BORING LOGS

1. FOR BORING LOCATIONS SEE FIGURE 12
2. COORDINATES ON BORING LOGS ARE REFERRED TO HAWAII STATE PLANE SYSTEM, ZONE 4.
3. DEPTHS AND ELEVATIONS ARE MEASURED FROM ZERO MLLW DATUM.
4. DESCRIPTION OF MATERIALS SHOWN ON THE LOGS ARE BASED ON VISUAL CLASSIFICATION OF SAMPLES IN THE FIELD. ALL SOIL CLASSIFICATIONS ARE BASED ON ASTM D 2487-69.
5. BORINGS B-1 TO B-11 WERE MADE IN MARCH 1965. HOLES 1, 2, 4, 5, 6 AND 7 WERE WASH JET DRILLED USING 1-INCH INJECTOR PIPE INSIDE 2-INCH CASING. HOLES 3 AND 8 WERE DRILLED USING A 4-INCH INSIDE DIAMETER CORE BARREL.
6. BORINGS B-12 TO B-21 WERE MADE IN MAY-JUNE 1980 USING 4" x 5-1/2" CORE BARREL AND STANDARD SPLIT SPOON SAMPLER.
7. DISCREPANCIES IN MATERIAL CLASSIFICATIONS BETWEEN THE 1965 AND 1980 BORINGS ARE ATTRIBUTED TO DIFFERENCES IN DRILLING METHODS EMPLOYED. WHERE DISCREPANCIES OCCUR, MATERIAL CLASSIFICATIONS SHOWN FOR THE 1980 BORINGS WILL GOVERN.

DESCRIPTION OF REEF ROCK

CORAL LIMESTONE: WHITE TO TAN, SINGLE CALCAREOUS MARINE FOSSIL GROWTH, UNIFORM CELLULAR TEXTURE AND LACY FABRIC. CELLS RANGE IN SIZE FROM MICRO TO MACRO AND MAY BE OPEN OR FILLED WITH SECONDARY CALCIUM CARBONATE AND BRECCIA (ANGULAR FRAGMENTS).

L-2 MODERATELY HARD TO HARD, PARTLY WEATHERED, LESS THAN 20% VUGS AND CAVITIES. SCRATCHES EASILY, DULL RINGS WHEN STRUCK WITH HAMMER. WILL REQUIRE SMALL AMOUNTS OF BLASTING, SPUDDING OR EQUIVALENT EXCAVATING EFFORT TO REMOVE.

L-3 CREAM TO TAN, SOFT, WEATHERED SKELETAL CORAL; CRUMBLES UNDER HAND PRESSURES; CAN BE EXCAVATED WITHOUT MUCH EFFORT.

CORAL LIMESTONE BRECCIA: CREAM TO TAN, DARKER COLORS INDICATE WEATHERING AND SOFTER ROCK. FRAGMENTS OF MANY CALCAREOUS MARINE FOSSILS AND SHELLS (REEF SCREE) IN A FINE GRAINED CEMENTING MATRIX OF CALCIUM CARBONATE. ANGULAR FRAGMENTS RANGE FROM SAND TO COBBLE IN SIZE, DEGREE OF CEMENTATION VARIES.

LB-3 SOFT, WEATHERED, MATRIX CEMENTING MATERIAL DECOMPOSED. MATERIAL CRUMBLES UNDER PRESSURE. CAN BE EXCAVATED WITHOUT MUCH EFFORT.

KIKIAOLA HARBOR KAUAI, HAWAII

BORING LOGS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-1

HOLE NUMBER B-12		
PROJECT KIKIAOLA HARBOR		
LOCATION N 46 790 E 433 730		
DATE STARTED 23 MAY 1980	DATE COMPLETED 23 MAY 1980	
ELEVATION MLLW	DEPTH M	DESCRIPTION OF MATERIALS
0		WATER
-5.2		SILTY SAND, SP-SM, BROWN-BLACK (BASALT AND CORAL SAND)
	10	N22
-11.7	12	CORAL LIMESTONE, L-3, WHITE WITH GRAY STAINS
		N50+
-14.0	14	CORAL LIMESTONE BRECCIA, LB-3 CREAM COLORED
		N50/0.4'
		N50/0.4'
	16	
-17.2		N50+

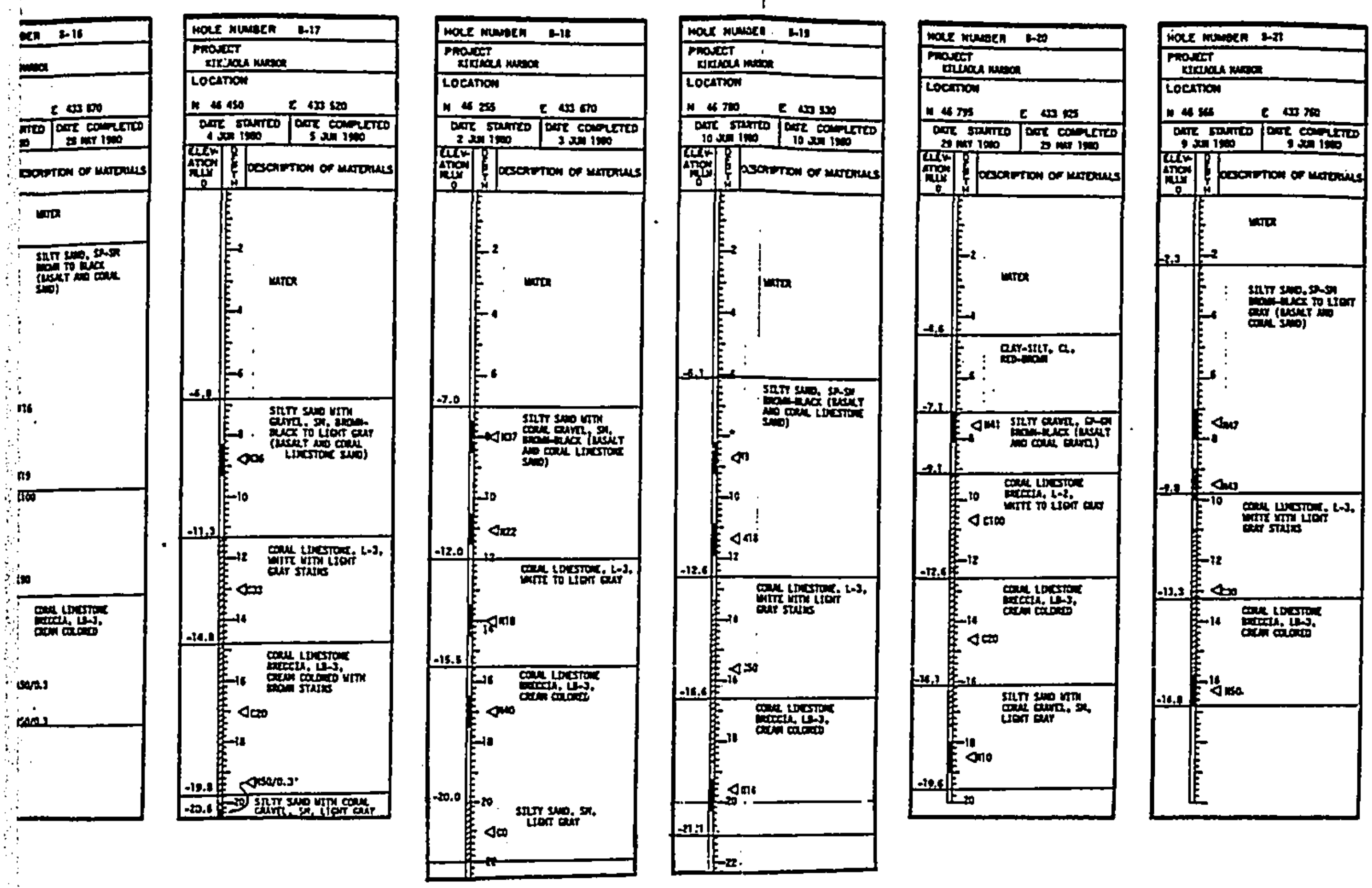
HOLE NUMBER B-13		
PROJECT KIKIAOLA HARBOR		
LOCATION N 46 865 E 433 890		
DATE STARTED 23 MAY 1980	DATE COMPLETED 23 MAY 1980	
ELEVATION MLLW	DEPTH M	DESCRIPTION OF MATERIALS
0		WATER
-4.0	4	CLAY-SILT, ML, RED-BROWN
-6.9		SILTY SAND, SM, BROWN-BLACK (BASALT AND CORAL SAND)
-12.8		CORAL LIMESTONE BRECCIA, LB-3, CREAM COLORED
	14	N25
		N19
-18.8		

HOLE NUMBER B-14		
PROJECT KIKIAOLA HARBOR		
LOCATION N 46 655 E 433,535		
DATE STARTED 28 MAY 1980	DATE COMPLETED 28 MAY 1980	
ELEVATION MLLW	DEPTH M	DESCRIPTION OF MATERIALS
0		
-7.8	8	SILTY SAND WITH GRAVEL, SP-SM BROWN (BASALT AND CORAL LIMESTONE SAND)
	10	N14
	12	N17
-12.8		CORAL LIMESTONE, L-3, WHITE TO CREAM
	14	N11
-15.8	16	CORAL LIMESTONE BRECCIA, LB-3, CREAM COLORED
	18	N13
-18.8		SILTY SAND WITH CORAL GRAVEL, CREAM WITH STREAKS OF TAN
	20	N30
-22.8		

HOLE NUMBER B-15		
PROJECT KIKIAOLA HARBOR		
LOCATION N 46 605 E 434 035		
DATE STARTED 22 MAY 1980	DATE COMPLETED 22 MAY 1980	
ELEVATION MLLW	DEPTH M	DESCRIPTION OF MATERIALS
0		WATER
-4.4	4	SILTY SAND, SP-SM BROWN TO BLACK (BASALT AND CORAL SAND)
	8	N17
-9.5	10	CORAL LIMESTONE, LB-3 WHITE WITH GRAY STAINS
		N17
-12.2	12	CORAL LIMESTONE BRECCIA, LB-3, CREAM COLORED
	14	N48
-17.2		SILTY SAND, SM, CREAM COLORED
	18	N23
-19.6	20	

HOLE NUMBER B-16		
PROJECT KIKIAOLA HARBOR		
LOCATION N 46 490 E 433 870		
DATE STARTED 22 MAY 1980	DATE COMPLETED 28 MAY 1980	
ELEVATION MLLW	DEPTH M	DESCRIPTION OF MATERIALS
0		WATER
-1.7	2	SILTY SAND, SP-SM BROWN TO BLACK (BASALT AND CORAL SAND)
		N16
		N19
-9.7		C100
	12	C90
-13.2	14	CORAL LIMESTONE BRECCIA, LB-3, CREAM COLORED
	16	C50/0.3
-17.5		C50/0.3

HOLE NUMBER B-17		
PROJECT KIKIAOLA HARBOR		
LOCATION N 46 460 E 433 520		
DATE STARTED 4 JUN 1980	DATE COMPLETED 5 JUN 19	
ELEVATION MLLW	DEPTH M	DESCRIPTION OF MA
0		WATER
-4.8		SILTY SAND WITH GRAVEL, SM, BRO BLACK TO LIGHT (BASALT AND CORA LIMESTONE SA
		C06
-11.3	12	CORAL LIMESTONE, WHITE WITH LIGHT GRAY STAINS
		C33
-14.8	16	CORAL LIMESTONE BRECCIA, LB-3, CREAM COLORED WI BROWN STAINS
		C20
-19.8		C50/0.3'
-20.6	20	SILTY SAND WITH CO GRAVEL, SM, LIGHT

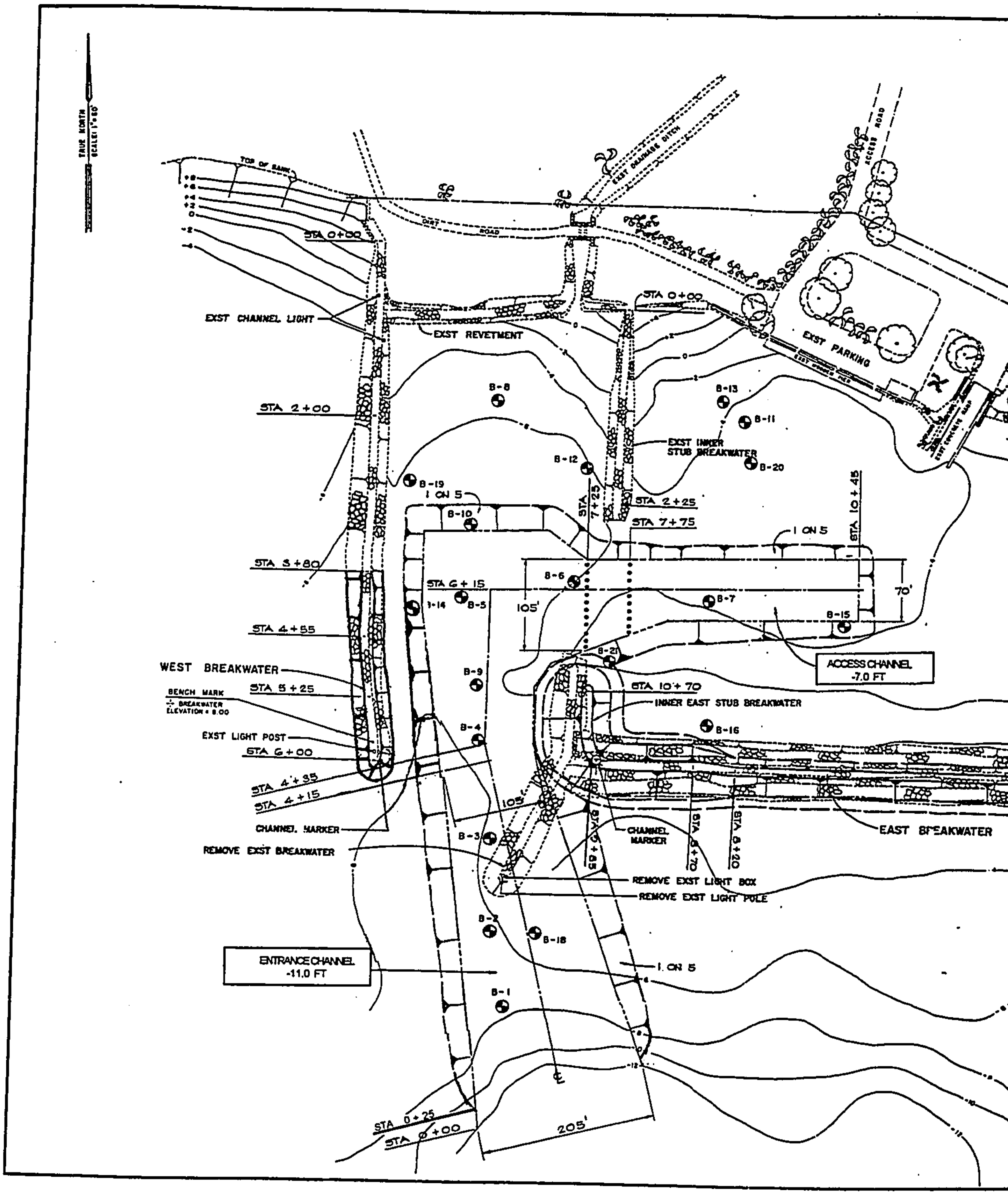


KIKIAOLA HARBOR KAUAI, HAWAII

BORING LOGS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-2


TRUE NORTH
TOP OF BANK
STA 0+00
DIRT ROAD
EXST DRAINAGE DITCH
ACCESS ROAD
EXST CHANNEL LIGHT
EXST REVETMENT
STA 0+00
EXST PARKING
STA 2+00
B-8
B-13
B-11
EXST INNER STUB BREAKWATER
B-12
B-20
B-19
1 ON 5
STA 7+25
STA 2+25
B-10
STA 7+75
1 ON 5
STA 10+45
STA 3+80
B-6
STA 6+15
105'
70'
B-14
B-5
B-7
B-15
STA 4+55
B-21
ACCESS CHANNEL
-7.0 FT
WEST BREAKWATER
B-9
STA 10+70
BENCH MARK
BREAKWATER ELEVATION = 8.00
STA 5+25
INNER EAST STUB BREAKWATER
B-16
EXST LIGHT POST
B-4
STA 6+00
STA 4+35
STA 4+15
105'
CHANNEL MARKER
EAST BREAKWATER
REMOVE EXST BREAKWATER
B-3
CHANNEL MARKER
STA 8+70
STA 8+20
REMOVE EXST LIGHT BOX
REMOVE EXST LIGHT POLE
B-2
B-18
ENTRANCE CHANNEL
-11.0 FT
1 ON 5
B-1
STA 0+25
STA 0+00
205'

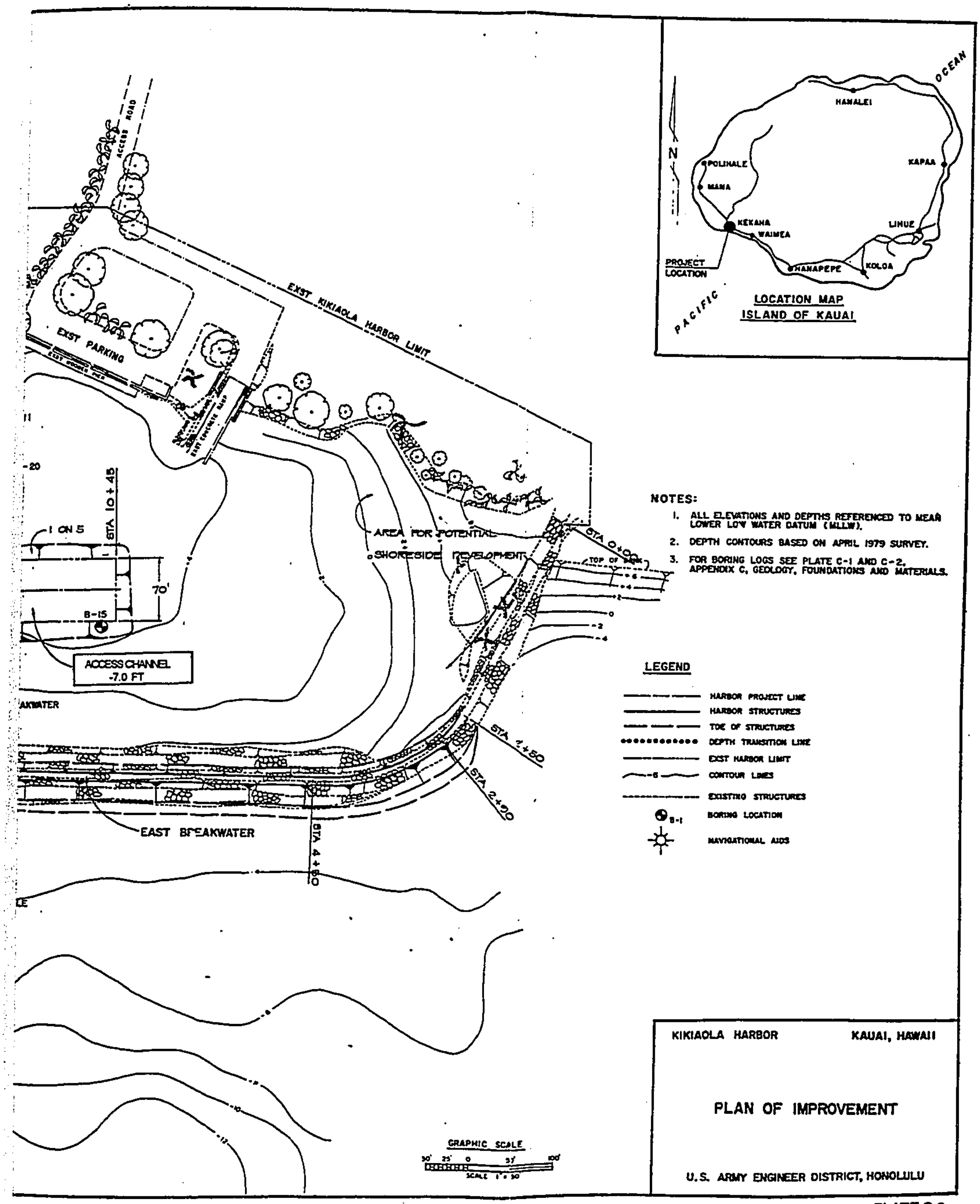

ACCESS ROAD
EXST PARKING
EXST KIKIAOLA HARBOR LIMIT
AREA FOR POTENTIAL
SHORESIDE DEVELOPMENT
1 ON 5
STA 10 + 45
70'
B-15
ACCESS CHANNEL
-7.0 FT
EAST BREAKWATER
STA 4 + 60
STA 2 + 50
STA 1 + 50
STA 0 + 00
TOP OF BANK
OCEAN
HANALEI
POLIHALE
MANA
KAPAA
KEKAHA
WAIMEA
LIHUE
HANAPEPE
KOLOA
PROJECT
LOCATION
PACIFIC
N
LOCATION MAP
ISLAND OF KAUAI
NOTES:
1. ALL ELEVATIONS AND DEPTHS REFERENCED TO MEAN LOWER LOW WATER DATUM (MLLW).
2. DEPTH CONTOURS BASED ON APRIL 1979 SURVEY.
3. FOR BORING LOGS SEE PLATE C-1 AND C-2, APPENDIX C, GEOLOGY, FOUNDATIONS AND MATERIALS.
LEGEND
HARBOR PROJECT LINE
HARBOR STRUCTURES
TOE OF STRUCTURES
DEPTH TRANSITION LINE
EXST HARBOR LIMIT
CONTOUR LINES
EXISTING STRUCTURES
BORING LOCATION
NAVIGATIONAL AIDS
GRAPHIC SCALE
SCALE 1" = 50'
KIKIAOLA HARBOR
KAUAI, HAWAII
PLAN OF IMPROVEMENT
U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE C-3

2H and 1V on 1.5H were found to be stable for the head and trunk sections, respectively. Results of the above stability analyses were used as a basis in selection of side slopes for the remaining breakwater modifications.

CONSTRUCTION CONSIDERATIONS

16. Silt curtains or other barriers will be used to contain turbidity during dredging of the entrance and access channel. Disposal of dredged excavated materials on land will require construction of sediment basins and/or berms to settle out suspended fines prior to discharge of return water to the harbor.

SOURCES OF CONSTRUCTION MATERIALS

17. Stones reclaimed from the existing breakwaters will be used in the breakwater modifications to the greatest extent possible.

18. The balance of the stone required for the breakwater modifications could be obtained from field stones located on the lower slopes of the Waimea Mountains, approximately two to three miles northwest of the harbor near Kokee Road and the Waiawa Reservoir. An abandoned quarry site is located just off Alae Road above field No. 4. Drilling and blasting would be required to obtain armor stone from the quarry. Field stones in practically unlimited quantity are available in the cane fields in the Koloa area.

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NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.4 WES WAVE RESPONSE STUDY

APPENDIX D

Draft Miscellaneous Paper CERC-97-xx
July 1997

Wave Response of Kikiaola Harbor, Kauai, Hawaii

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Prepared for U.S. Army Engineer Division, Pacific Ocean

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Preface

This study was authorized by the U.S. Army Engineer Division, Pacific Ocean (POD), and was conducted by personnel of the Coastal Oceanography Branch (COB), Research Division (RD), Coastal and Hydraulics Laboratory (CHL), of the U.S. Army Engineer Waterways Experiment Station (WES). The study was conducted during the period August 1996 through July 1997. Messrs. Tim Young and Lincoln Gayagas, POD, oversaw progress of the study.

Dr. Edward F. Thompson, COB, was the WES point of contact for the study. This report was prepared by Dr. Thompson, Dr. Lihwa Lin, and Ms. Lori L. Hadley, all of COB, and Dr. Jon M. Hubertz, formerly of COB. Drs. Lin and Hubertz conducted the wave climate analysis portion of the study. Direct supervision was provided by Dr. Martin C. Miller, Chief, COB. General supervision was provided by Mr. H. Lee Butler, formerly Chief, RD, Mr. Charles C. Calhoun, Jr., Assistant Director, CHL, and Dr. James R. Houston, Director, CHL.

At the time of publication of this report, Dr. Robert W. Whalin was Director of WES. COL Bruce K. Howard, EN, was Commander.

1 Introduction

Background

Kikiaola Harbor is a small, shallow-draft harbor on the Island of Kauai. The harbor is approximately 100 miles west and a little north of Honolulu, Oahu, and is located along the western part of Kauai's south shore (Figure 1). Nearby towns of Kekaha and Waimea are 1 mile northwest and 1.5 mile east of the harbor, respectively. Lihue, the county seat and business center of Kauai, is located approximately 23 miles east of the harbor. The local shoreline is a relatively straight, low, wide beach that reaches from Oomano Point at its western extent to the Waimea River on the east, a distance of 2.7 miles.

Kikiaola Harbor was originally developed by the State of Hawaii in 1959. Inner and outer stub extensions to the east breakwater and a short inner breakwater were added in 1964 to form the present harbor (Figure 2). The additional structures were needed to reduce surge within the harbor. A wharf and boat ramp are located along the north boundary of the harbor, east of the inner breakwater.

Prevailing northeast tradewinds result in a strong predominance of winds from northeast, east, and southeast at Kikiaola Harbor. Typical wind speeds are 10 to 20 mph. Winter storms can generate strong winds from the south. The harbor is exposed to waves approaching from a sector between N 82° W and S 46° E (Figure 1), though the small island of Niihau creates some sheltering in the western part of this sector. Southern swell, generated by storms in the southern Pacific and Indian Oceans, is a significant part of the wave climate. Also, waves generated by storms in the North Pacific can wrap around the western side of Kauai and affect Kikiaola Harbor. Hurricanes can attack the harbor. This source of waves is important for structure design but is sufficiently rare that it does not impact the operational concerns of the present study.

Use of the existing harbor is limited by two primary factors. First, the harbor is quite shallow. Sediment movement along the local coast, predominantly from east to west, has resulted in shoaling of the entrance and inner harbor. Second, the existing entrance experiences breaking wave conditions which are hazardous to navigation. These two factors are interrelated. Breaking waves are more likely in the existing, shoaled entrance than they would be in a deeper, maintained entrance channel.

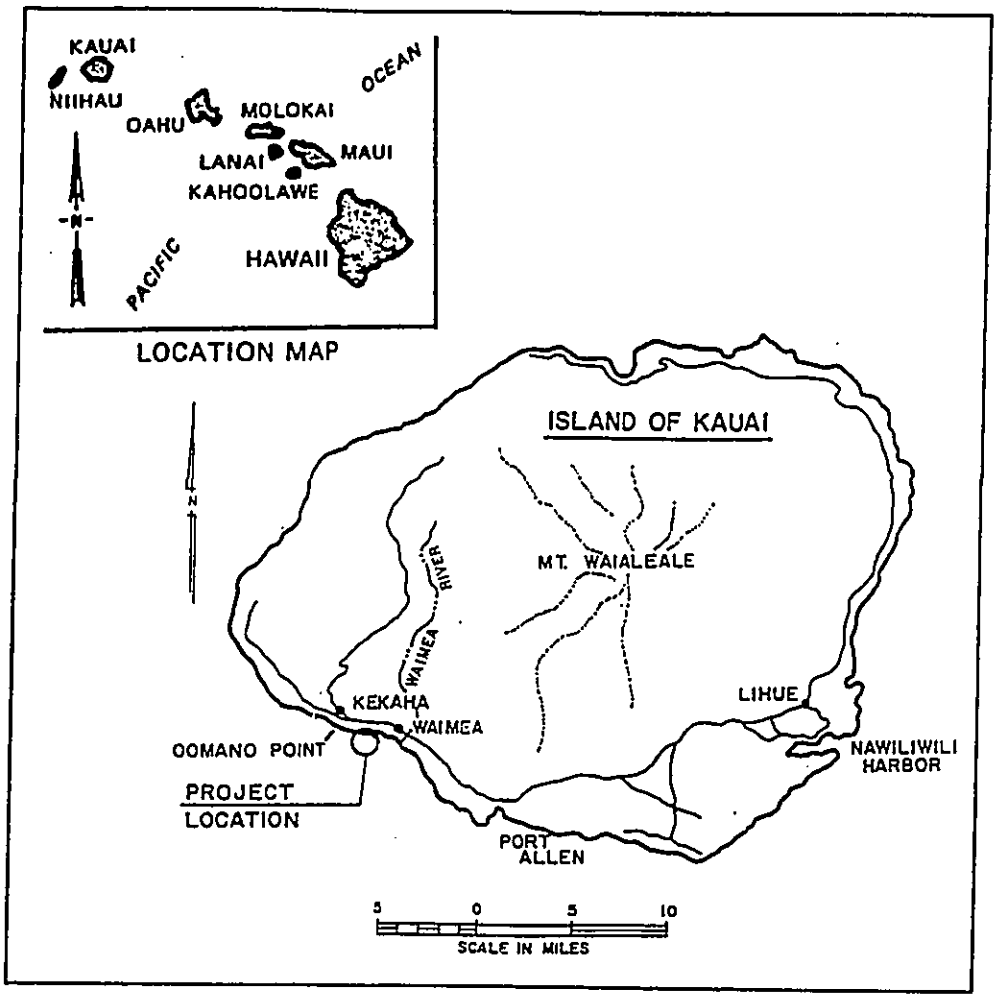

Figure 1. Kikiaola Harbor location

The U.S. Army Engineer Division, Pacific Ocean, developed several plans for improving operational conditions in Kikiaola Harbor (U.S. Army Engineer Division, Pacific Ocean 1980). The present study focuses on evaluating wave conditions in the most promising plans to help insure that operational objectives are met.

Study Approach

The study described in this report was performed by the U.S. Army Engineer Waterways Experiment Station (WES), Coastal and Hydraulics Laboratory (CHL). The approach consisted of the following components:

a. Develop wave climate information at the harbor site.

b. Use a numerical model to investigate existing and alternative harbor modification plans.

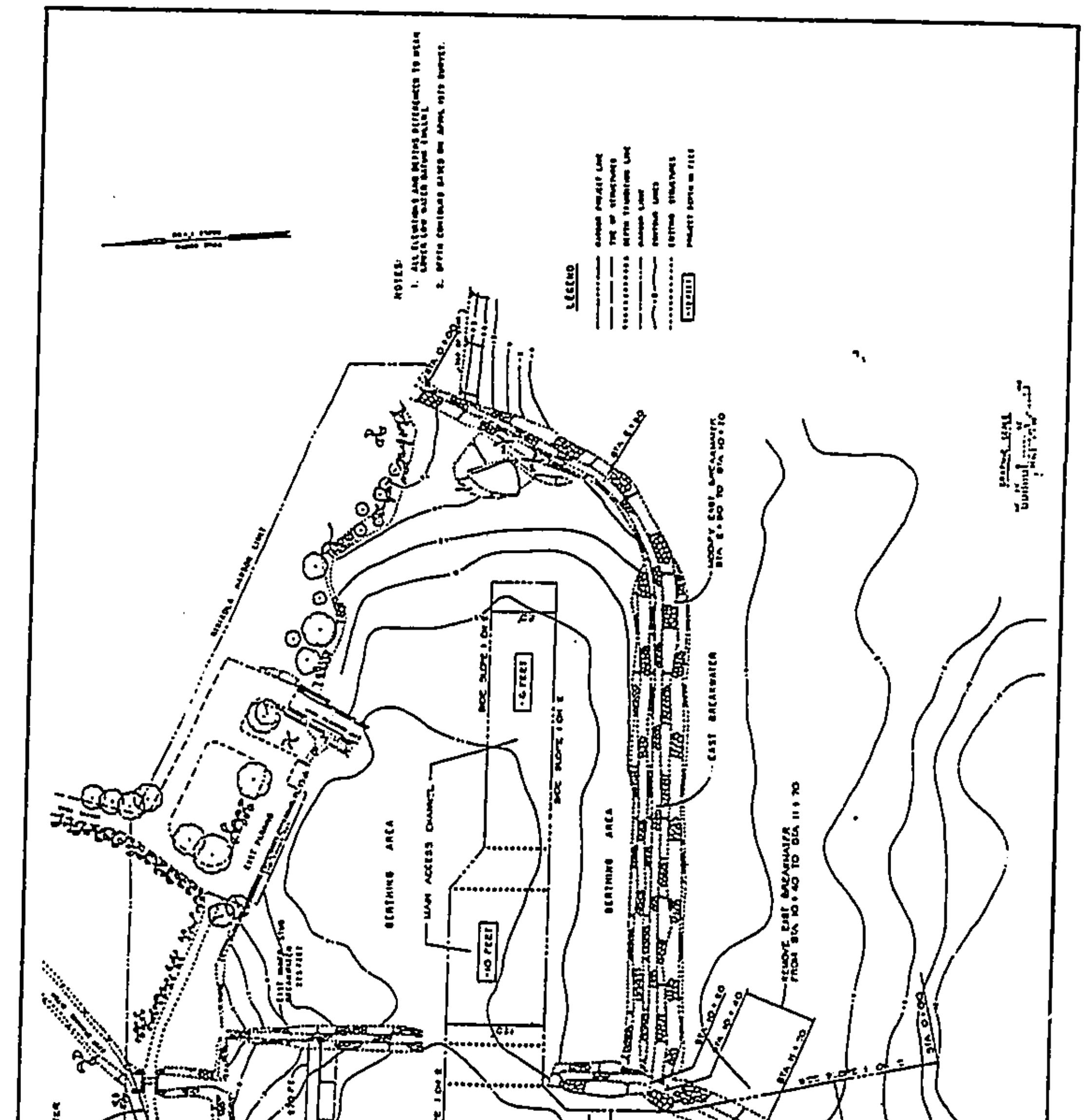

Figure 2. Kikiaola Harbor, existing plan

Wind wave and swell climate was investigated primarily with numerical hindcast information covering a period of one year. Ideally, a longer time period would be used to establish wave climate, but only one year was available from a comprehensive re-hindcast of the Pacific Ocean within the time frame of this study. Even one year of information can be expected to give reasonable representation of the lower 99 percent of wave conditions, which cover the main concerns in this study (Thompson and Harris 1972). Buoy measurements from several locations were used to help validate the hindcasts. Hindcast wave information was used as a boundary condition for nested finer grids which allowed sheltering of the islands of Kauai and Niihau to be modeled. Deepwater waves offshore of Kikiaola Harbor were transformed by a simple method to a depth of 4 m for use as an incident condition in the harbor wave model. The wave climate study is presented in Chapter 2.

A numerical wave model was set up to cover the harbor and an area outside the harbor extending about 300 yd seaward of the entrance. Two proposed harbor plans and the existing harbor were studied. Both plans include modification of the east and west breakwaters, dredging of an entrance channel to a depth of 12 ft below MLLW, and dredging of an inner access channel to a depth of 8 ft MLLW. Special features of each plan are:

a. Plan 1 (Figure 3). Remove outer stub of east breakwater; remove and reconstruct inner stub of east breakwater a small distance further east; raise crest elevation of exposed portions of east breakwater by 3-4 ft and flatten seaward slope to 1:2; widen outer 220 ft of west breakwater; dredge 725-ft long entrance channel with width varying from 105 to 205 ft and maneuvering area to facilitate a 90 deg turn into access channel; dredge 320-ft long access channel varying in width from 70 to 105 ft.

b. Plan 6 (Figure 4). Remove outer and inner stubs of east breakwater; raise crest elevation of exposed portions of east breakwater by 3-4 ft and flatten seaward slope to 1:2; extend east breakwater further west to a distance of 100 ft past the existing west breakwater location; shorten west breakwater to allow space for access channel; dredge entrance and access channels comparable to those in Plan 1.

The numerical model used for the studies, HARBD, is the standard USAEWES tool for numerical harbor wave investigations. The model includes the following assumptions:

a. No wave transmission through the breakwaters.

b. No wave overtopping of structures.

c. Structure crest elevations above the water surface cannot be tested or optimized.

d. Currents in the channel can not be evaluated.

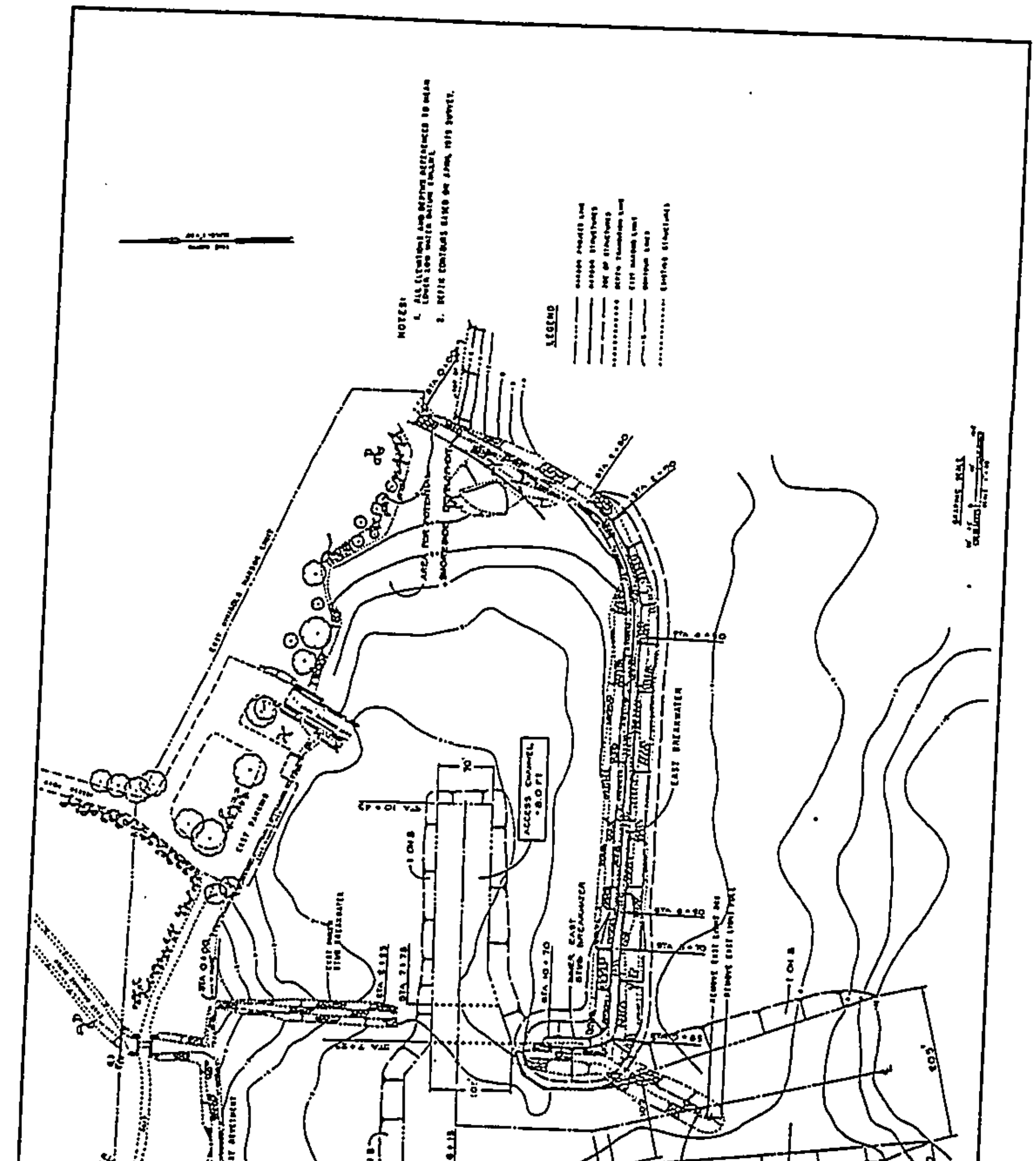

Figure 3. Plan 1

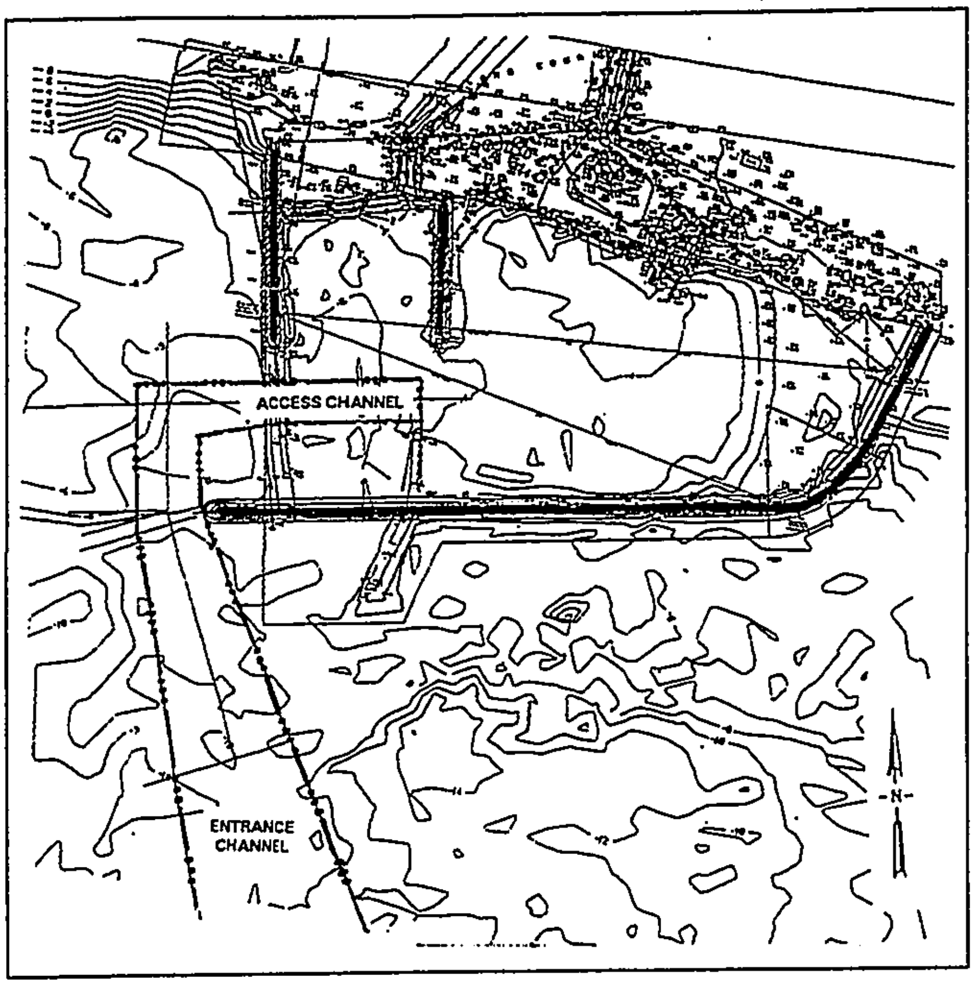

Figure 4. Plan 6

e. Wave breaking effects in the entrance and harbor cannot be considered directly.

f. No nonlinear effects are considered.

g. Diffraction around structure ends is represented by diffraction around a blunt vertical wall with specified reflection coefficient.

Despite limitations imposed by the above assumptions, HARBD is considered suitable for meeting the numerical modeling objectives of the Kikiaola Harbor study. Development of the numerical model and test procedures is described in Chapter 3.

Response of the existing and alternative harbor plans to waves was studied using numerical model results. Harbor response to wind waves and swell (*short waves*) is presented in Chapter 4. The harbor short wave response is related to wave climate and to standard U.S. Army Corps of Engineers criteria in channels and berthing areas. Harbor oscillation characteristics (response to *long waves*) are presented in Chapter 5. The long wave study included only the existing harbor and Plan 6.

Conclusions and recommendations are given in Chapter 6. This chapter is followed by references and appendices with detailed information supporting the main report and notation definitions.

2 Wind Wave and Swell Climate

Sources

Four sources of wind wave and swell information were available to develop wave climate outside the harbor entrance, including three National Data Buoy Center (NDBC) buoys with open exposure to the south and the Wave Information Studies (WIS). WIS has hindcast waves over the Pacific Ocean and saved information at selected deepwater stations around the Hawaiian Islands. Buoy locations and corresponding WIS deepwater (Level 1) stations are shown in Fig. 5. The original WIS Pacific hindcast covered only the north Pacific (Corson et al. 1986). That study is presently being updated to extend coverage into the south Pacific as well. At the time of the Kikiaola Harbor study, only one year (1989) was completed. Because waves from the south Pacific are a critical part of the climate at Kikiaola Harbor, the 1-year updated WIS hindcast was used in this study in preference to the original WIS information.

Deepwater Wave Climate

The deepwater WIS hindcast for 1989 was calculated in three steps, with each step giving increased refinement. The initial and coarsest step, Level 1, covered the entire Pacific Ocean basin with a grid spacing of 2.5 deg of latitude/longitude (Fig. 6). Information at a sequence of points enclosing U.S. Pacific coasts (shown in the figure) was saved to use as a boundary condition for a more refined, localized Level 2 grid. The Level 2 grid (Fig. 7), with mesh spacing 1.0 deg latitude/longitude, provided boundary conditions around the Hawaiian Islands for a Level 3 grid with 0.25-deg resolution (Fig. 8). An additional refinement was added for this study to represent the sheltering effects of the islands of Kauai and Niihau (the small island 15 miles southwest of Kauai) on the project site. This Level 4 grid had a resolution of 0.017-deg latitude/longitude and encompassed both Kauai and Niihau. Wind wave growth was included in Levels 1-3 and propagation effects were included in all levels of hindcast.

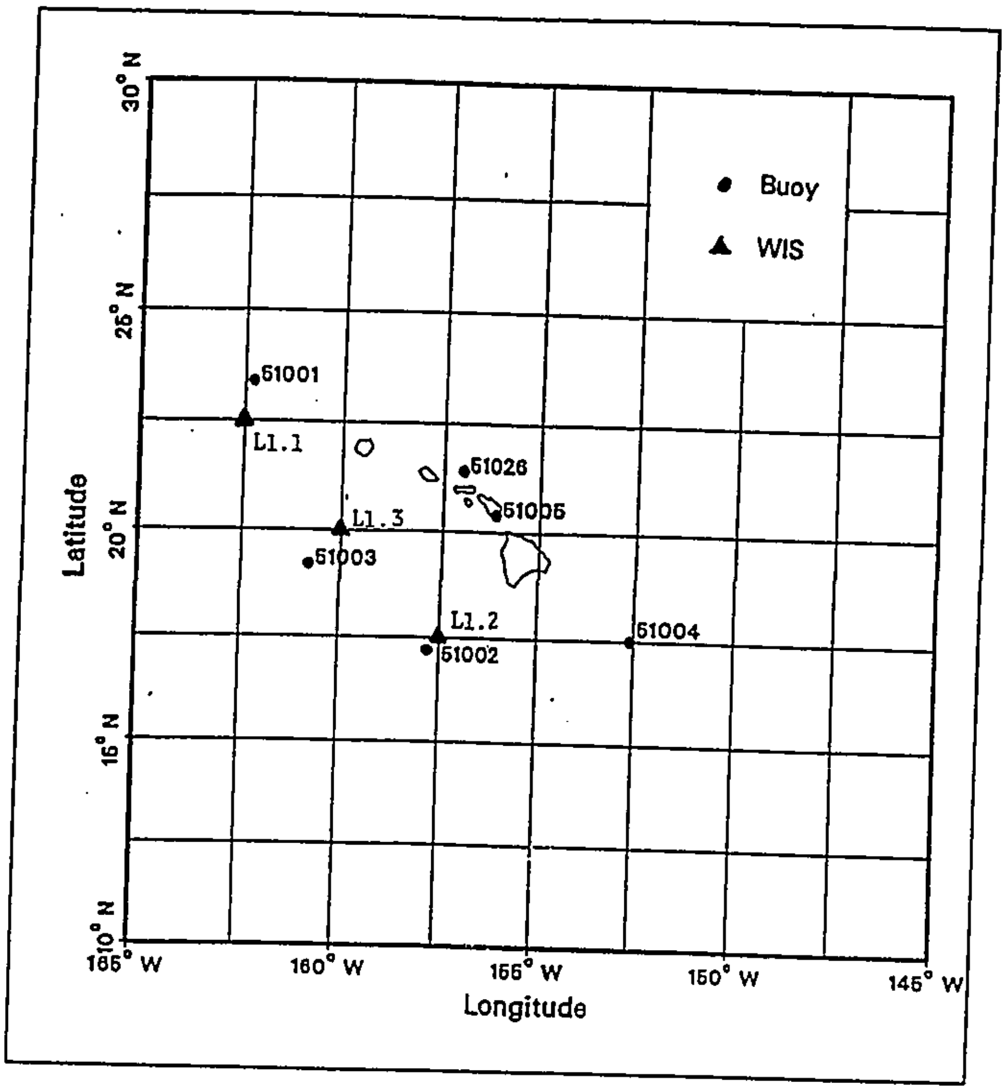

Figure 5. Location map for NDBC buoys and nearby WIS Level 1 stations

Hindcast waves during 1989 were compared with NDBC buoy measurements over the same time period. Each buoy was compared to the nearest WIS Level 1 station. Comparison statistics show root-mean-square (rms) differences and mean differences in significant wave height, H_s, and mean spectral wave period, T_m (Table 1). The biases are quite small and the rms differences are typical of a validated hindcast model (Brooks and Brandon 1995).

It is important to evaluate whether the time period of special hindcast is representative of the long term climate incident to the south coast of Kauai. Wave parameter summaries for the deepwater sources are compared in Table 2. Long term mean values of H_s for the three buoys are within 0.1 m of the corresponding WIS stations during 1989. Mean T_p values are within 1 sec. Standard deviations of H_s are similar between the buoys and WIS stations. Standard deviation of T_p is

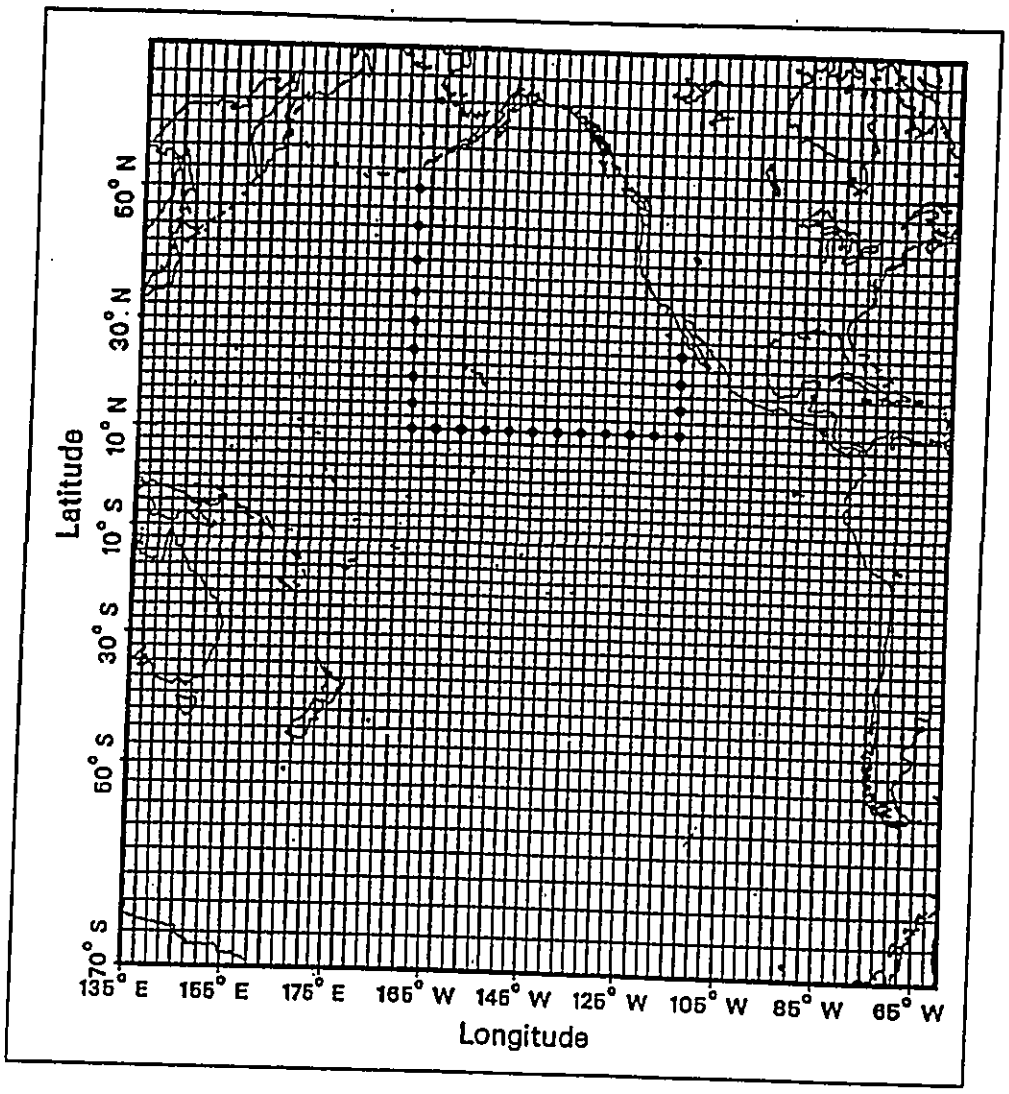

Figure 6. Location map for wave climate study, WIS Level 1 grid

Table 1
Comparison of WIS Level 1 Hindcasts and NDBC Buoy Data, 1989

WIS Station	NDBC Buoy	RMS Difference		Bias	
		H_s (m)	T_m (sec)	H_s (m)	T_m (sec)
L1.1	51001	0.47	1.6	-0.06	-0.6
L1.2	51002	0.53	1.9	0.03	-0.4
L1.3	51003	0.51	1.6	0.10	-0.6

* Calculation based on model minus measured values.

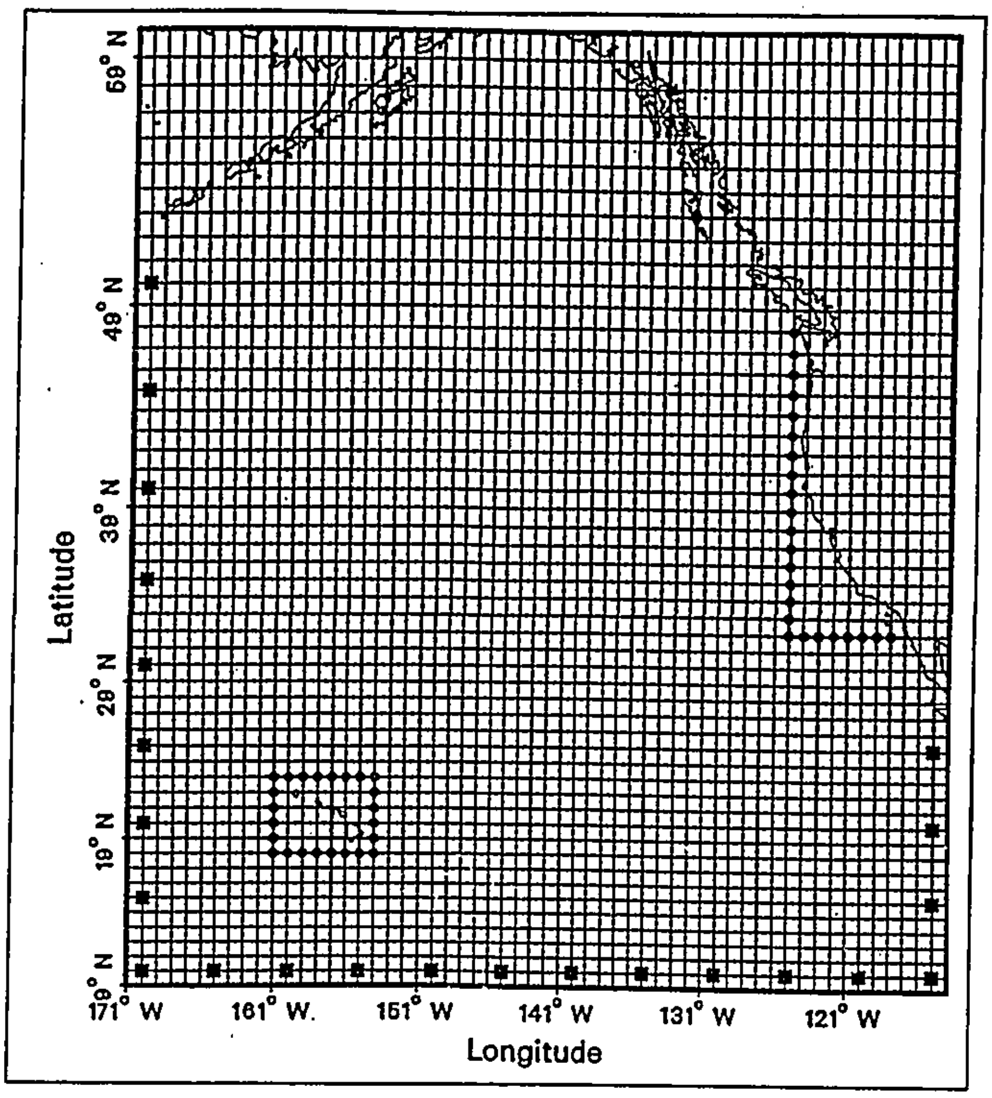

Figure 7. Location map for wave climate study, WIS Level 2 grid

somewhat greater for the buoys than for the WIS stations. Overall, the WIS information for the year 1989 appears representative of the long term climate.

Wave information from the special WIS Level 4 hindcast was saved at a deepwater point about one mile offshore from Kikiaola Harbor. Wave climate at this point is summarized in Figs. 9-11. Wave directions are predominantly from the south (180 deg) and west northwest (300 deg). Waves coming from the west, northwest, and north outside the islands are partially blocked by Niihau and western Kauai before they can arrive at Kikiaola Harbor. The concentration of waves coming from 300 deg indicates that a significant amount of wave energy is penetrating around and between the islands.

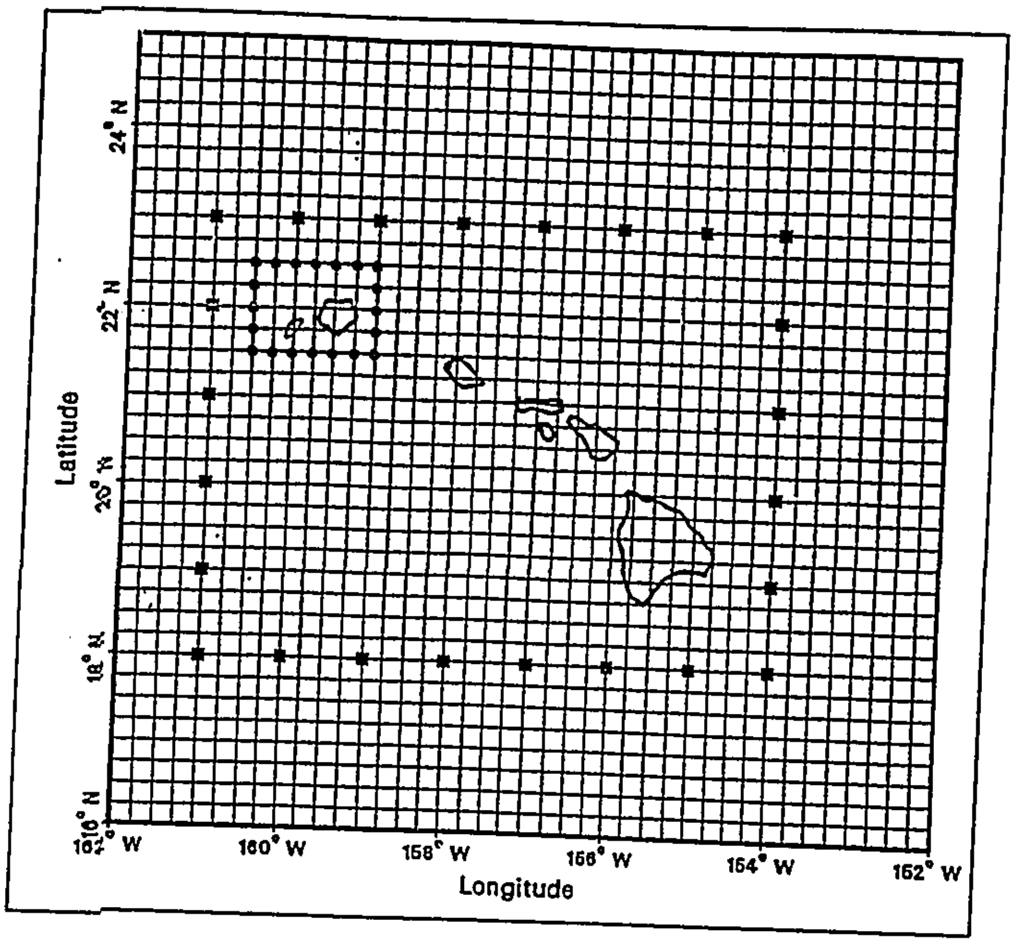

Figure 8. Location map for wave climate study, WIS Level 3 grid

Table 2
Summary Statistics, NDBC Buoys and WIS

Statistical Parameter	Buoy 51001[1]	WIS L1.1[2]	Buoy 51002[3]	WIS L1.2[2]	Buoy 51003[4]	WIS L1.3[2]
Mean H_s (m)	2.4	2.3	2.4	2.3	2.2	2.3
Standard deviation of H_s (m)	0.9	0.6	0.7	0.5	0.7	0.6
Mean T_p (sec)	10.5	11	10.2	11	10.4	11
Standard deviation of T_p (sec)	2.9	2	2.8	2	2.9	1

[1] Data from Feb 81 through Dec 93
[2] Data from Jan-Dec 89
[3] Data from Sep 84 through Dec 93
[4] Data from Nov 84 through Dec 93

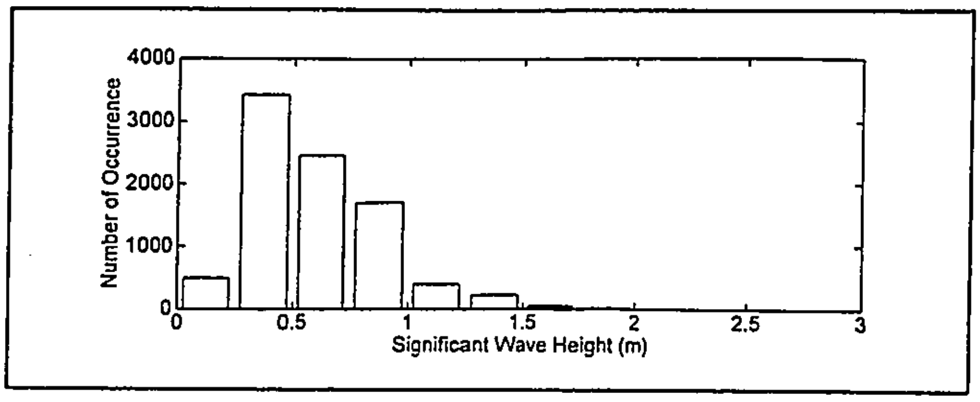

Figure 9. Deepwater wave climate, H_s

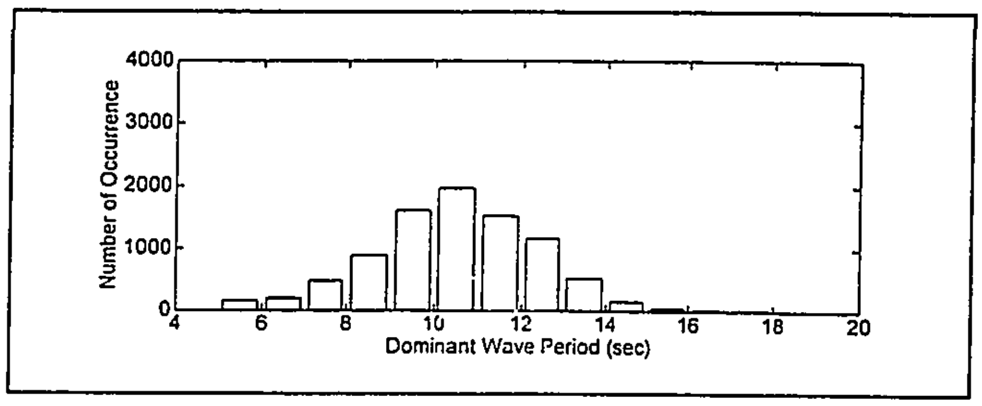

Figure 10. Deepwater wave climate, T_p

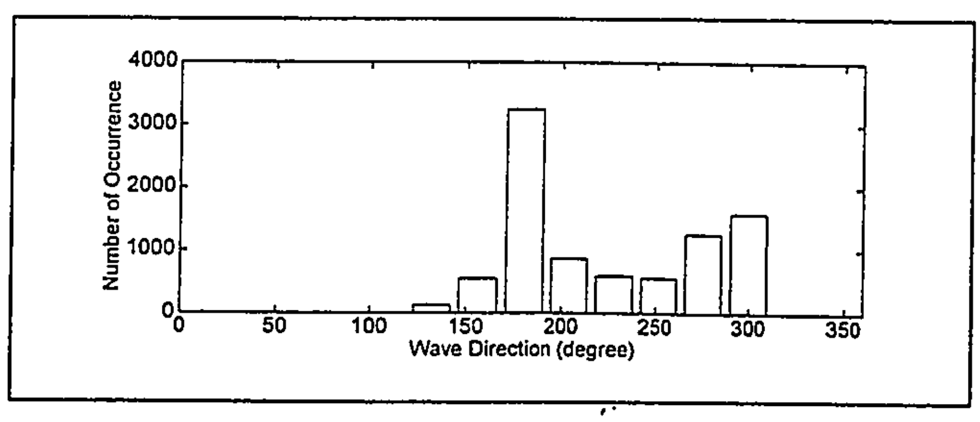

Figure 11. Deepwater wave climate, θ_m (deg, coming from)

Wave Climate at Kikiaola Harbor

The deepwater wave climate analysis suggests that data from the special one-year hindcast reasonably characterizes the wave climate immediately incident to Kikiaola Harbor. The hindcast information must be transformed into shallow water to provide wave climate at the seaward boundary of the HARBD model, in water depth of approximately 13 ft (4 m).

Initially, the nearshore transformation was attempted using the STWAVE and RCPWAVE models in the Automated Coastal Engineering System (ACES 2.0) (Leenknecht and Tanner 1996; Leenknecht, Tanner, and Sherlock 1997). The models gave inconsistent results over the highly irregular bathymetry near Kikiaola Harbor. Since bathymetry contours are fairly straight and parallel seaward of about 18 ft MLLW, the deepwater wave conditions were transformed to 13-ft depth using simplified refraction procedures. Each deepwater wave condition was represented as a combination of many multi-directional wave components. The amount of directional spreading was greatest for short period cases and gradually narrowed as T_p increased. Each component was refracted over straight, parallel bottom contours with an east-west orientation. Components were recombined in 13-ft depth to give a shallow water significant wave height and dominant direction.

Wave climate in 13-ft depth seaward of the harbor is summarized in Figs. 12 and 13. The distribution of wave periods, T_p , is not shown because it is basically unchanged in the transformation process. Wave directions are concentrated between the south and south southwest.

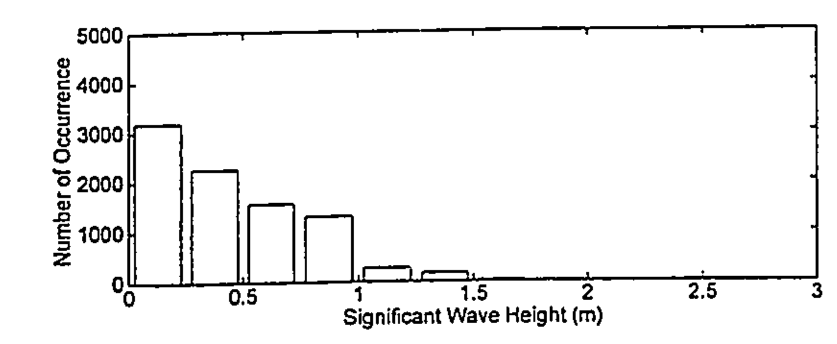

Figure 12. Harbor entrance wave climate, H_s

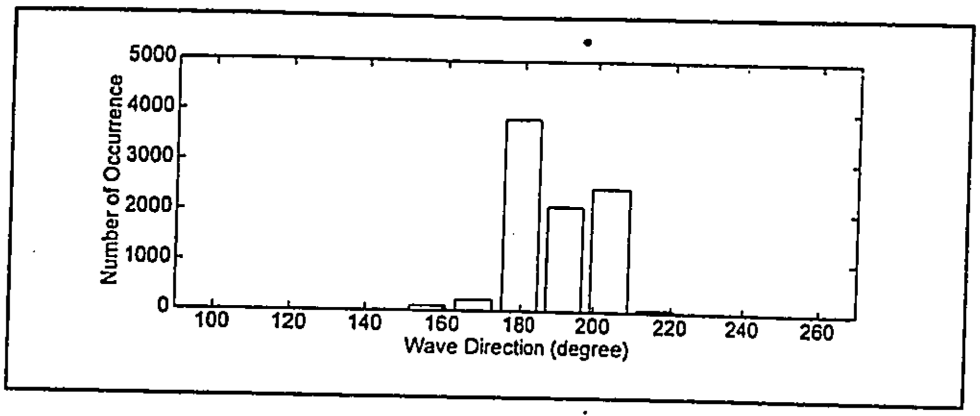

Figure 13. Harbor entrance wave climate, θ_m (deg, coming from)

3 Numerical Model

Objectives and Approach

The numerical model study had two objectives:

a. Advance understanding of the existing harbor wave response.

b. Evaluate the effect of proposed harbor modifications on wave response.

The harbor wave response model is presented in the following section, including a brief description of the HARBD model and implementation of the model at Kikiaola Harbor. The final section of this chapter describes the test procedures and calculations.

As part of the test procedures, a suite of incident wave conditions must be specified at the seaward boundary of the area covered by HARBD. Incident short waves are determined by consideration of transformed WIS information outside the harbor. Incident long waves are specified over a broad range of frequencies but only a normally-incident direction to identify possible harbor resonant responses.

Model Description

Model Formulation

The numerical wave model HARBD is a steady state hybrid element model used in the calculation of linear wave response in harbors of varying size and depth (Chen 1986, Chen and Houston 1987, and Lillycrop and Thompson 1996). The model as applied in this study is described in a recent report on Kahului Harbor, Maui, Hawaii (Thompson et al. 1996). An overview of the model and its applications is given by Thompson and Hadley (1995).

The principal output information available from HARBD consists of amplification factor and phase at each node in the numerical grid. These are defined as

$$A_{amp} = \left|\frac{a}{a_i}\right| = \left|\frac{H}{H_i}\right| = |\phi|$$

$$\psi = \tan^{-1}\left[\frac{Im\{\phi\}}{Re\{\phi\}}\right] \tag{1}$$

where A_{amp} = amplification factor,
a, a_i = local and incident wave amplitudes,
H, H_i = local and incident wave heights,
ϕ = velocity potential,
ψ = phase relative to the incident wave,
$Im\{\phi\}$ = imaginary part of ϕ,
$Re\{\phi\}$ = real part of ϕ.

Amplification factors are easily interpreted. Phases are helpful in viewing wind wave and swell propagation characteristics and in interpreting standing wave patterns. In long wave applications, phases prove useful for determining relative phase differences within the harbor, interpreting harbor oscillation patterns, and identifying potentially troublesome nodal areas.

Spectral Adaptation

HARBD computes harbor response to specified wave period and direction combinations. However the model is often used to approximate irregular wind wave and swell behavior, as in physical model tests with irregular waves and all field cases. More realistic numerical model simulations can be obtained by linearly combining HARBD results from a range of regular wave frequencies and directions in the irregular wave spectrum. With proper weighting, regular wave results represent a desired spectral distribution of energy.

Spectral adaptation of the HARBD model is done as a post-processing step using the standard, regular wave output from the model. For a given set of incident wave directions representing the range of possible approach directions, HARBD is run for a number of wave periods spread between the shortest period consistent with grid resolution constraints and the longest swell period of interest. Details of the procedure are given by Thompson et al. (1996).

The effective amplification factor at each node is computed as

$$(A_{amp})_{eff} = \sqrt{\sum_{k=1}^{N_T}\sum_{n=1}^{N_D} w_n\, w_k\, A^2_{amp}(f_k, \theta_n)} \tag{2}$$

where $(A_{amp})_{eff}$ = effective, or spectral, amplification factor at a node
$A_{amp}(f_k, \theta_n)$ = nodal amplification factor for HARBD computational frequency f_k and direction θ_n
N_T = number of HARBD computational wave periods
N_D = number of HARBD computational wave directions

w_k = weighting factor for k'th HARBD computational frequency
w_n = weighting factor for n'th HARBD computational direction

Finite Element Grids

The finite element numerical grid depicting existing conditions at Kikiaola Harbor was created using WES's finite element grid development software (Turner and Baptista 1993) (Figure 14). The grid covers the entire Kikiaola Harbor area and extends somewhat seaward into Waimea Bay. The land boundary was matched to recent POD surveys of the harbor. Grid element size is based on the criterion of 6 elements per wavelength (the minimum recommended resolution with HARBD) for a 6-sec wave in 4-ft water depth. Depths for areas of interest in the existing and plan harbors generally exceed 4 ft. Some areas of interest in the existing harbor are shallower than 4 ft (even at a high tide water level of +1 ft MLLW), but it was impractical to make the grid significantly finer. The grid was expected to be adequate for the existing harbor, as well as the plan harbors. For the longer period waves, the grid gives a high degree of resolution. Grid characteristics are summarized in Table 3.

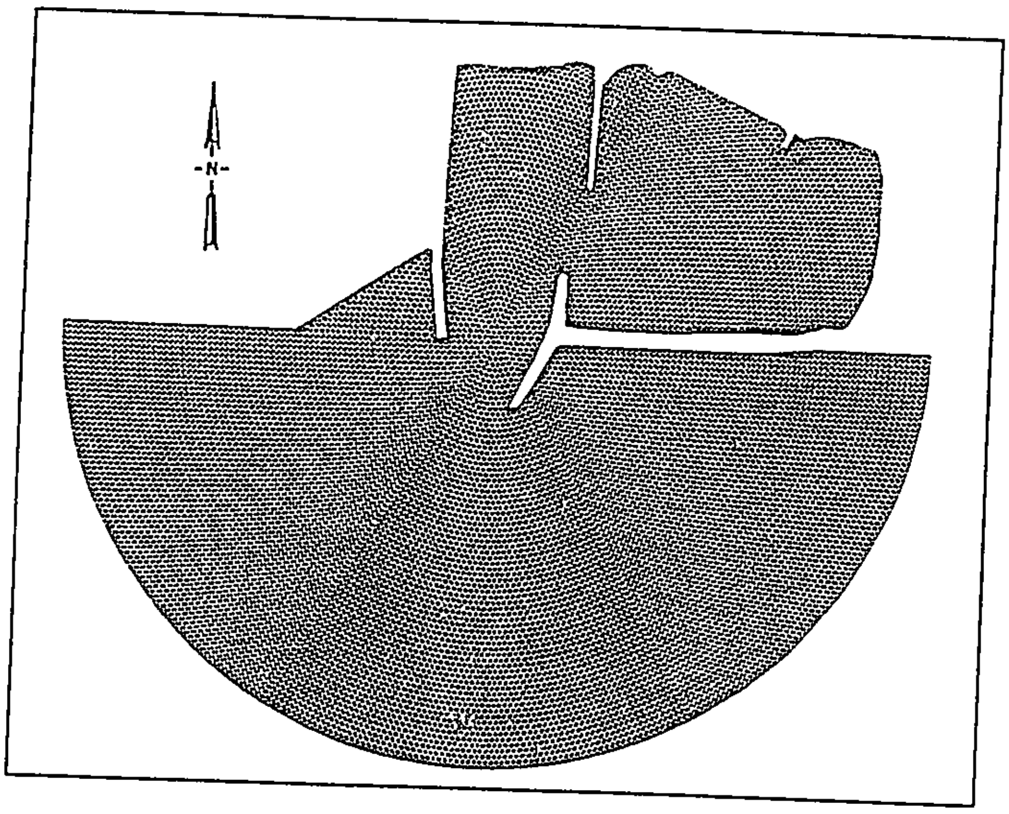

Figure 14. Grid of existing harbor

Table 3 Grid Sizes					
Harbor Plan	Number of:				Length of Typical Element (ft)
	Elements	Nodes	Solid Boundary Elements	Semicircle Boundary Nodes	
Existing	24227	12461	462	232	11
Plan 1	24524	12602	447	232	11
Plan 6	27345	14014	450	232	11

The radius of the seaward semicircle is 854 ft. This is equivalent to 2.1 and 8.1 wavelengths for the longest and shortest short wave periods considered, assuming a representative water depth of 11 ft (10-ft depth below MLLW plus 1-ft tide). The semicircle size and location were chosen to include both breakwaters and the immediate nearshore area. The semicircle extends sufficiently far seaward to cover the most important nearshore bathymetry while maintaining a reasonable number of grid elements.

Bathymetric data were obtained from recent (summmer of 1996) POD surveys of the harbor area and extending seaward to the 300 ft depth contour. NOAA hydrographic chart 19386 provided a useful reference for bathymetry outside the survey area. Digitized depths were transferred onto the finite element grid using the WES grid software package. A contour plot of bathymetry in the existing harbor is given in Figure 15. Bathymetry was modified for Plans 1 and 6 to include project depths in the entrance and access channels (Appendix A). Per discussions with POD, the plan bathymetry also includes deepening of the harbor areas expected to be used for mooring (Fig. 16).

Reflection coefficients, K_r, are needed for all solid boundaries. For the short wave tests, K_r values were estimated from existing Corps of Engineers guidance, photos, and field notes from a May 1996 site visit by WES and POD representatives, and past experience. The solid boundary was divided into nine zones and a reflection coefficient was estimated for each zone (Figure 17). Reflection coefficients range from 0.05 for the shallow, gently sloped beach along the southeast shore of the existing harbor to 0.5 for all breakwater areas. Similar reflection coefficients were used in the plan harbors. Additional parameter values used in the numerical model are summarized in Table 4.

Different parameters are used for the long wave tests. The reflection coefficient was set to 1.0 for all solid boundaries, since long waves generally reflect very well from a coastal boundary. A reflection coefficient of zero was used along the open boundary west of the west breakwater. Long waves are more

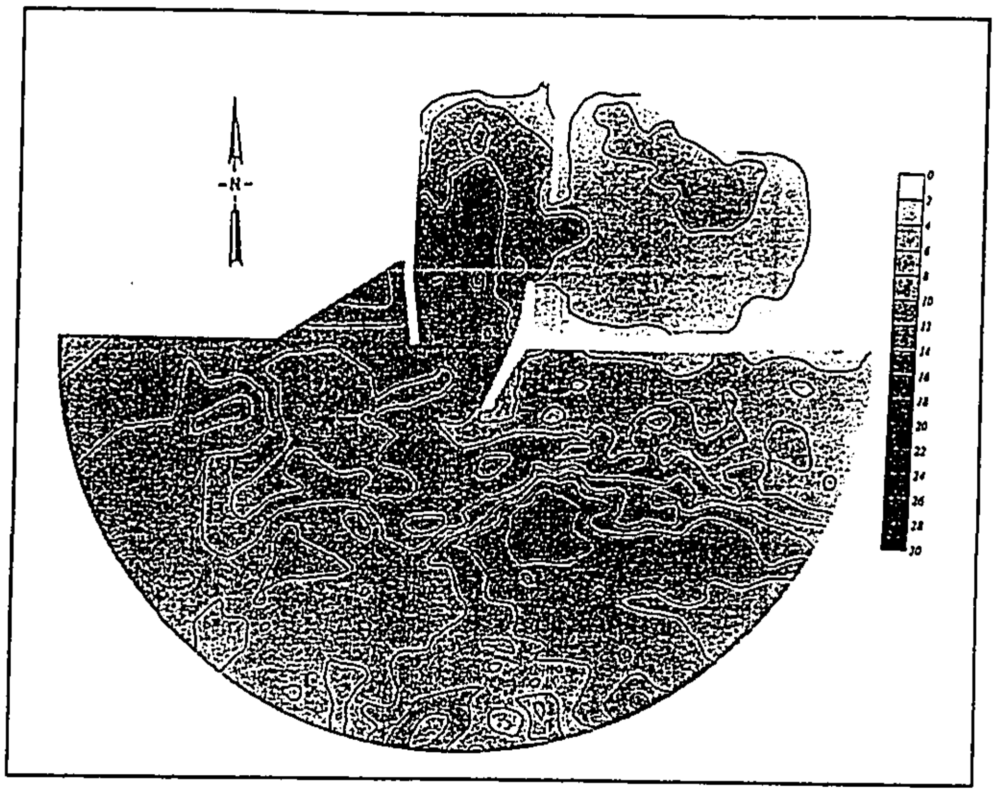

Figure 15. Bathymetry, existing harbor

Table 4
Parameter Values Used in HARBD

Parameter	Value	
	Short Waves	Long Waves
Bottom friction, β	0.0	0.032
Coastline reflection, $K_{r,coast}$	1.0	1.0
Depth in infinite region, d_{far}	10 ft below MLLW	10 ft below MLLW

affected by bottom friction than short waves, so a value of β greater than zero is appropriate. A value of $\beta = 0.032$ was selected, based on experience calibrating to field data at other sites, principally Kahului Harbor (Thompson et al. 1996). This and other long wave parameters are given in Table 4.

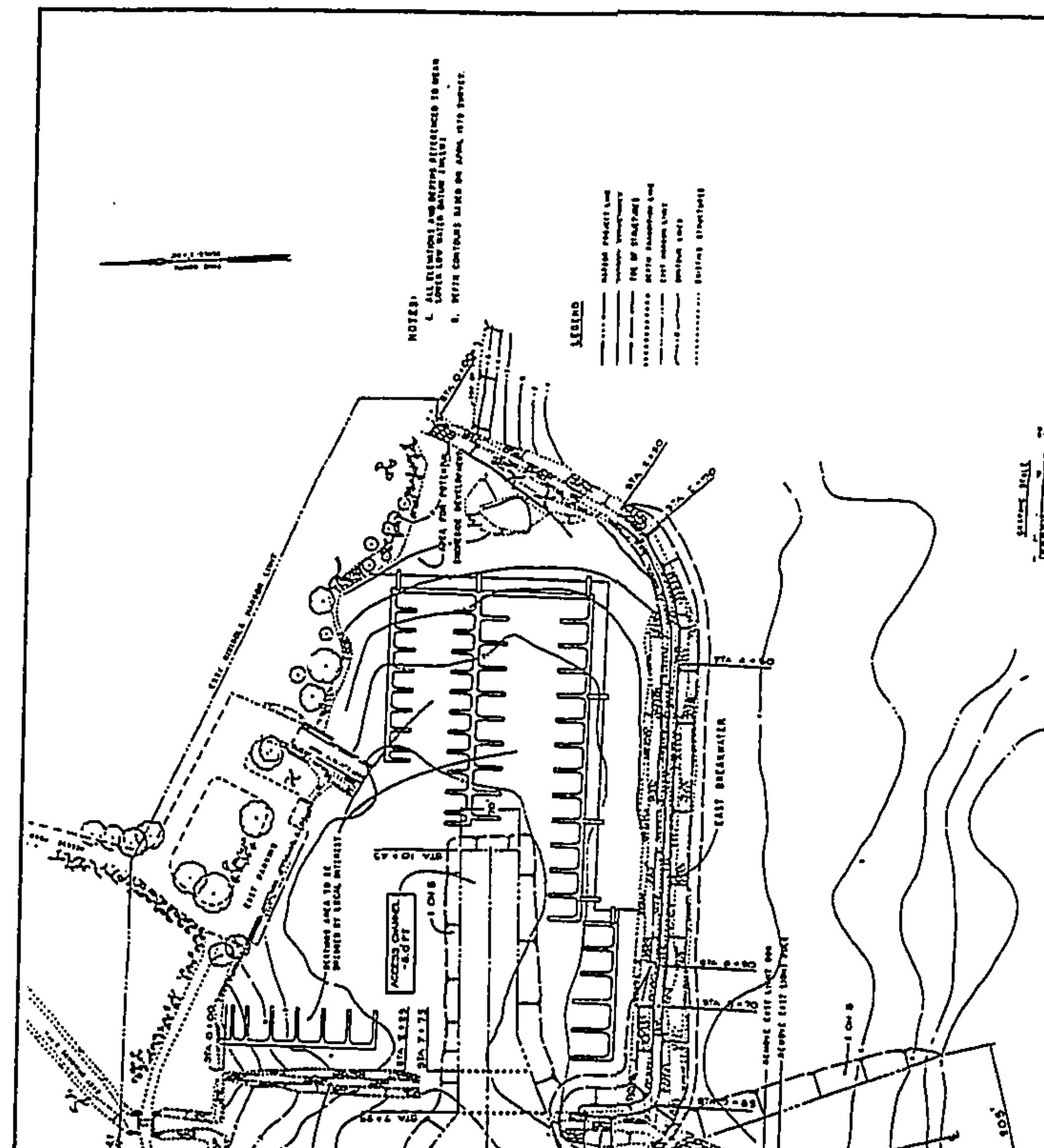

Figure 16. Possible berthing plan for Kikiaola Harbor (U.S. Army Corps of Engineers 1980)

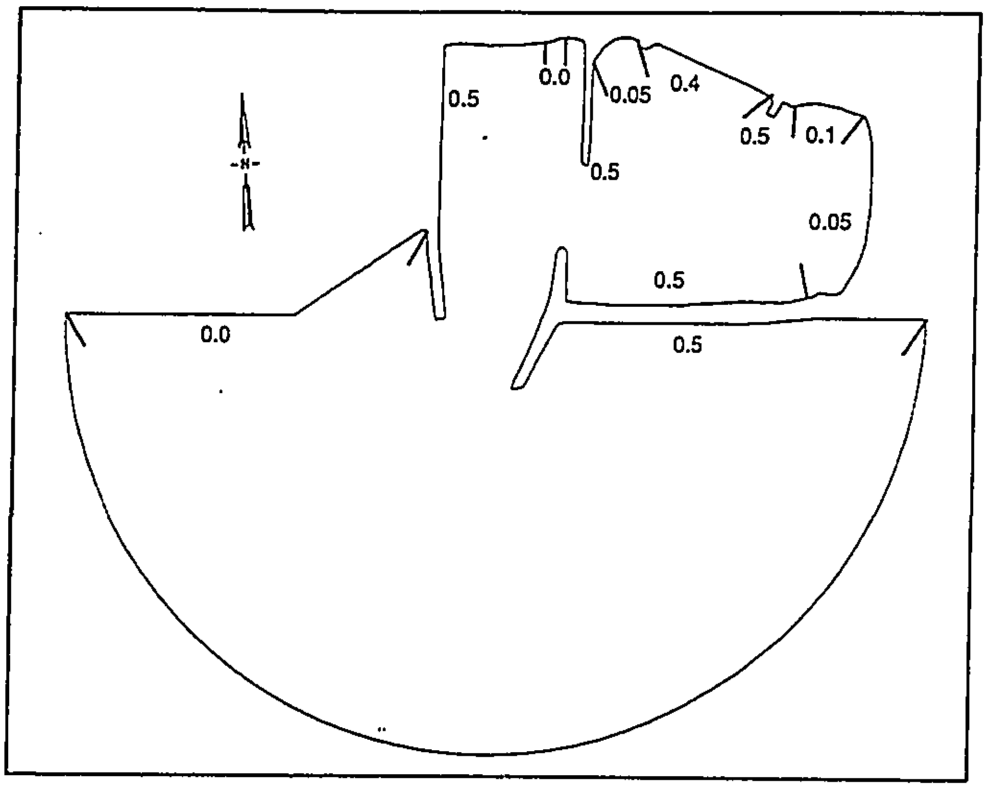

Figure 17. Wave reflection coefficient values, short waves, existing harbor

Test Procedures and Calculations

Incident Wave Conditions

A range of short and long wave conditions incident to Kikiaola Harbor was considered. A representative range of wave periods and directions which could cause damaging conditions inside the harbor was included, based on WIS information.

The short wave periods and approach directions considered are given in Table 5. These conditions provide reasonable coverage of the WIS information for the area, summarized in Figures 10, 12 and 13. The shortest period represents a local

Table 5
Summary of Incident Short Wave Conditions

Wave Period (sec)		Wave Direction (deg, coming from)
6	15	164
7	16	184
8	17	204
9	18	
10	19	
11	20	
12	21	
13	22	
14		

sea condition and the longest represents a very long swell condition. Directions were chosen to include likely approach directions to the harbor entrance and to give adequate representation of the directional spectrum in post-processing. Test directions were straight into the harbor (184 deg) and 20-deg increments to either side (coming from, relative to true north). Incident wave directions and the angular orientation of the seaward semicircular model boundary are illustrated in Figure 18.

For the study of existing harbor conditions and comparison of alternatives, HARBD was run with the full set of short wave periods and directions in all possible combinations. Model results were then evaluated for directional spectra with T_p and θ_m values as follows: periods of 6, 7, ..., 20 sec and directions of 150, 160, ..., 210 deg azimuth (coming from). These values cover the range of conditions in the WIS nearshore information.

Incident long wave conditions considered are given in Table 6. A fine resolution in wave frequency was used over the full range of possible resonant conditions to insure that all important peaks were identified. A total of 451 periods was considered. Only one approach direction is included, since past studies have indicated that harbor response is relatively insensitive to incident long

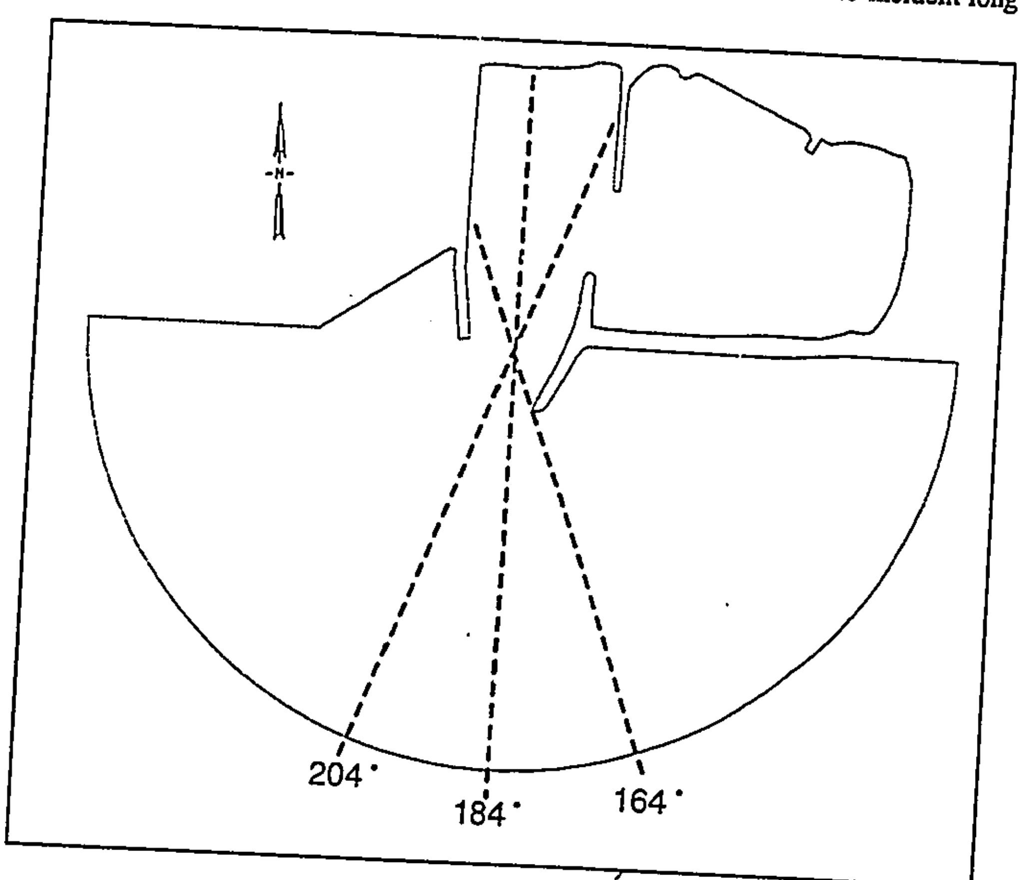

Figure 18. Incident wave directions

wave direction. This direction represents a wave directly approaching the harbor entrance from deep water.

One water level was tested. The tide range at Kikiaola Harbor is relatively small, with a mean range of about 1 ft. Harbor wave response is unlikely to vary much with water level over this tidal range. The water level was selected as +1.0 ft above mean lower low water, representative of a high tide condition.

Table 6
Summary of Incident Long Wave Conditions

Wave Period (sec)	Wave Direction (deg, coming from)
25.00	184
25.06	
25.13	
...[1]	
500.0	

[1] Frequency increments are 0.0001 Hz for periods of 25-80 sec and 0.00006 Hz for periods of 80-500 sec.

Calculation of Spectra

Numerical model test results for short waves in Kikiaola Harbor are all based on spectral post-processing of the initial HARBD runs. Hence, short wave amplification factors are all in the form of $(A_{amp})_{eff}$ in Eq. 2. This approach requires, first, that HARBD be run with the range of wave periods and directions to be considered in the spectral calculations. Second, values of peak wave period, T_p, corresponding to the peak spectral frequency; wave approach direction, θ_m; spectral peak enhancement factor, γ; and directional spreading factor, s, must be specified. The T_p and θ_m values were chosen to represent wind wave and swell conditions at the harbor, as discussed in the section on Incident Wave Conditions. Values for γ and s were approximated as discussed by Thompson et al. (1996).

Output Basins

In order to get special coverage of areas where harbor traffic would most likely be affected by wave conditions, between 15 and 25 output locations or "basins" were selected to cover each harbor layout. A basin is a small cluster of elements over which the HARBD response is averaged to give a more representative output. Whenever possible basins were positioned to coincide with basins of other plans, particularly those of the existing harbor (Appendix A). Each basin in this study contains 12-15 elements. HARBD output information was saved at each of these locations in addition to the detailed output at nodes.

4 Harbor Response To Wind Waves and Swell

Numerical model studies of the harbor response to wind waves and swell were directed primarily toward assessing the operational performance of alternative harbor modifications. Results are summarized in this chapter. Amplification factors are presented in the following section. The final section gives H_s values exceeded 10 percent and 1 percent of the time, a result more directly applicable to operational performance. The H_s values are derived from a combination of amplification factors from the numerical model and wave hindcast information outside the harbor. They are compared to operational criteria for wind waves and swell.

Amplification Factors

Amplification factors, representing directionally-spread short wave spectra in the form of $(A_{amp})_{eff}$ in Eq. 2, were calculated for a variety of wind wave and swell conditions. Figure 19 illustrates the behavior of a common wave condition at Kikiaola Harbor, a 12-sec wave approaching from 200 deg azimuth. Contour plots of $(A_{amp})_{eff}$ for the existing and plan harbors are shown. The plots indicate reduced wave heights in the entrance channel near the main breakwater entrance in the plan conditions, as compared to the shoaled entrance in the existing harbor. Also, the plans are more effective than the existing harbor in affording protection to wharf and mooring areas from this wave condition.

Plots of wave phase (ψ in Eq. 1) are included in Figure 19. Since the phase lines show the alignment of wave crests, they give a visual representation of diffraction and shoaling effects on wave direction and length as the 12-sec waves interact with harbor structures and bathymetry. For clarity of presentation, the phase plots were taken from 12-sec *regular* wave results.

For a more concise comparison between the existing harbor and alternative plans, average values of $(A_{amp})_{eff}$ were computed for each basin across wave periods ranging from 6 sec through 20 sec. Figure 20 illustrates results for the existing harbor and two plans. The $(A_{amp})_{eff}$ changes progressively as incident wave direction changes. As would be expected, amplification tends to be greater for directions of more direct approach to the basins. As illustrated in Figure 19, the wind wave and swell response in the harbor is basically a result of diffraction

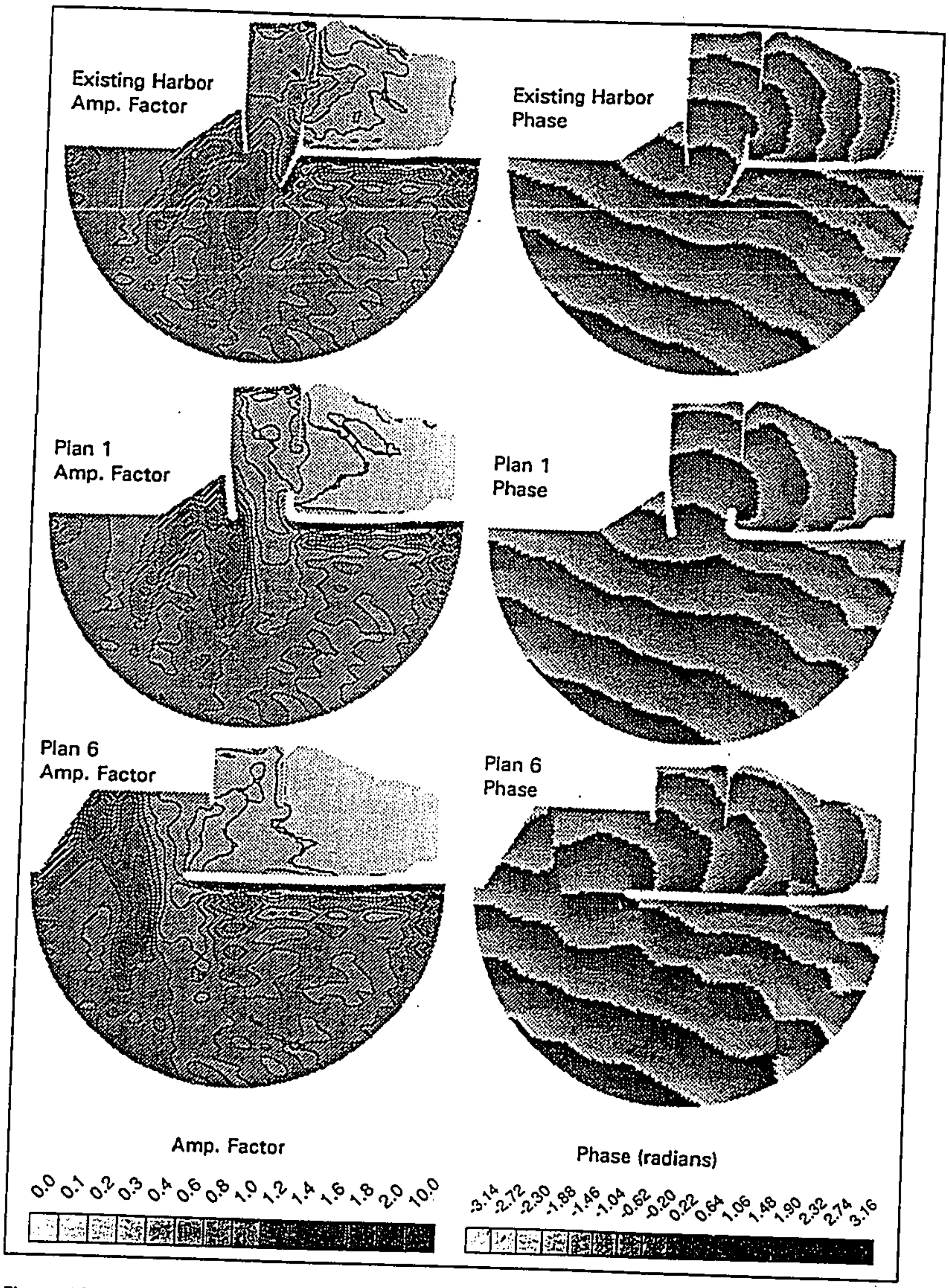

Figure 19. Amplification factor and phase contours, 12-sec wave period, 200-deg direction

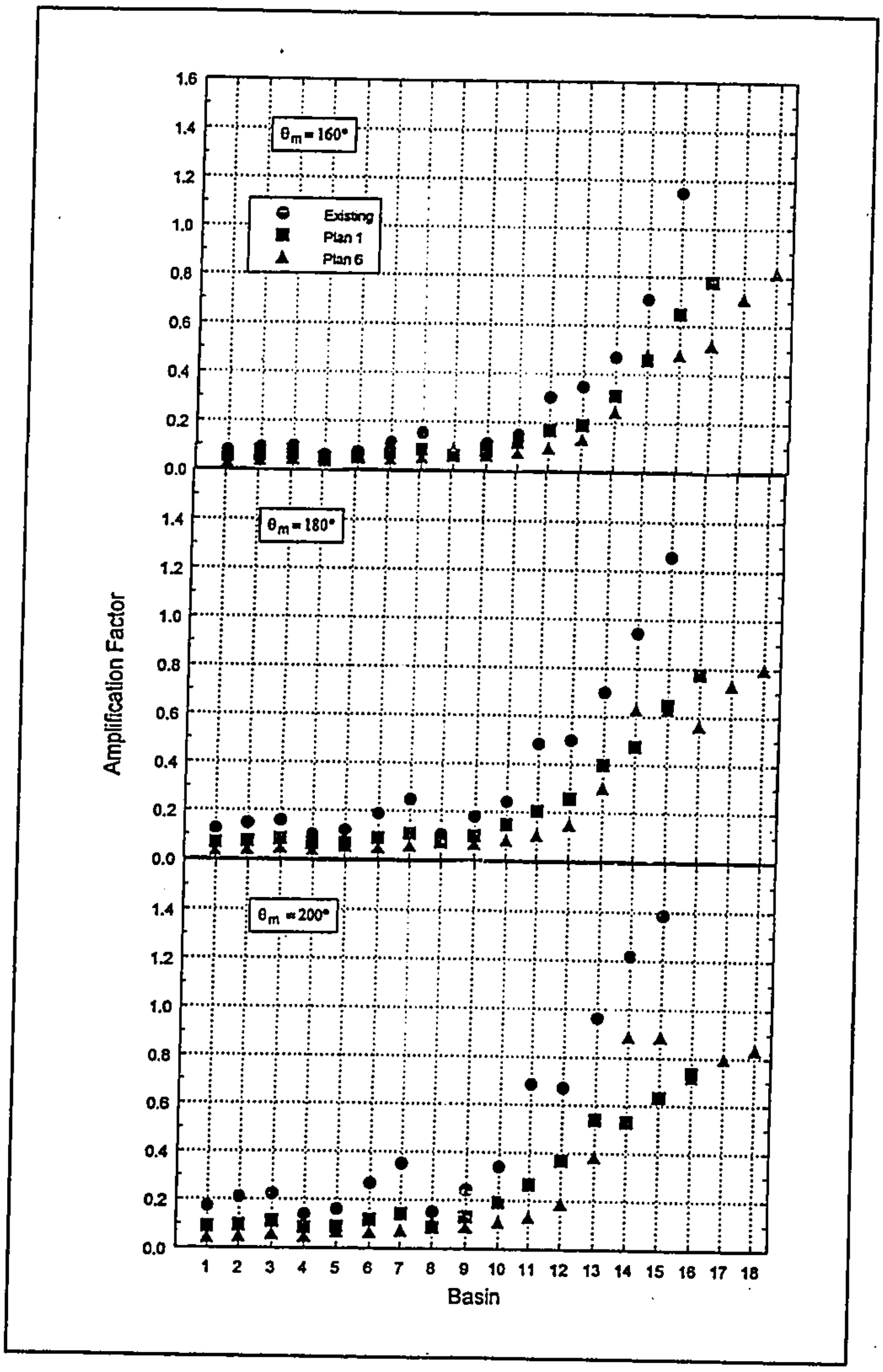

Figure 20. Comparison of $(A_{amp})_{eff}$ averaged over periods of 6-20 sec

through the breakwater gap. Boundary reflection characteristics have only a localized effect on the waves. Complete results of $(A_{amp})_{eff}$ averaged over wave period are given in Appendix B.

An even more concise description of $(A_{amp})_{eff}$ at each basin can be obtained by considering wave climate as well. A climate-based amplification factor is calculated for each basin as

$$(A_{amp})_{climate} = \sum_{j=1}^{N_T} \sum_{k=1}^{N_D} ((A_{amp})_{eff})_{jk} \frac{N_{jk}}{N_{total}} \tag{3}$$

where

jk = indices denoting the j^{th} period interval and k^{th} direction interval, where the intervals are based on the incident wave conditions in Table 5

$((A_{amp})_{eff})_{jk}$ = spectral amplification factor for the j^{th} period and k^{th} direction

N_{jk} = number of incident wave conditions with T_p and θ_m in the j^{th} and k^{th} period and direction intervals

N_{total} = total number of incident wave conditions

This climate-based amplification factor is given in Appendix B for every basin and harbor plan.

Amplification factors for basins in the shallower harbor areas can be expected to be conservative because bottom friction was set to zero in the HARBD model runs. This choice of bottom friction is standard procedure for wind wave and swell simulations and it has served well in many previous studies. However, in the study of Kahului Harbor, it appeared clear that the lack of bottom friction was significantly affecting model results in one very shallow basin (Thompson et al. 1996). Some very shallow basins in Kikiaola Harbor may be similarly affected. A trial run of the existing harbor with β=0.032 indicated the extra complications of using bottom friction (which makes amplification factors dependent on wave incident wave height as well as period and direction) were not warranted in this study.

Evaluation Against Operational Criteria for Wind Waves and Swell

Standard operational criteria used by the U.S. Army Corps of Engineers (USACE) for wind waves and swell in shallow draft harbors are:

- wave height in berthing areas will not exceed 1 ft more than 10 percent of the time

- wave height in entrance and access channels and turning basins will not exceed 2 ft more than 10 percent of the time

Wave heights for assessing the USACE criteria were computed by combining the time history of wave hindcast information with harbor model results to create a time history of wave heights at each harbor basin. For each WIS hindcast time, the corresponding wave height at a harbor basin is

$$(H_s)_{harbor} = (A_{amp})_{eff} \times (H_s)_{WIS} \tag{4}$$

where

$(H_s)_{harbor}$ = significant wave height at a harbor basin

$(A_{amp})_{eff}$ = spectral amplification factor interpolated between values for periods and directions in Table 5 to represent T_p and θ_m at the seaward HARBD boundary

$(H_s)_{WIS}$ = significant wave height at the seaward HARBD boundary

The 12-month time history of $(H_s)_{harbor}$ at each basin was sorted into descending order and the value of H_s which was exceeded 10 percent of the time was identified. The H_s value exceeded 1 percent of the time was also identified. The H_s with 1 percent exceedance relates to a more demanding operational condition, which may also be helpful in assessing performance of the harbor plans.

Significant wave heights exceeded 10 percent of the time are less than 1 ft at the wharf in the existing and plan harbors (Figure 21). The USACE criteria for acceptable berthing areas and channels are shown in the figure as solid lines. Wave conditions in the inner channel satisfy the USACE criterion in the existing and plan harbors. However, wave conditions in the outer portion of the existing channel exceed the criterion. Wave conditions in the outermost portions of the channel in Plans 1 and 6 slightly exceed the USACE criterion. In conjunction with the increased width of the outermost portion of the plan channels, the small exceedance of the USACE criterion is unlikely to interfere with safe navigation.

The H_s values exceeded 1 percent of the time are considerably higher than those exceeded 10 percent of the time, but show similar relative trends (Appendix B). The existing wharf area still falls below the 1-ft wave height threshold. Values of H_s with 10- and 1-percent exceedence are tabulated in Appendix B.

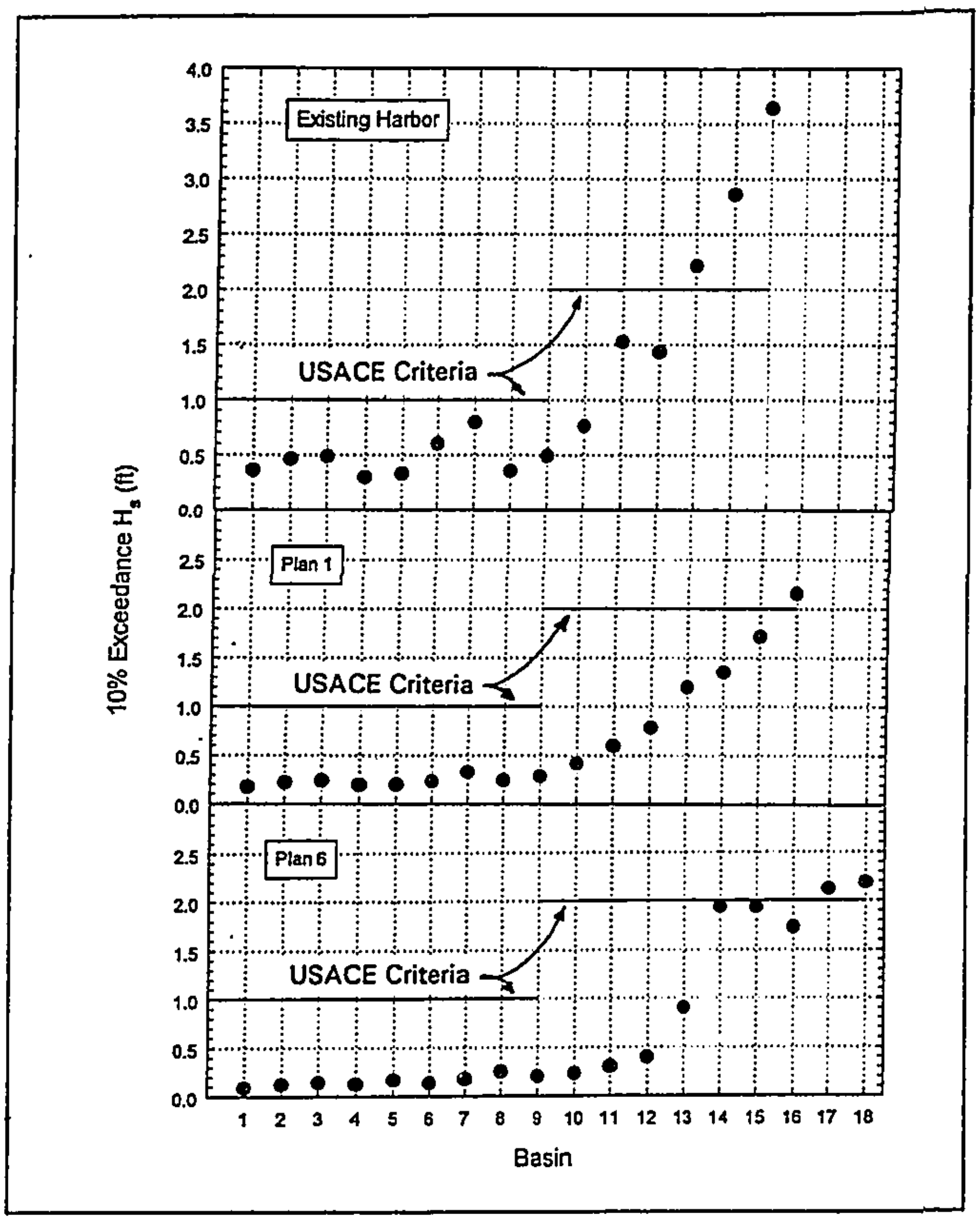

Figure 21. Comparison of H_s exceeded 10 percent of the time

5 Harbor Oscillations

To evaluate harbor resonance characteristics, the HARBD numerical model was run for the existing harbor and Plan 6. Incident long wave periods ranged from 25 sec to 495 sec in very fine increments, as discussed in Chapter 3. These evaluations were included because oscillations are an important part of interpreting the existing harbor wave response, and modifications to the harbor can potentially lead to operational problems due to harbor oscillations. Amplification factor results are presented in the following section. The operational significance of the results is discussed in the final section.

Amplification Factors

Amplification factors for the long waves involved in harbor oscillation behave differently than those for wind waves and swell. Long waves, because of their length relative to harbor dimensions and their reflectivity from harbor boundaries, form *standing wave* patterns in the harbor. Standing wave behavior in a simple closed basin of uniform depth is illustrated in Figure 22. In the fundamental mode of oscillation, *antinodes* occur at both basin walls and a *node* midway between walls. Second and third modes of oscillation are also illustrated. Antinodes always occur at the walls. Additional antinodes and nodes occur at regular intervals between walls, with the number of antinodes and nodes dependent on the mode of oscillation.

The water surface in a standing wave has its greatest vertical motion at antinodes. There is no vertical movement at an ideal node, but horizontal velocities reach a maximum there. In terms of amplification factors, this behavior gives large values of $A_{amp,I}$ at antinodes and small values around

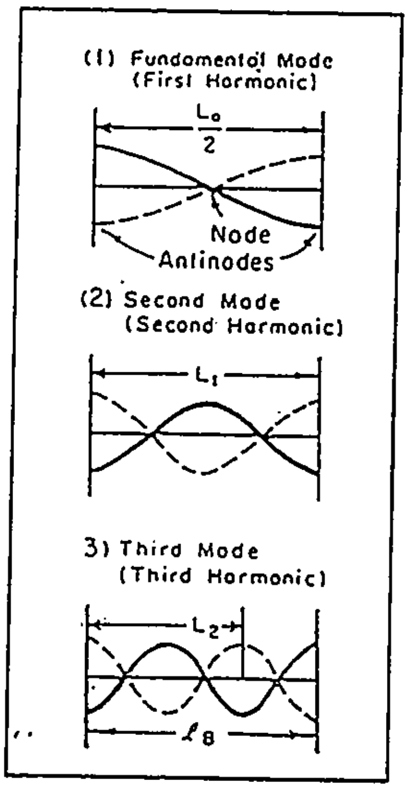

Figure 22. Harbor oscillation definitions

nodes (the notation $A_{amp,l}$ is used to denote *long* wave amplification factors). Contrary to wind waves and swell, small values of $A_{amp,l}$ are not necessarily indicative of a tranquil harbor area.

Phases in a standing wave also behave differently than for typical wind waves and swell. For example, the water surface in the fundamental mode of oscillation in Figure 22 simultaneously reaches a maximum at every point to the left of the node. These points are all in phase. At the same time, every point to the right of the node reaches a minimum value. These points are also in phase with each other but exactly out of phase with the points to the left of the node. Thus phases in a simple standing wave are constant between an antinode and node. They quickly change by 180 deg (or π radians) across the node and remain constant up to the next node or boundary.

Because of the nature of long wave behavior, harbor oscillation studies must include consideration of likely antinode locations, particularly harbor corners. Several output basins were added to those used for wind waves and swell, as shown in Appendix A.

Amplification factors for basins in the existing harbor and Plan 6 are shown as a function of wave frequency in Appendix C. Some frequencies produce a strong resonant amplification, with peak amplification factors between about 2 and 7. Some of the same resonant frequencies appear at several basins though the strength of amplification can vary considerably between basins. A large peak at very low frequency (0.00214 Hz or 470-sec period in existing harbor; 0.00274 Hz or 365-sec period in Plan 6) shows at every basin and plan. This peak represents the Helmholtz (or *grave*) mode of oscillation, in which the entire harbor rises and falls in unison. Phase is constant over the whole harbor. Computed values of $A_{amp,l}$ over the range of frequencies up to and including the Helmholtz mode were divided by two because these oscillations affect the entire numerical model domain and would otherwise give a distorted view of the harbor effect.

Amplification factor and phase contour plots for six of the dominant resonant peaks in the existing harbor (excluding Helmholtz resonance) show oscillation patterns. In the amplification factor plots, areas of high amplification are evident as darker shades of gray (Figure 23). Corresponding phase contours are shown in Figure 24. Areas in which phase contours are tightly bunched indicate nodal areas. As would be expected for standing waves, nodal lines in Figure 24 coincide with low amplification factors in Figure 23. The phase plots also indicate areas of the harbor which rise and fall together during the resonant condition (same gray shade). Thus the oscillation patterns can be interpreted.

The 150.60-sec resonant period shown in Figure 23 represents a relatively simple rocking oscillation between the outer and inner harbor areas. The nodal line lies just inside of the entrance to the inner harbor. In the 61.35-sec period resonance, opposite corners of the harbor complex act in phase. The main entrance and northeast corner rise and fall together, as do the north part of the outer harbor and the southeast corner of the inner harbor. A nodal line intersects the wharf. Shorter period resonances occur across shorter harbor dimensions or as higher order modes along the longer dimensions. The 40.16-sec resonance

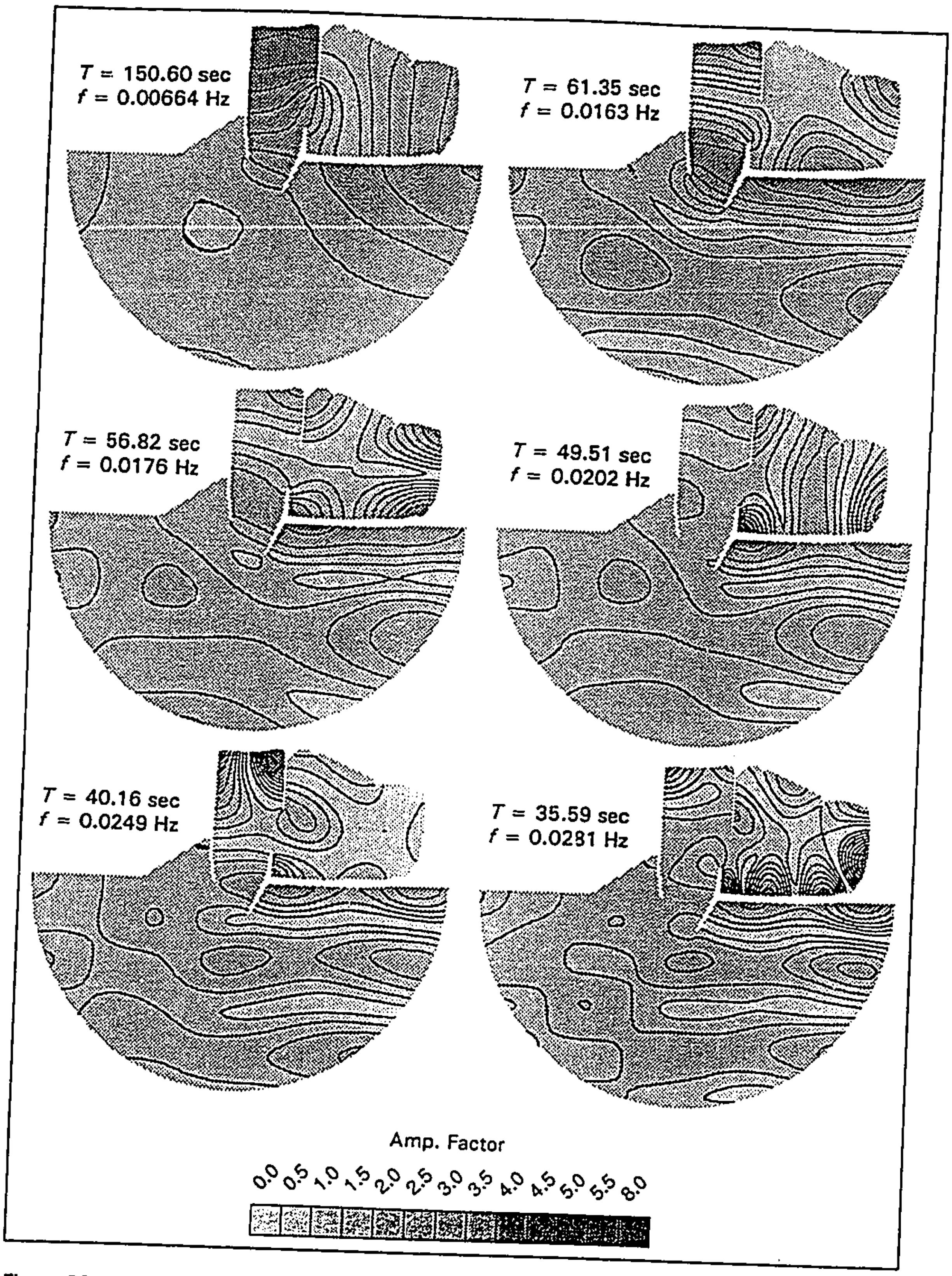

Figure 23. Resonant long wave amplification factor contours, existing harbor

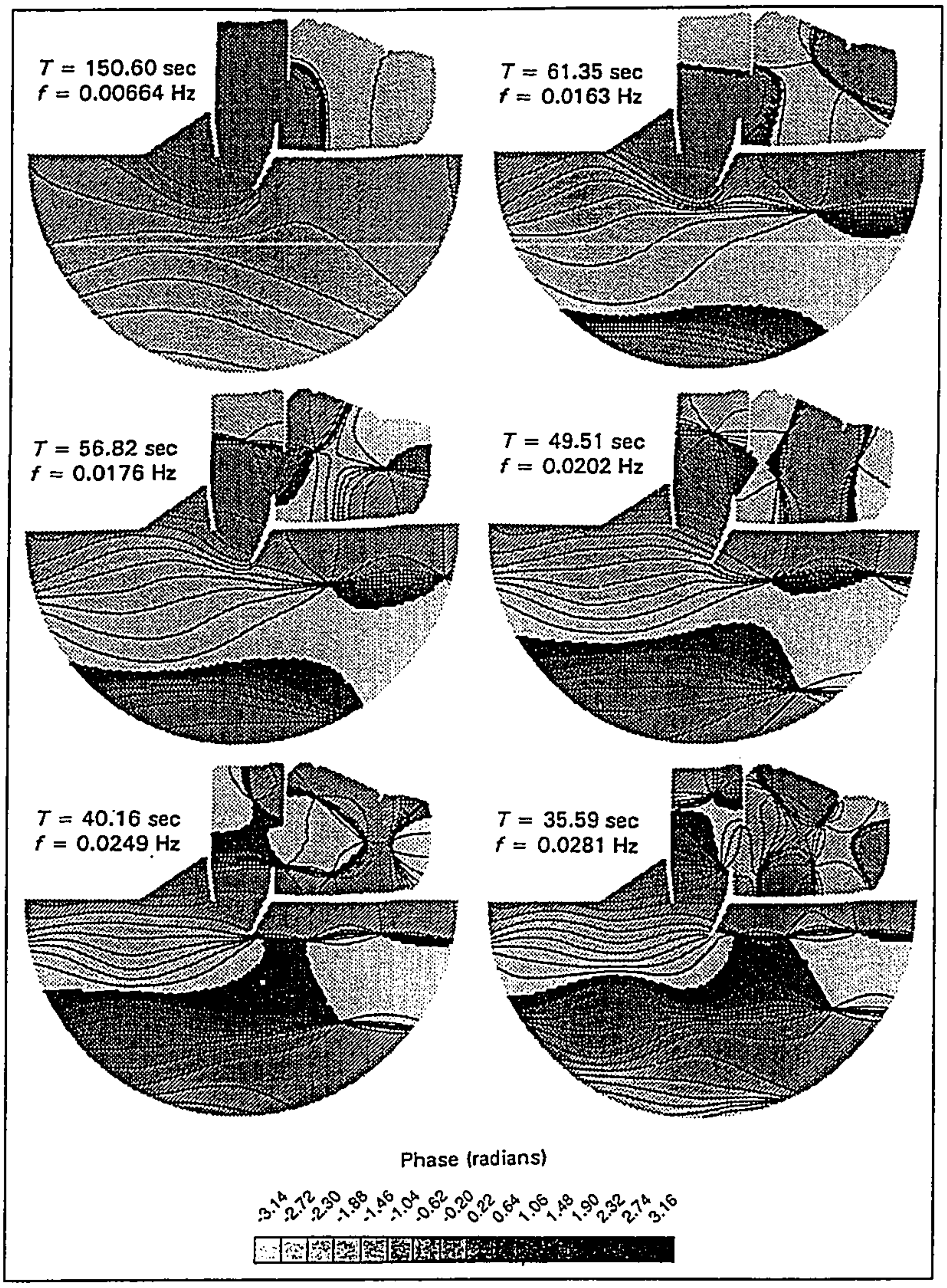

Figure 24. Resonant long wave phase contours, existing harbor

between the west breakwater and the inner east breakwater stub is of special note because it generated the highest amplification factors.

Long wave amplification factors shown here may be overestimated for resonant peaks at periods less than about 100 sec. Wave reflection coefficient at all solid boundaries was set to 1.0 for all long wave runs, but the recent Kahului Harbor study and physical reasoning indicate that small reductions in reflection coefficient at the shorter long wave periods may be appropriate.

Amplification factor and phase contour plots for the main resonant frequencies in Plan 6 are given in Figures 25 and 26. The longest period resonance, with a period of 113.64 sec, is a simple rocking motion between the inner and outer harbors. The period of this resonance is shorter than the similar resonance in the existing harbor, mainly due to the greater water depths in Plan 6. The 73.53-sec resonance is a rocking motion between the east and west areas of the inner harbor. The north area of the outer harbor also participates in phase with the east inner harbor. The 57.47-sec motion is a simple rocking between the north and south areas of the harbor complex. As with the existing harbor, a strong resonance occurs between the west breakwater and the inner east breakwater stub. The period of this resonance, 39.68 sec, is nearly the same as in the existing harbor.

Evaluation Against Operational Criteria for Long Waves

Procedures for evaluating the operational acceptability of different harbor plans subjected to long waves are reviewed by Thompson et al. (1996) in relation to the deep draft Kahului Harbor. Long wave heights (which are unavailable at Kikiaola Harbor since no wave gage data were collected) are a key factor in most of the procedures, but some operational evaluation can be based on amplification factors.

An operational guideline is based on the value of $A_{amp,l}$ for the higher resonant peaks. Experience with Los Angeles and Long Beach harbors has indicated that if $A_{amp,l}$ is greater than about 5, some operational difficulties may be encountered. If $A_{amp,l}$ is greater than 10, major operational problems can be expected.[1] This guideline may be applied to the plots in Appendix C. The only output basins signaling potential operational problems are located in the corner just west of the inner east stub breakwater (Basin 21 in the existing harbor; Basin 24 in Plan 6). Values of $A_{amp,l}$ at this location are approximately 7 in the existing harbor and 5 in Plan 6. Since this area is not planned for operational use, the existing and Plan 6 harbors do not appear to suffer from detrimental harbor oscillations.

[1] Personal Communication, William C. Seabergh, Research Hydraulic Engineer, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

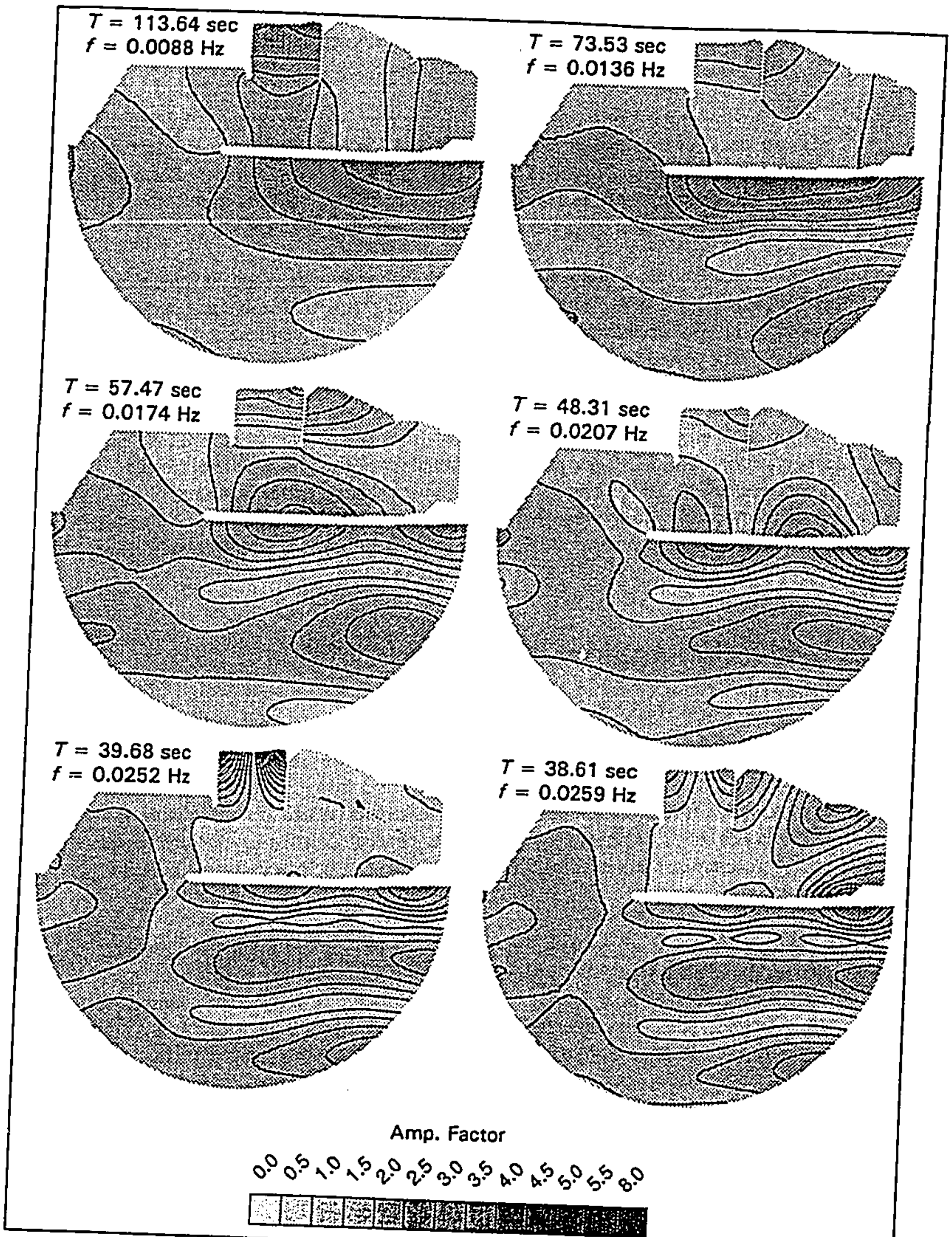

Figure 25. Resonant long wave amplification factor contours, Plan 6

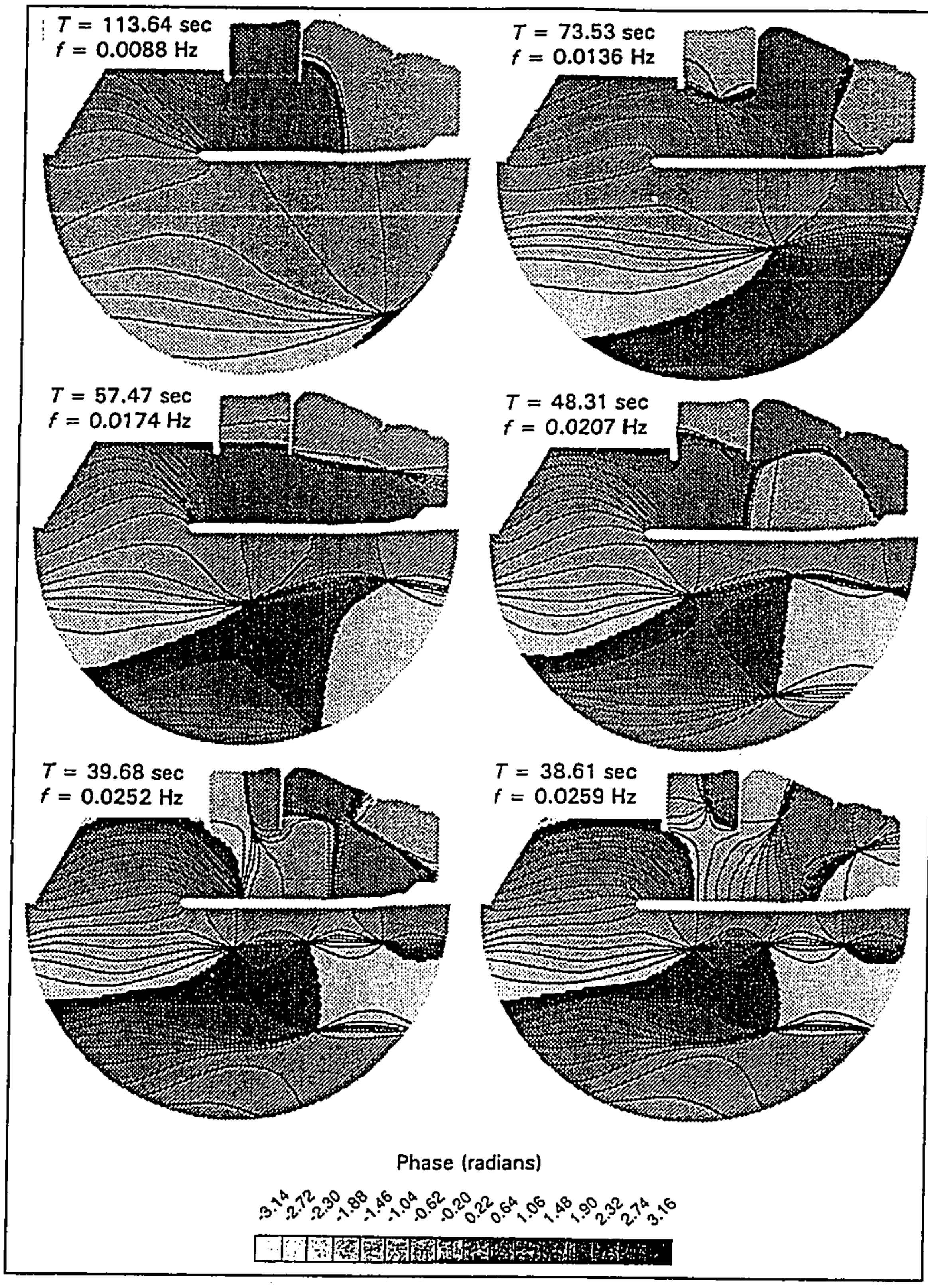

Figure 26. Resonant long wave phase contours, Plan 6

Plan 6 shows a small improvement in harbor oscillation performance over the existing harbor. The differences are most notable as reduced amplification factor peaks in harbor and outer basin corners (Appendix C).

6 Conclusions and Recommendations

Numerical model studies of the wave response of Kikiaola Harbor have produced valuable information about the existing harbor and possible modifications. The numerical model was used to simulate the behavior of the existing harbor and two alternative modifications to the harbor. Model results are compared with criteria for operational acceptability and with experience in the existing harbor to the extent possible. The effectiveness of proposed alternatives for wind wave and swell protection does not necessarily correlate with protection from oscillations. These two aspects of harbor operability are both considered in judging success of the alternative plans.

Performance of the alternative plans can be summarized by their success relative to simple, meaningful criteria. For wind waves and swell, success was defined as meeting or bettering the USACE criteria for harbor and entrance channel tranquillity (Chapter 4). A major reduction in the occurrence of wave breaking in the entrance channel is also desired. Plan performance relative to each of these wind wave and swell concerns is as follows:

a. USACE criterion in berthing areas. Plan 1, Plan 6, and the existing harbor all satisfied this criterion. Berthing areas are well protected from wind waves and swell in all plans.

b. USACE criterion in entrance and access channels. Plan 1 satisfied this criterion everywhere except at the seaward end of the entrance channel, where the 10 percent exceedance H_s is 2.2 ft (compared to 2.0 ft specified in the criterion). Plan 6 also satisfied the criterion everywhere except in the seaward part of the entrance channel. The existing, shoaled outer entrance channel significantly failed the USACE criterion. The inner portion of the existing channel, beginning at around the 90-deg turn, satisfied the criterion.

For both Plan 1 and Plan 6, the outer entrance channel flares out to give extra width for vessel maneuvering. A small exceedance of the USACE criterion in the wider, more open channel may not be cause for concern.

Wave conditions in the landward portion of the Plan 6 entrance channel are a potential navigation concern. From where the channel passes just west of the main breakwater up to the 90-deg turn into the lee of the breakwater, wave conditions approach (but do not exceed) the USACE criterion. The ability of vessels to navigate safely past the breakwater head and turn into protected waters should be given due consideration. Experience with the existing harbor, which also requires a 90-deg turn in an area where wave heights can be fairly high (Figure 21), should be helpful in assessing the navigation concerns.

c. *Breaking waves*. Breaking waves are a potential concern in the exposed entrance channel. The HARBD numerical model does not identify breaking wave conditions, but they can be inferred from wave heights and water depths. In the existing channel, the shoaled depths are less than 6 ft in some areas. The 10 percent exceedance H_s outside the breakwater entrance was estimated as 3.6 ft (Figure 21). When H_s exceeds about 0.5-0.6 times the depth, signficant wave breaking can be expected. Thus the existing entrance channel would be expected to experience breaking wave conditions more than 10 percent of the time.

In Plan 1 and Plan 6, the channel depth is 12 ft and the 10 percent exceedance H_s is around 2 ft or less. Thus breaking wave conditions would not be expected in these plans.

There are several key limitations on the above conclusions. First, the coast around Kikiaola Harbor is an area of active sediment movement. The existing channel and harbor have experienced shoaling problems. The present study was based on actual depths of the existing harbor but project depths of Plan 1 and Plan 6. If either plan were constructed and significant shoaling occurred, the wind wave and swell response would change from the estimates of this study. Also, wave breaking could again become a problem. Sediment transport and channel shoaling were outside the scope of this study, but they are important considerations in selecting a final plan for the harbor.

Another limitation is the wave climate information. It was derived from one year of hindcasts in a rather difficult area. Conclusions based on wave climate would have had a higher confidence level if high-quality local measurements were available. Limitations associated with the numerical harbor model were presented in Chapter 1. The absence of wave breaking and currents are the most relevant limitations in the present study.

Harbor response to long waves (harbor oscillations) was analyzed for the existing harbor and Plan 6. Plan 1 was not included in this part of the study. Based on experience in other harbors correlating long wave amplification factors with operational problems, the existing harbor and Plan 6 both appear to be free of oscillation problems. The only harbor area of potential concern is between the west breakwater and the inner east breakwater stub, which is not planned as a mooring facility. Oscillations in Plan 6 are less than in the existing harbor.

A physical model study to optimize the preferred plan may be cost effective as a final phase of the studies. A focused physical model study is likely to result in cost savings beyond the study cost in fine-tuning design details such as breakwater length, crest height, and slope. Also, the physical model can reproduce some processes not represented in the numerical model, such as wave breaking.

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Appendix A
Bathymetry and Output Basin Locations

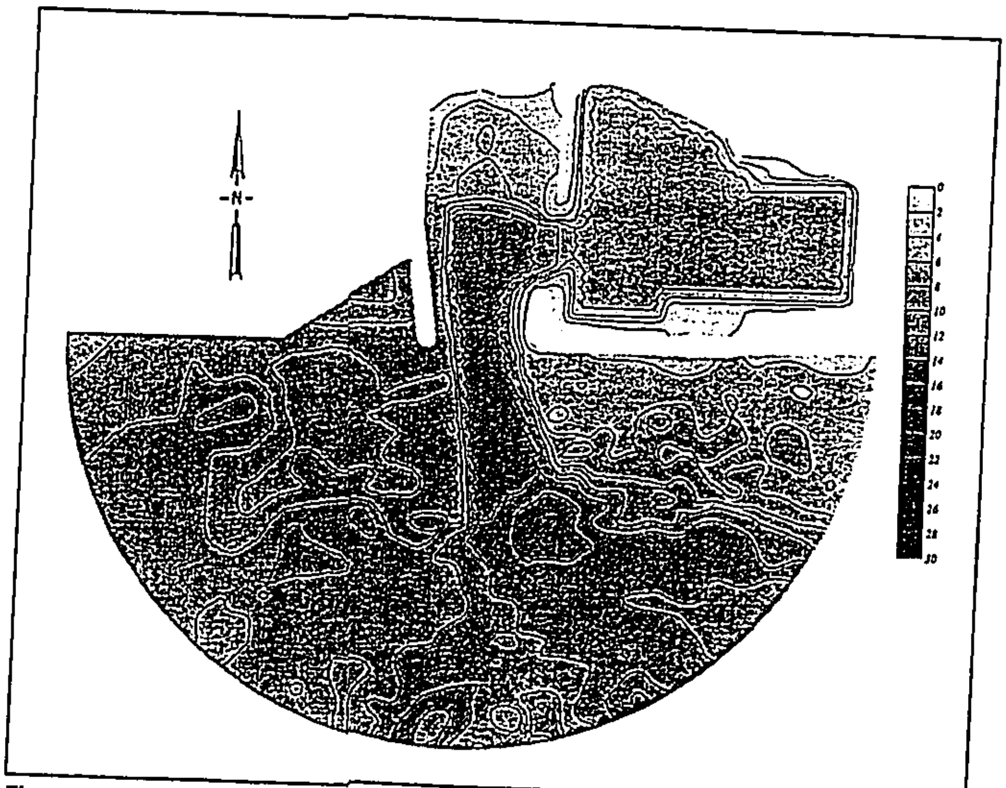


Figure A1. Bathymetry, Plan 1

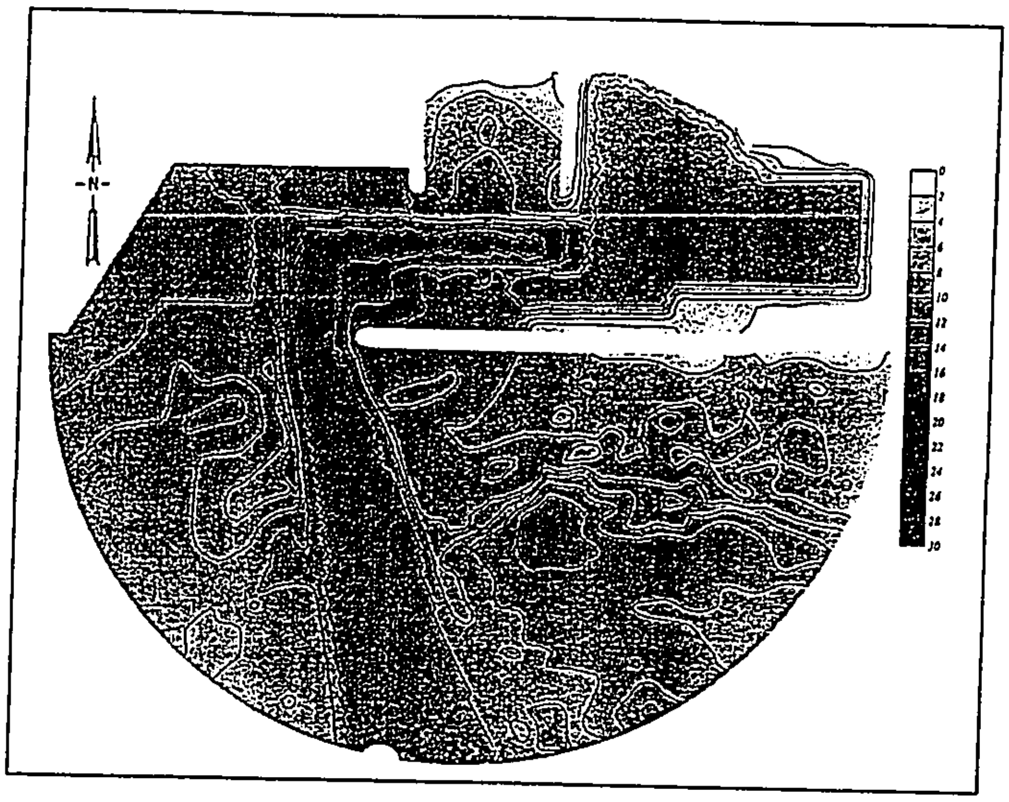


Figure A2. Bathymetry, Plan 6

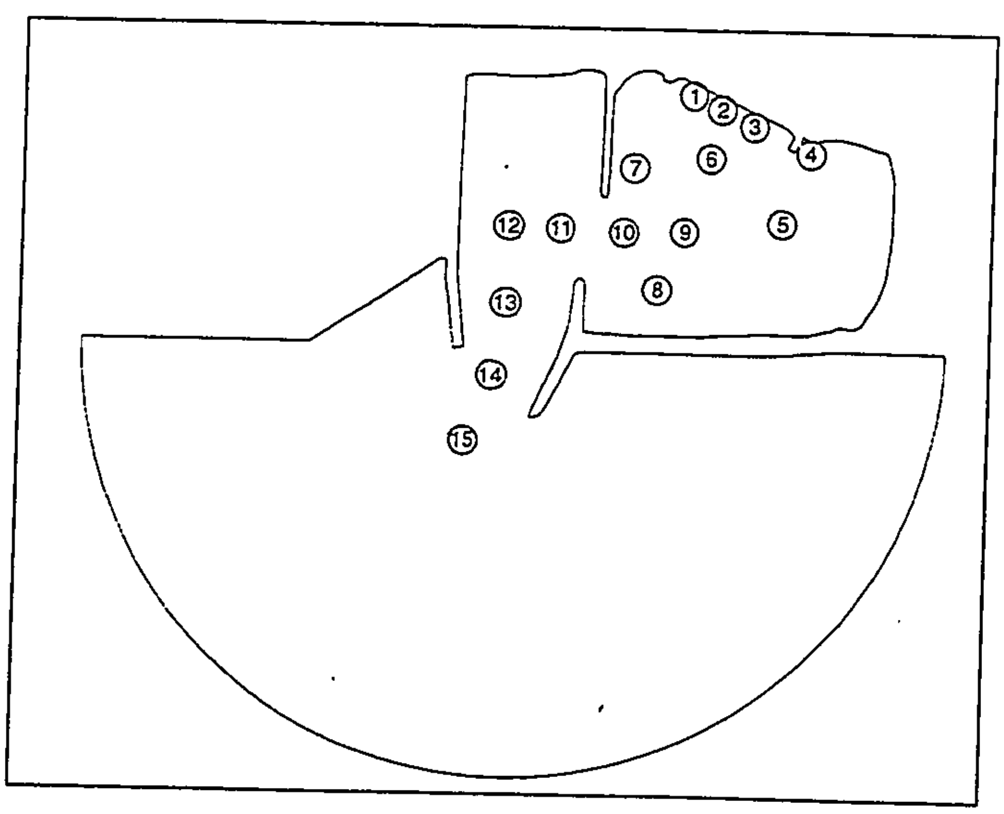


Figure A3. Basin locations, wind waves and swell, existing harbor

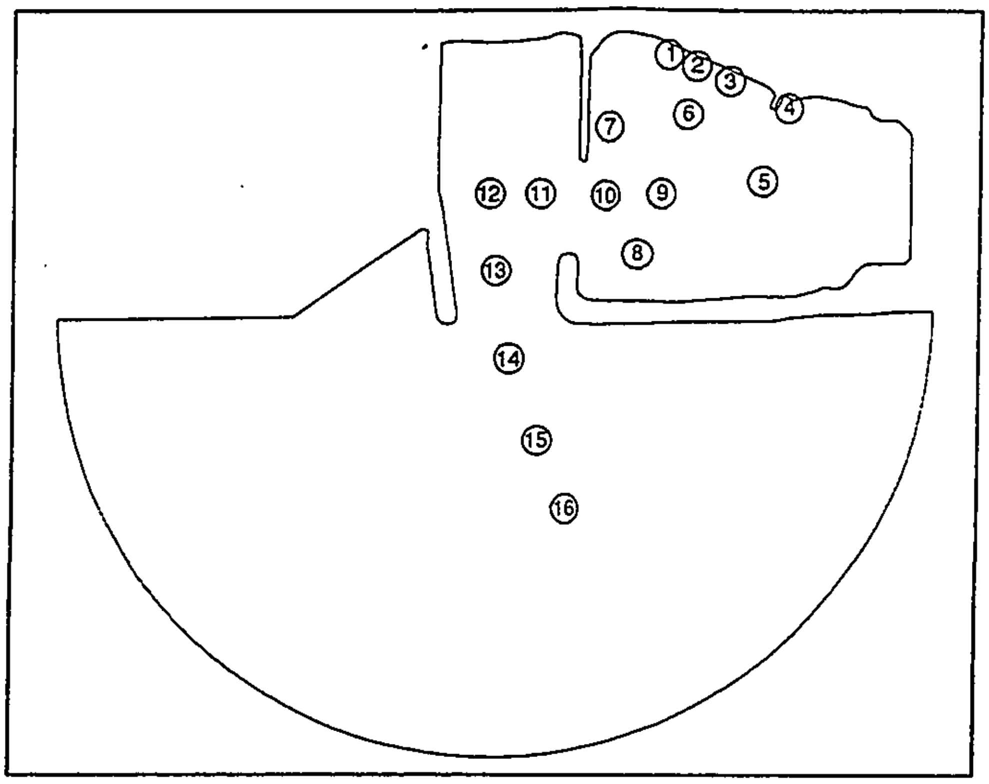


Figure A4. Basin locations, wind waves and swell, Plan 1

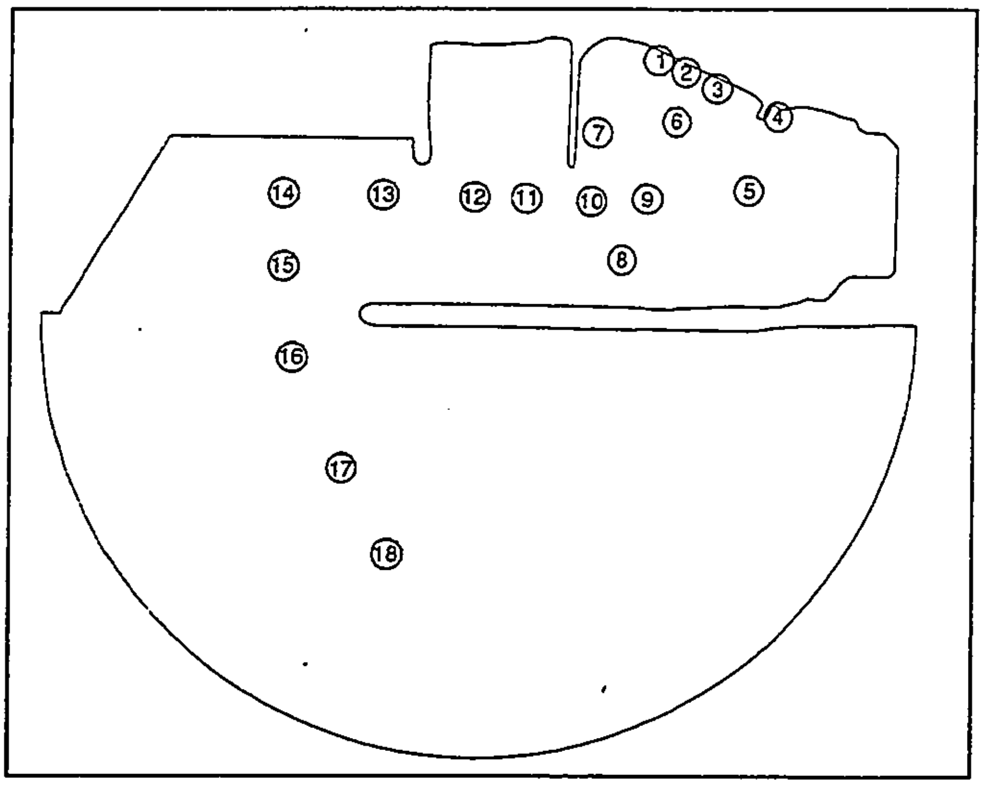


Figure A5. Basin locations, wind waves and swell, Plan 6

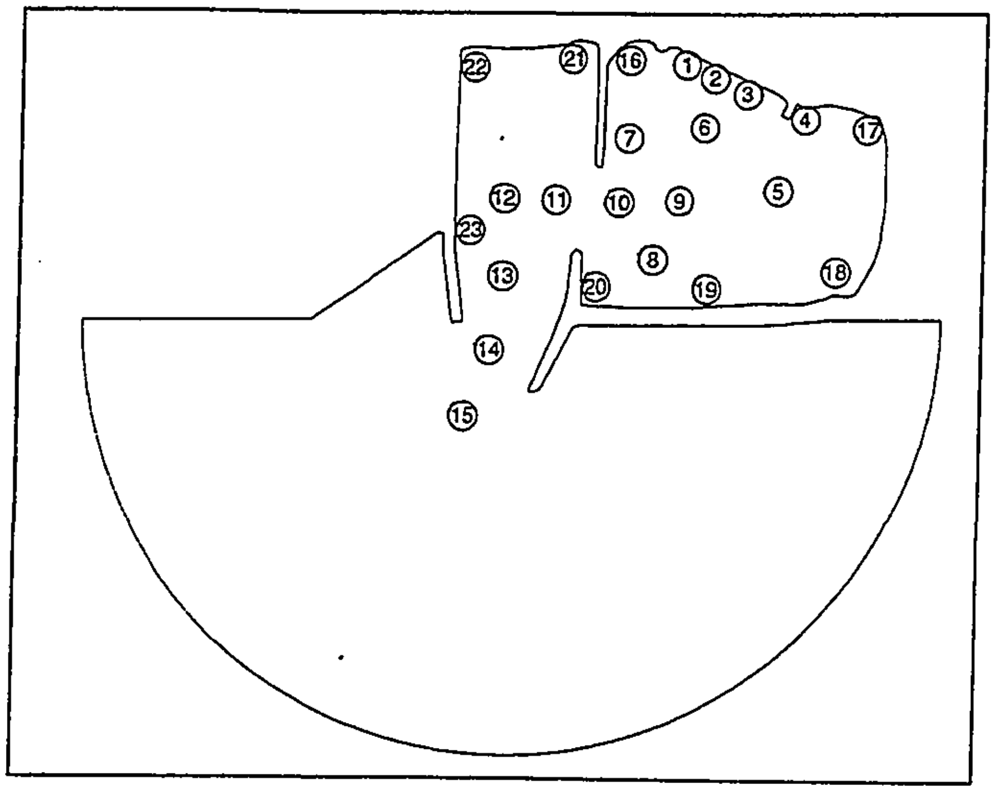


Figure A6. Basin locations, harbor oscillations, existing harbor

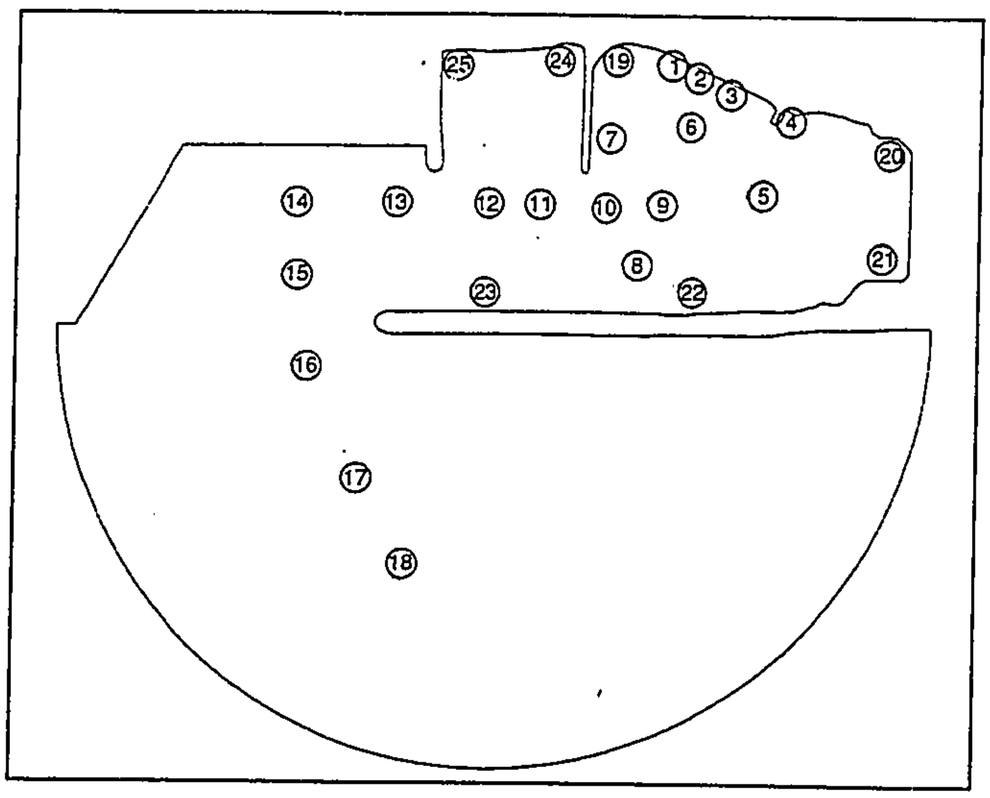


Figure A7. Basin locations, harbor oscillations, Plan 6

Appendix B
Wind Wave and Swell Summaries from Numerical Model

Table B1
$(A_{amp})_{eff}$ Values Averaged Over Wave Period, Existing Harbor

Basin	Wave Direction (deg. azimuth, coming from)						
	150	160	170	180	190	200	210
1	0.06	0.08	0.10	0.12	0.15	0.17	0.19
2	0.07	0.09	0.12	0.15	0.18	0.21	0.23
3	0.07	0.10	0.12	0.16	0.19	0.22	0.24
4	0.05	0.06	0.08	0.10	0.12	0.14	0.15
5	0.06	0.07	0.09	0.12	0.14	0.16	0.18
6	0.09	0.11	0.15	0.19	0.23	0.27	0.29
7	0.12	0.15	0.19	0.25	0.30	0.35	0.39
8	0.05	0.06	0.08	0.10	0.13	0.15	0.17
9	0.09	0.11	0.14	0.18	0.21	0.24	0.26
10	0.11	0.15	0.19	0.24	0.29	0.34	0.37
11	0.24	0.30	0.38	0.48	0.59	0.69	0.75
12	0.29	0.35	0.41	0.50	0.59	0.67	0.73
13	0.38	0.47	0.57	0.70	0.84	0.96	1.05
14	0.63	0.71	0.81	0.94	1.09	1.22	1.31
15	1.12	1.15	1.19	1.26	1.32	1.39	1.43

Table B2
$(A_{amp})_{eff}$ Values Averaged Over Wave Period, Plan 1

Basin	Wave Direction (deg. azimuth, coming from)						
	150	160	170	180	190	200	210
1	0.05	0.05	0.06	0.07	0.08	0.09	0.10
2	0.05	0.06	0.06	0.07	0.08	0.10	0.10
3	0.06	0.06	0.07	0.08	0.10	0.11	0.12
4	0.04	0.05	0.05	0.06	0.08	0.09	0.09
5	0.05	0.05	0.06	0.07	0.08	0.09	0.10
6	0.06	0.07	0.03	0.09	0.10	0.12	0.13
7	0.08	0.08	0.09	0.11	0.13	0.14	0.15
8	0.06	0.06	0.07	0.07	0.08	0.09	0.09
9	0.08	0.08	0.09	0.10	0.12	0.13	0.14
10	0.11	0.12	0.13	0.15	0.17	0.19	0.21
11	0.16	0.17	0.18	0.21	0.24	0.27	0.28
12	0.18	0.19	0.22	0.26	0.31	0.37	0.40
13	0.29	0.31	0.34	0.40	0.47	0.54	0.59
14	0.45	0.46	0.46	0.48	0.50	0.53	0.55
15	0.64	0.65	0.65	0.65	0.64	0.63	0.62
16	0.77	0.78	0.78	0.78	0.76	0.74	0.71

Table B3
$(A_{smp})_{eff}$ Values Averaged Over Wave Period, Plan 6

Basin	Wave Direction (deg. azimuth, coming from)						
	150	160	170	180	190	200	210
1	0.03	0.03	0.03	0.03	0.04	0.05	0.05
2	0.04	0.04	0.04	0.04	0.05	0.05	0.06
3	0.04	0.04	0.04	0.05	0.05	0.06	0.07
4	0.04	0.04	0.04	0.04	0.05	0.05	0.06
5	0.05	0.05	0.05	0.06	0.06	0.07	0.08
6	0.05	0.05	0.05	0.05	0.06	0.07	0.08
7	0.05	0.06	0.06	0.06	0.07	0.08	0.08
8	0.09	0.09	0.09	0.10	0.10	0.11	0.12
9	0.06	0.06	0.06	0.07	0.08	0.09	0.10
10	0.08	0.08	0.08	0.09	0.10	0.11	0.12
11	0.10	0.10	0.10	0.11	0.12	0.13	0.14
12	0.13	0.13	0.14	0.15	0.17	0.19	0.20
13	0.23	0.25	0.27	0.30	0.35	0.39	0.41
14	0.44	0.48	0.54	0.63	0.76	0.89	0.97
15	0.44	0.48	0.54	0.63	0.76	0.89	0.97
16	0.52	0.52	0.53	0.57	0.64	0.72	0.77
17	0.71	0.71	0.72	0.73	0.76	0.80	0.83
18	0.83	0.82	0.81	0.80	0.81	0.84	0.86

Table B4
$(A_{amp})_{eff}$ Values Weighted by Wind Wave and Swell Climate

Basin	Plan		
	Existing	1	6
1	0.15	0.07	0.03
2	0.19	0.08	0.04
3	0.20	0.09	0.05
4	0.12	0.07	0.04
5	0.13	0.07	0.06
6	0.25	0.09	0.05
7	0.32	0.12	0.06
8	0.14	0.09	0.09
9	0.20	0.11	0.08
10	0.31	0.16	0.09
11	0.61	0.23	0.11
12	0.57	0.31	0.15
13	0.88	0.47	0.34
14	1.11	0.50	0.76
15	1.35	0.63	0.76
16		0.76	0.66
17			0.79
18			0.81

Table B5
H_s Values Exceeded 10 Percent and 1 Percent of the Time

Basin Number	H_s Values Exceeded 10% and 1% of Time (ft)					
	Existing		Plan 1		Plan 6	
	10%	1%	10%	1%	10%	1%
1	0.36	0.58	0.17	0.30	0.09	0.16
2	0.46	0.70	0.22	0.36	0.12	0.19
3	0.49	0.74	0.24	0.43	0.14	0.23
4	0.30	0.46	0.20	0.37	0.13	0.20
5	0.33	0.55	0.20	0.35	0.17	0.25
6	0.60	0.91	0.23	0.41	0.14	0.23
7	0.80	1.18	0.33	0.55	0.17	0.28
8	0.36	0.58	0.24	0.37	0.25	0.37
9	0.49	0.78	0.29	0.48	0.20	0.32
10	0.76	1.14	0.42	0.70	0.23	0.37
11	1.53	2.31	0.60	0.96	0.30	0.46
12	1.44	2.22	0.78	1.24	0.40	0.62
13	2.21	3.30	1.20	1.82	0.90	1.42
14	2.86	4.37	1.35	2.10	1.94	3.00
15	3.64	5.52	1.72	2.58	1.94	3.00
16			2.16	3.20	1.73	2.68
17					2.12	3.16
18					2.19	3.36

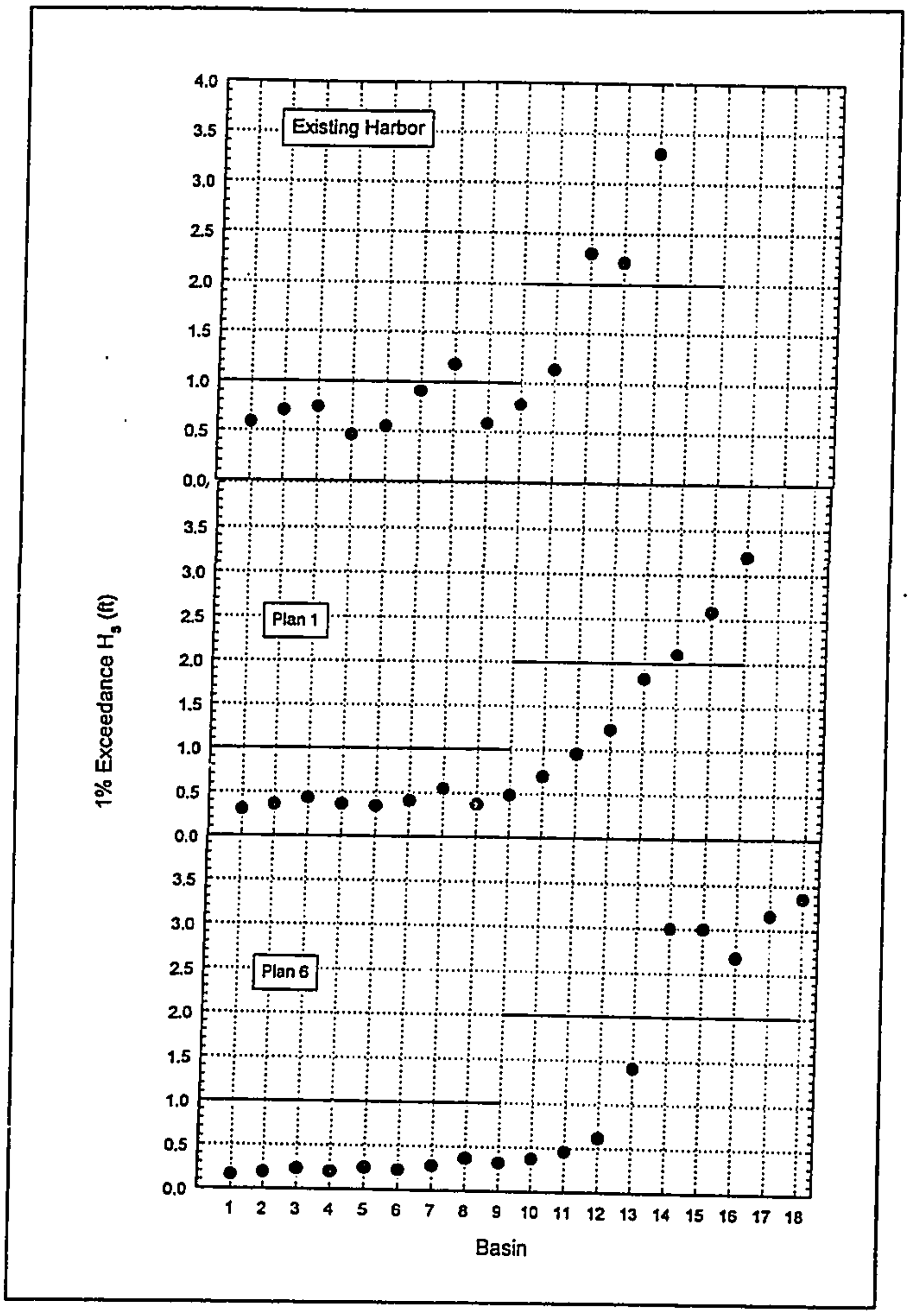


Figure B1. Comparison of H_s exceeded 1 percent of the time

Appendix C
Harbor Oscillation Summaries from Numerical Model

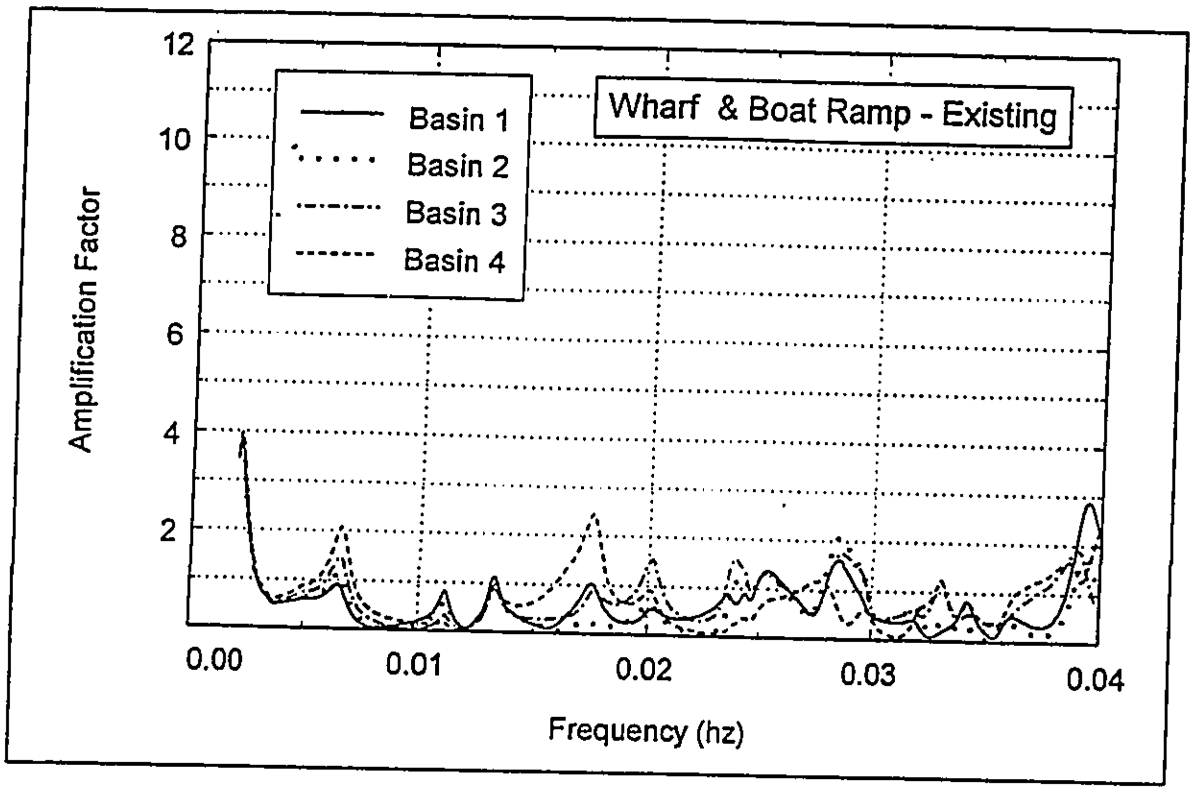


Figure C1. Long wave response, wharf and boat ramp, existing harbor

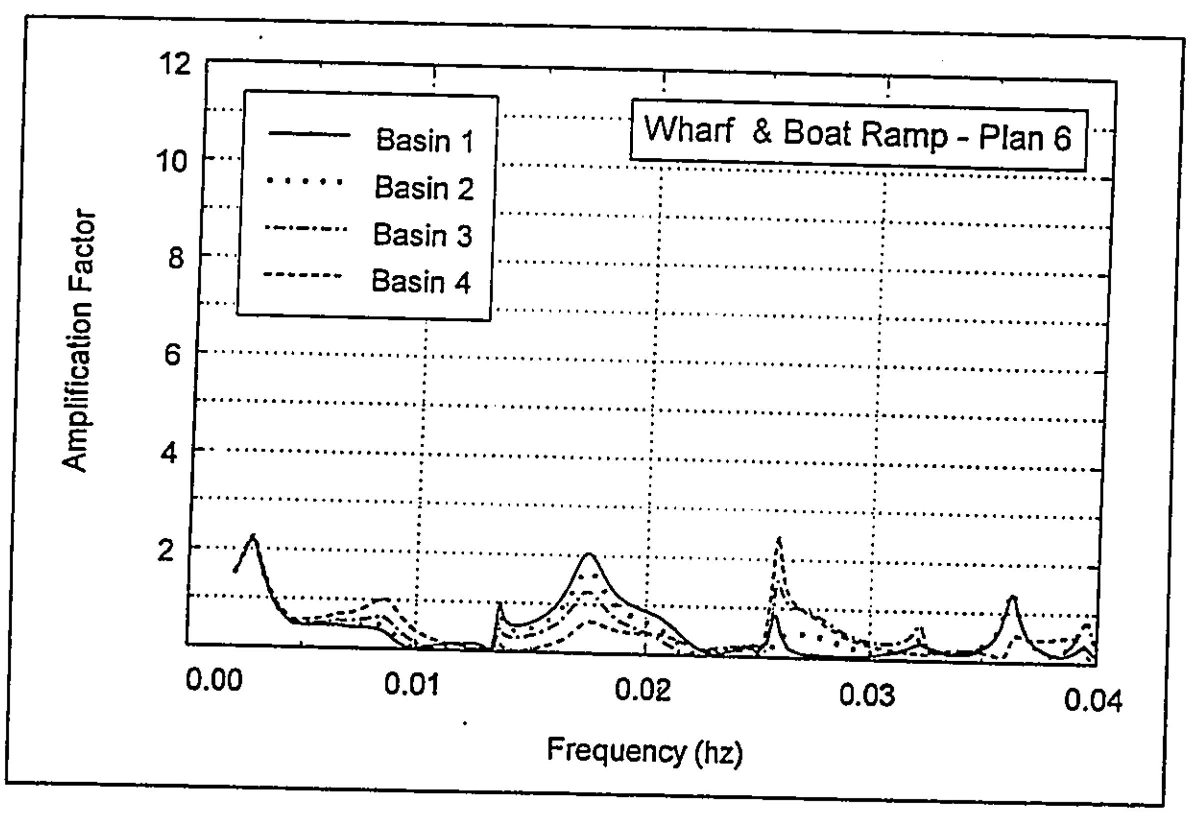


Figure C2. Long wave response, wharf and boat ramp, Plan 6

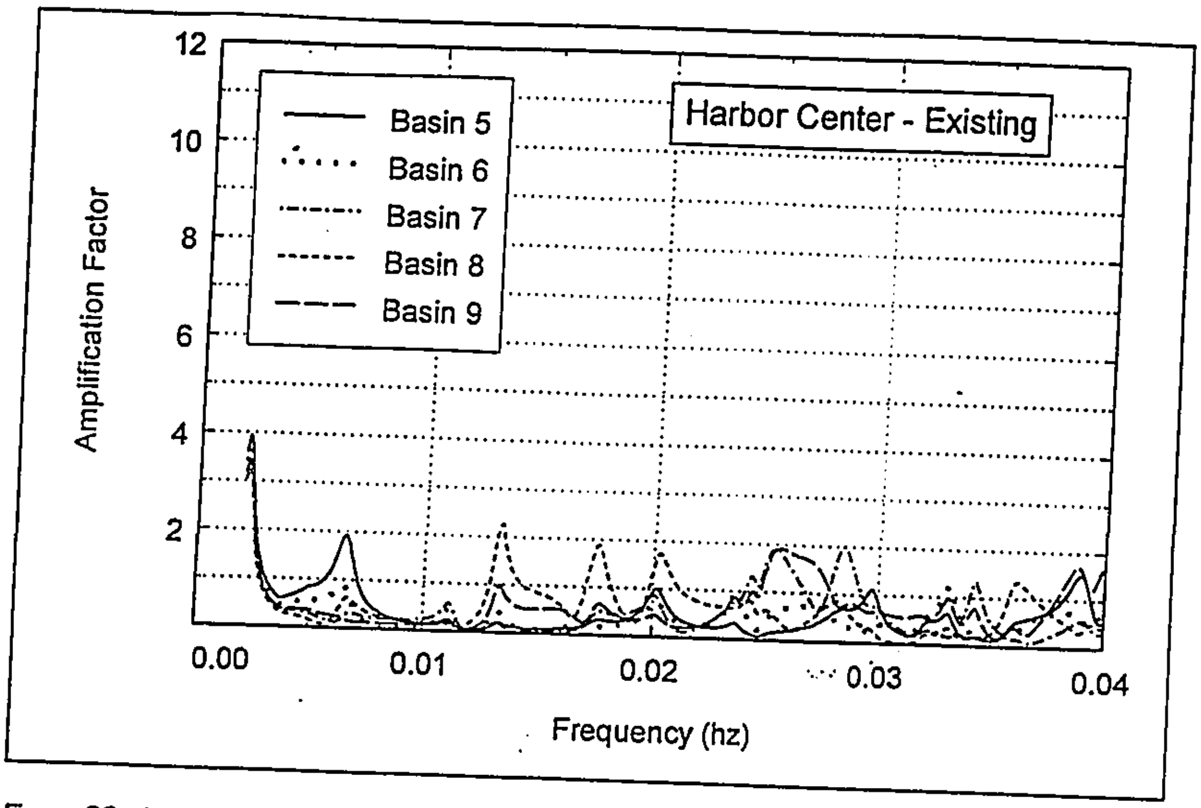


Figure C3. Long wave response, harbor center, existing harbor

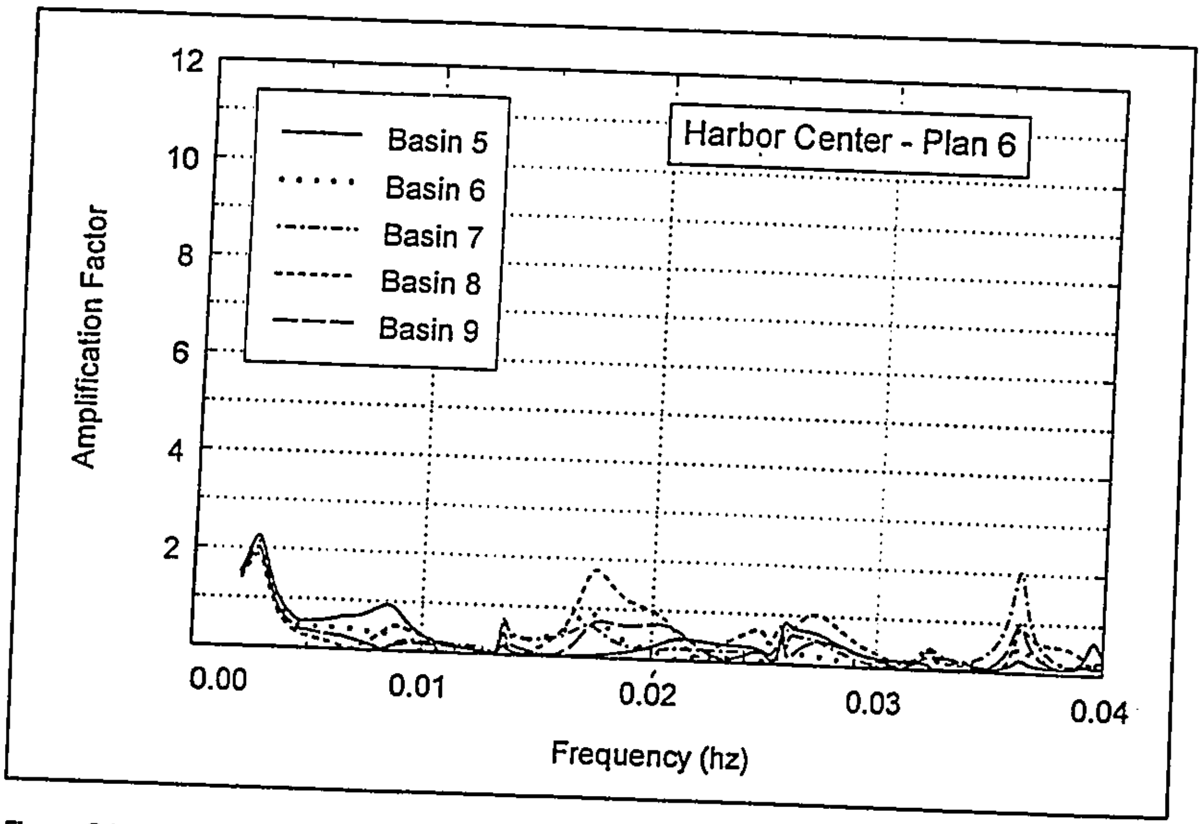


Figure C4. Long wave response, harbor center, Plan 6

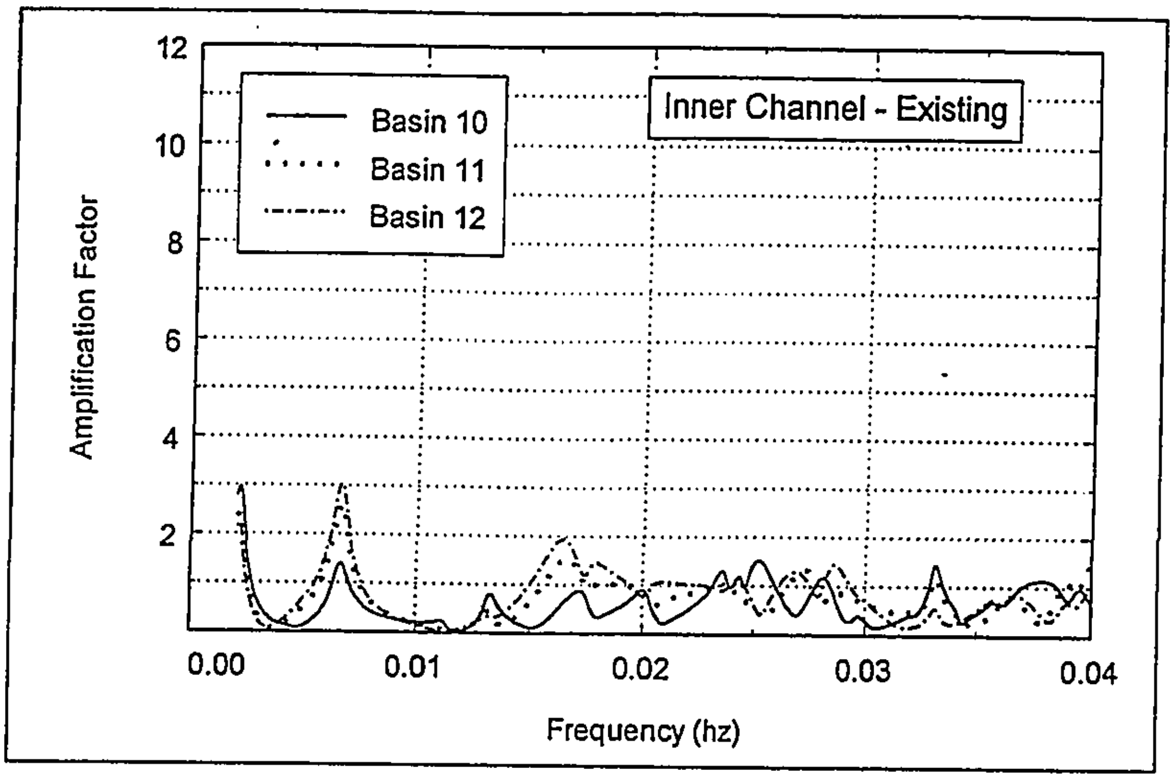


Figure C5. Long wave response, inner channel, existing harbor

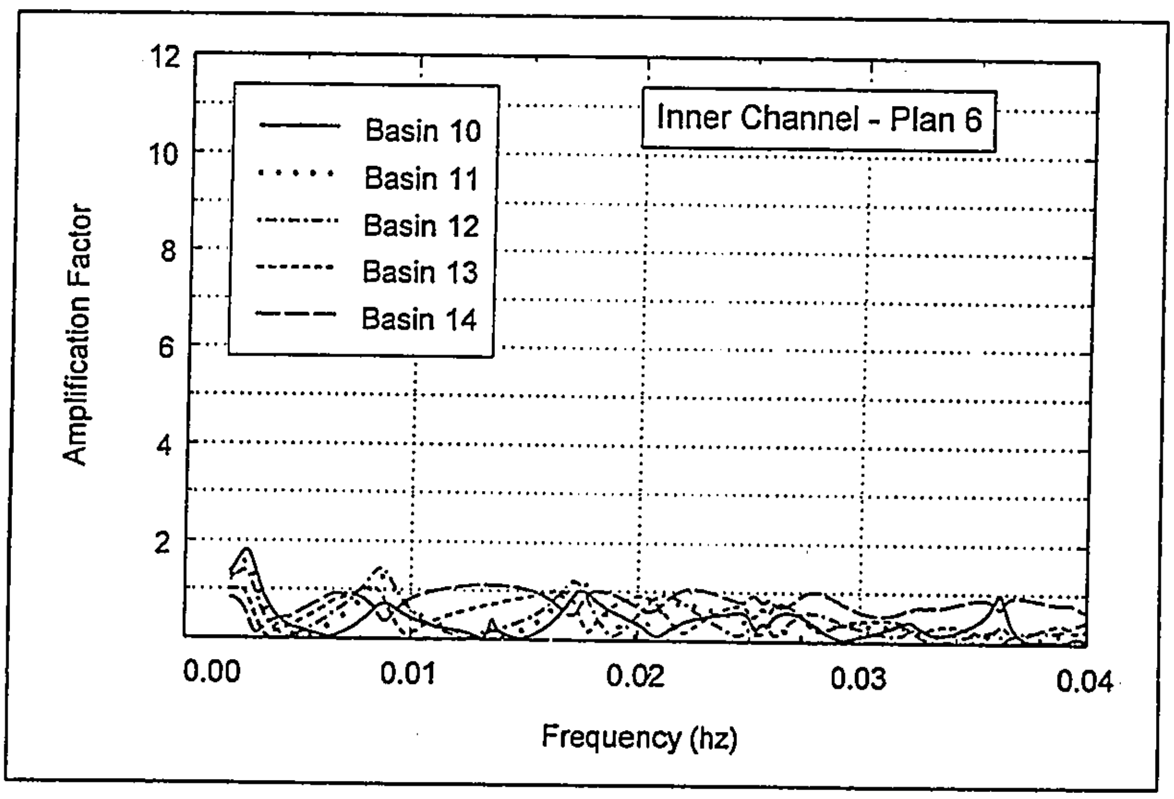


Figure C6. Long wave response, inner channel, Plan 6

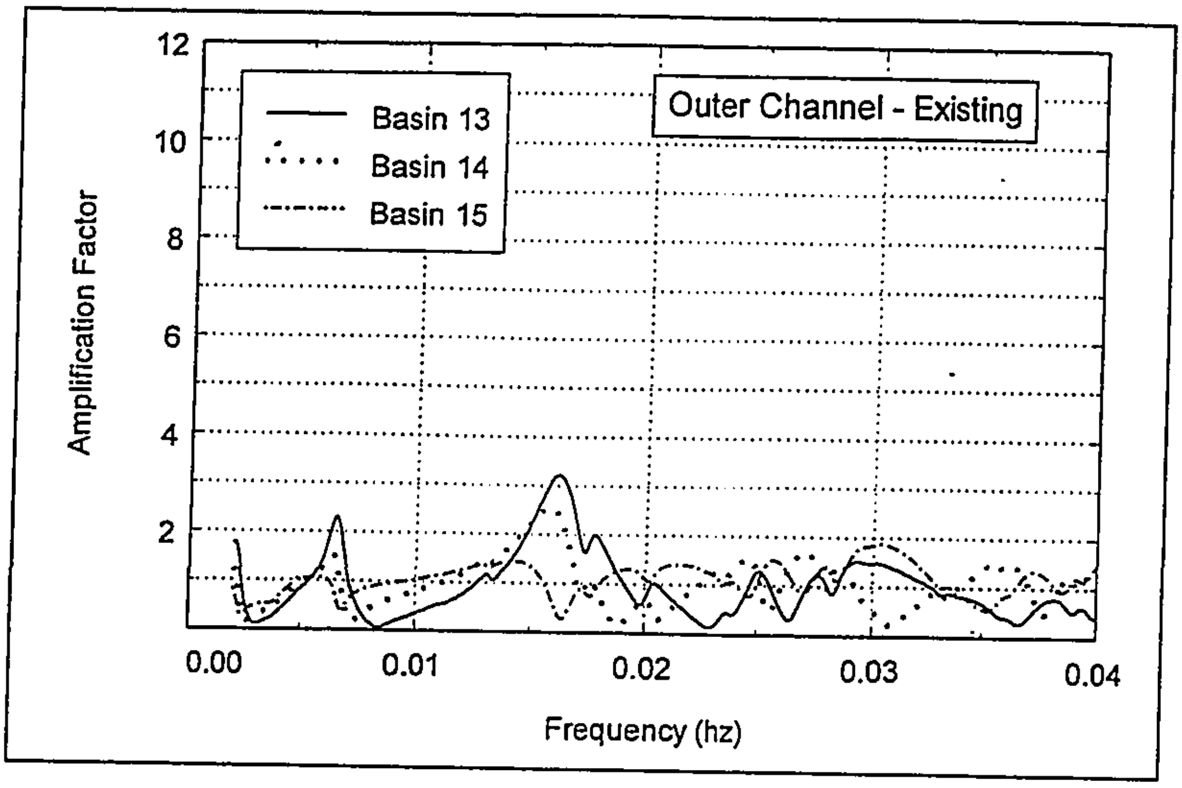


Figure C7. Long wave response, outer channel, existing harbor

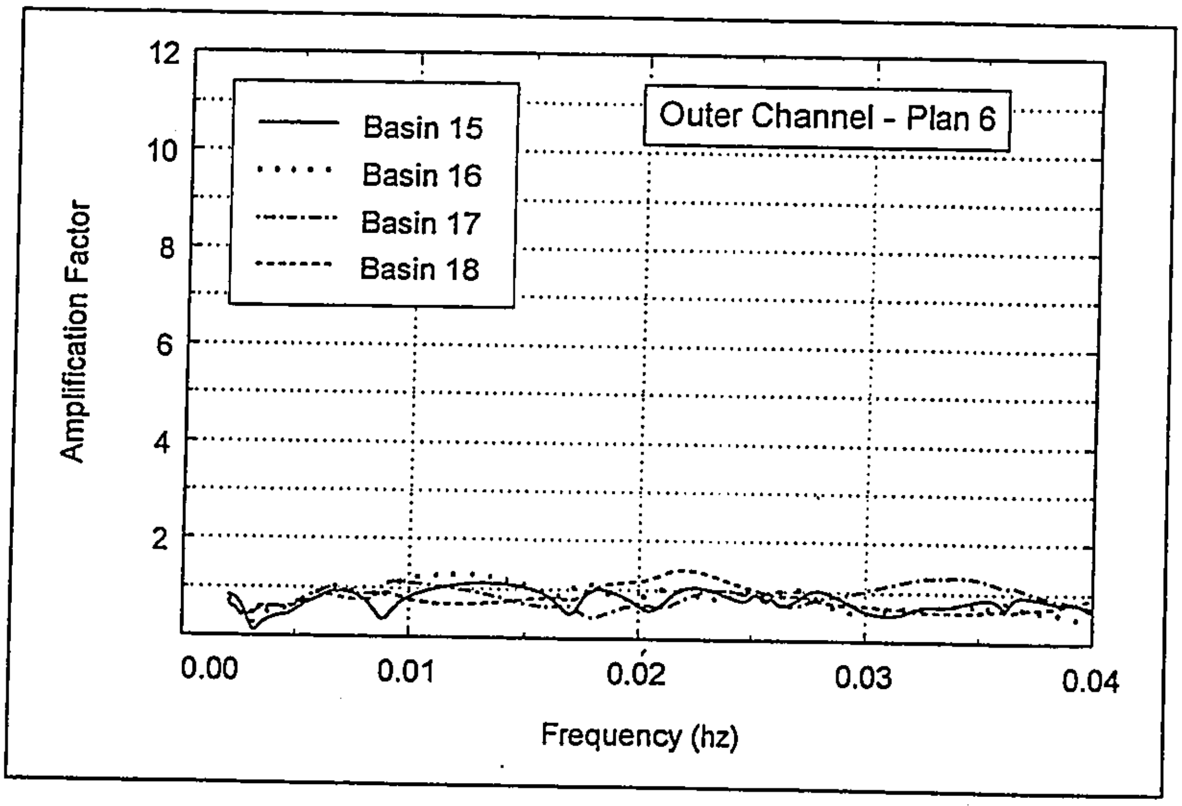


Figure C8. Long wave response, outer channel, Plan 6

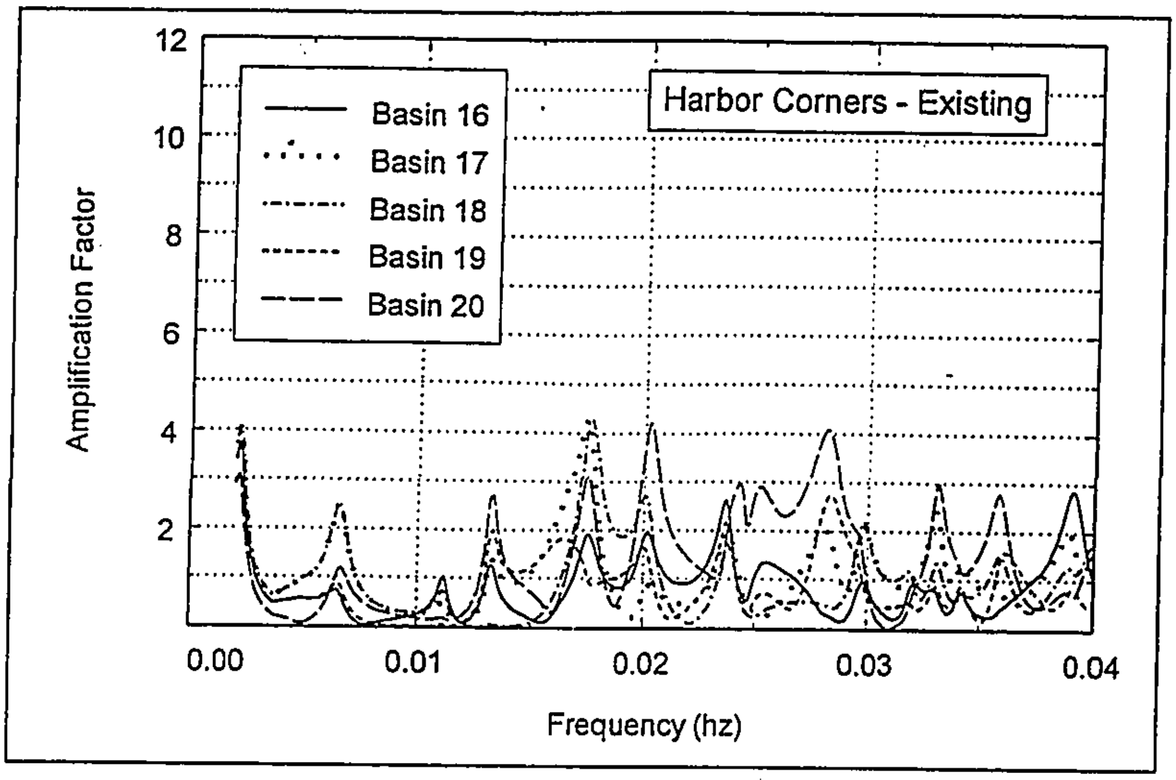


Figure C9. Long wave response, harbor corners, existing harbor

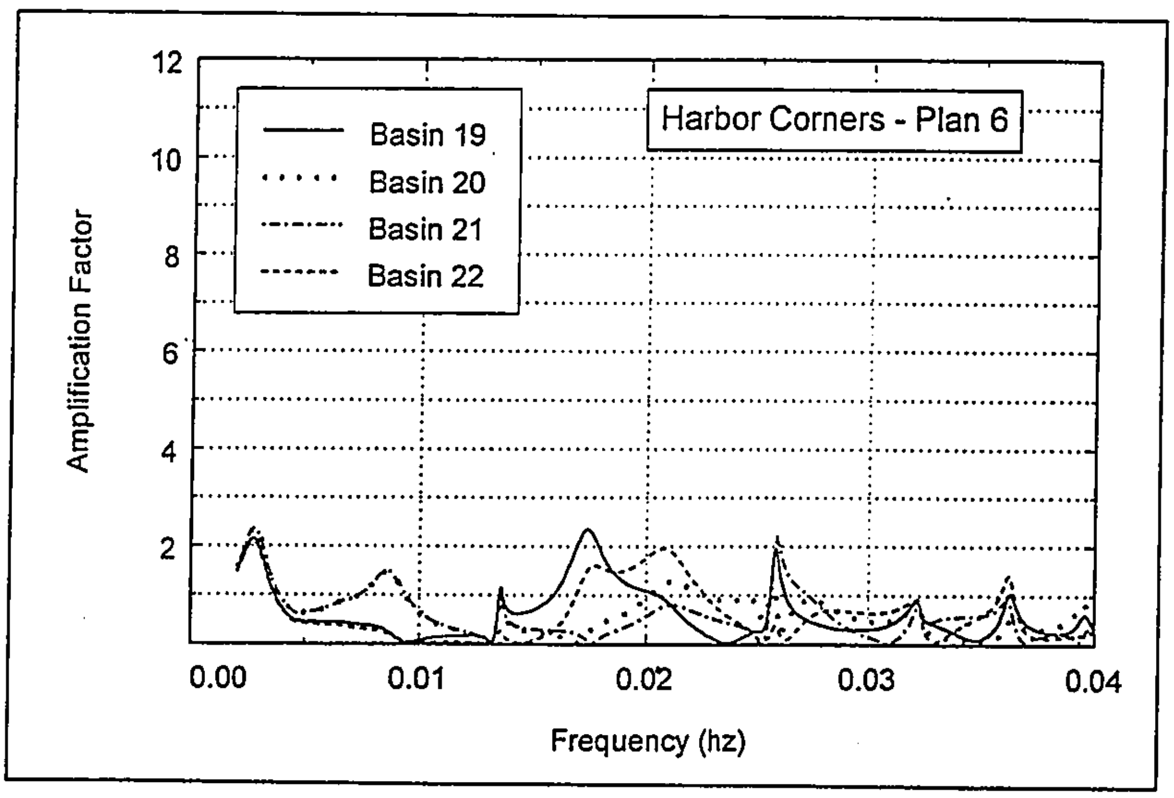


Figure C10. Long wave response, harbor corners, Plan 6

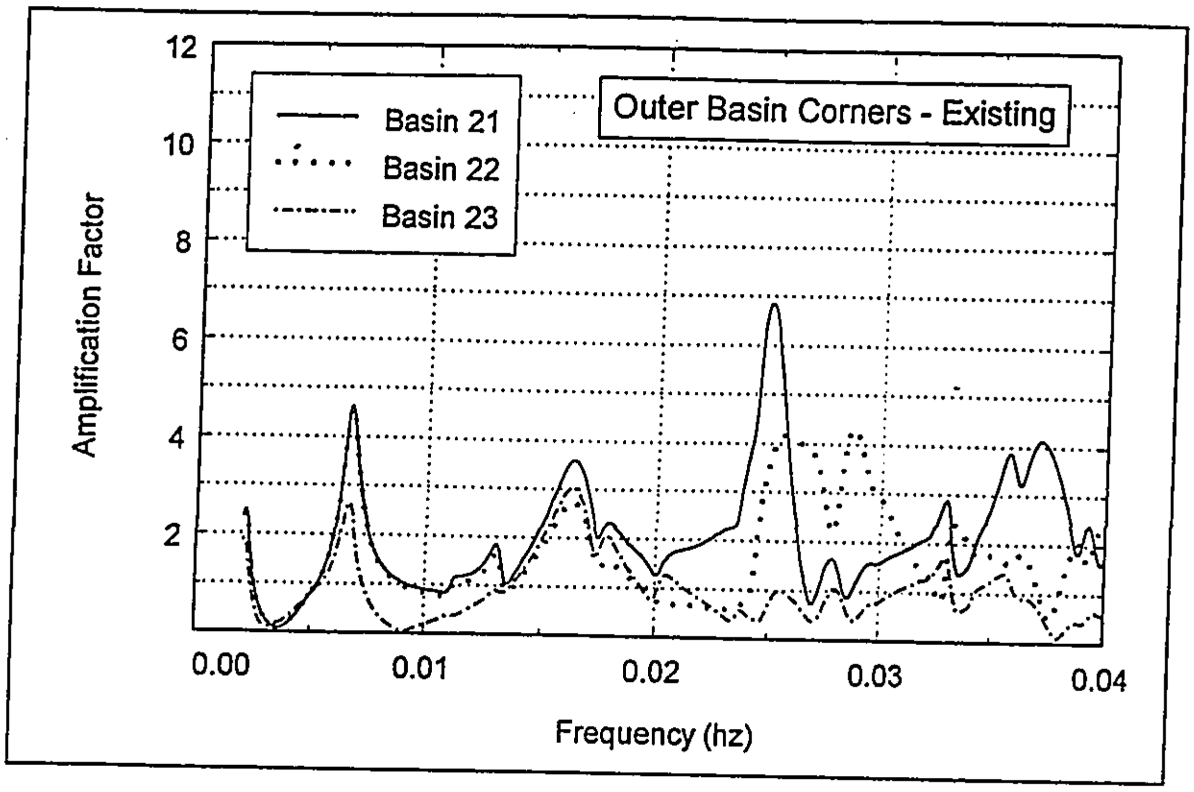


Figure C11. Long wave response, outer basin corners, existing harbor

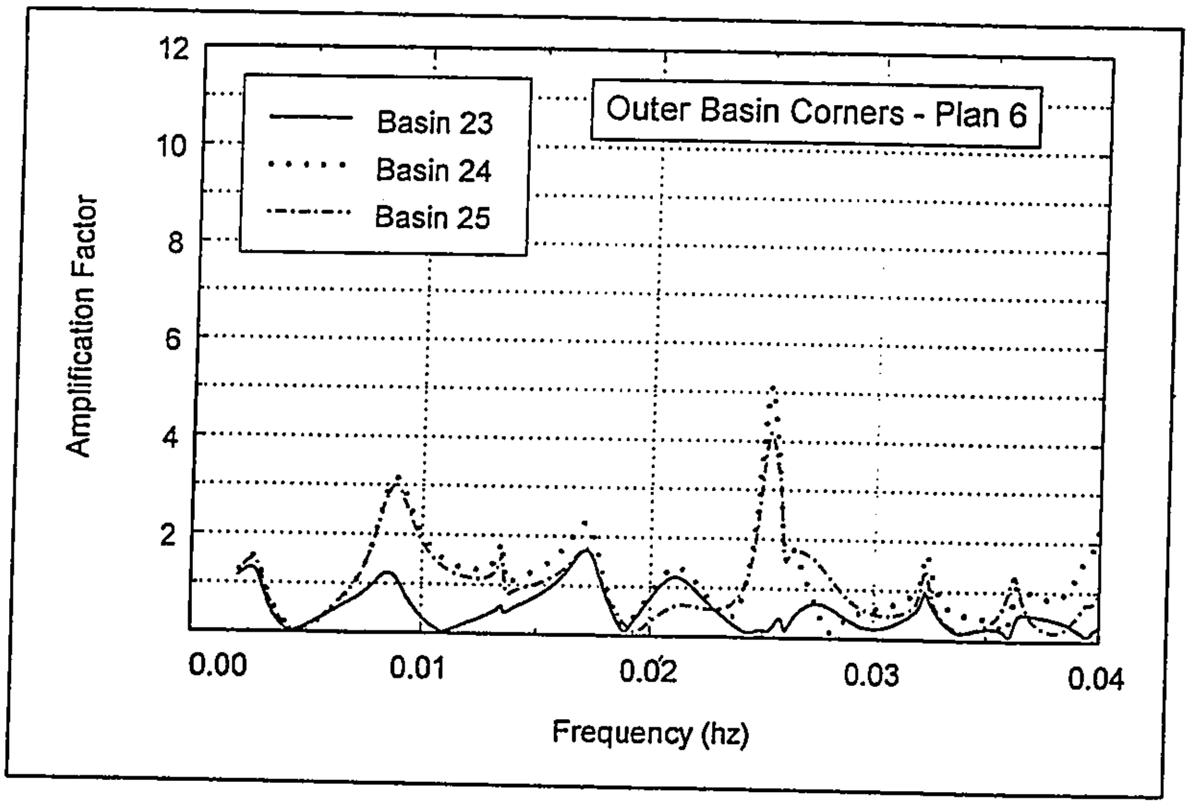


Figure C12. Long wave response, outer basin corners, Plan 6

Appendix D
Notation

a	Wave amplitude, m (ft)
a_i	Incident wave amplitude, m (ft)
A_{amp}	Wave amplification factor
$(A_{amp})_{eff}$	Effective, or spectral, wave amplification factor
$A_{amp,l}$	Wave amplification factor, long waves (harbor oscillations)
d	Water depth, m (ft)
d_{far}	Water depth far away from harbor, m (ft)
f	Wave frequency, Hz
H	Wave height, m (ft)
H_i	Incident wave height, m (ft)
H_s	Significant wave height, m (ft)
K_r	Reflection coefficient of a solid boundary
$K_{r,coast}$	Reflection coefficient of coastline far away from harbor
N_D	Number of HARBD computational wave directions for spectral approximation
N_T	Number of HARBD computational wave periods for spectral approximation
s	Directional spreading factor
T_m	Mean spectral wave period, sec
T_p	Peak spectral wave period, sec
w_k	Weighting factor for k'th HARBD computational frequency
β	Dimensionless bottom friction coefficient
γ	Spectral peak enhancement factor
θ_m	Mean wave direction
ϕ	Velocity potential
ψ	Wave phase

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.5 SEDIMENT TRANSPORT STUDY

APPENDIX E

SEDIMENT TRANSPORT AT KĪKĪAOLA HARBOR

Island of Kaua'i, Hawai'i

Prepared for:

U.S. Army Engineer Division, Pacific Ocean
Fort Shafter, Hawai'i
Contract No.: DACW83-94-D-0007
Delivery Order: 0009

Prepared by:

Sea Engineering, Inc.
Makai Research Pier
41-202 Kalaniana'ole Highway, Suite 8
Waimānalo, Hawai'i 96795

August 1996

SEDIMENT TRANSPORT AT KĪKĪAOLA HARBOR

INTRODUCTION

Kīkīaola Harbor is located on the southwest coast of the island of Kaua'i, between the towns of Waimea and Kekaha, 1.5 miles west of the Waimea river (Figure 1). The harbor was initially constructed by the State of Hawai'i in 1959, with improvements being made in 1961 and 1964. A relatively straight, wide beach, 2.7 miles in length, extends from the Waimea river to the harbor, and then to 'Ō'ōmanō Point near Kekaha. The adjacent land area consists of sugar cane fields and pasture land.

The stretch of beach between the Waimea river and 'Ō'ōmanō Point has been subject to progressive erosion throughout this century, causing the beach front road to be relocated three times between 1940 and 1955. Construction of the boat harbor reversed this trend on the beach east of the harbor (Waimea Beach), allowing beach accretion at an average rate of 2.3 ft per year between 1960 and 1988. However, during the same time period a similar rate of erosion took place on the beach west of the boat harbor (Kīkīaola Beach).

In conjunction with a topographic and hydrographic survey of Kīkīaola Harbor, and in order to help the design and planning of future harbor improvements, this study examines the physical factors and geologic processes affecting sedimentation near the harbor. Quantitative results are presented as derived from historical rates of accretion and from energetics-based sediment transport theories.

PREVIOUS WORK

Several investigations have taken place in the general region over the years. Unlike the reef-derived carbonate sands of most of Hawai'i's beaches, the dark sand along this reach is terrigenous, and is probably composed of the ferro-magnesian minerals olivine, augite,and calcic plagioclase feldspar (Moberly and Chamberlain, 1964). Inman, Gayman and Cox, (1963), analyzed the cacium carbonate content of sand samples taken from the shoreline at sea level between the Waimea River and Kokole Point, 6 miles to the west. Their results showed a steady increase in calcium carbonate content with distance away from the river.

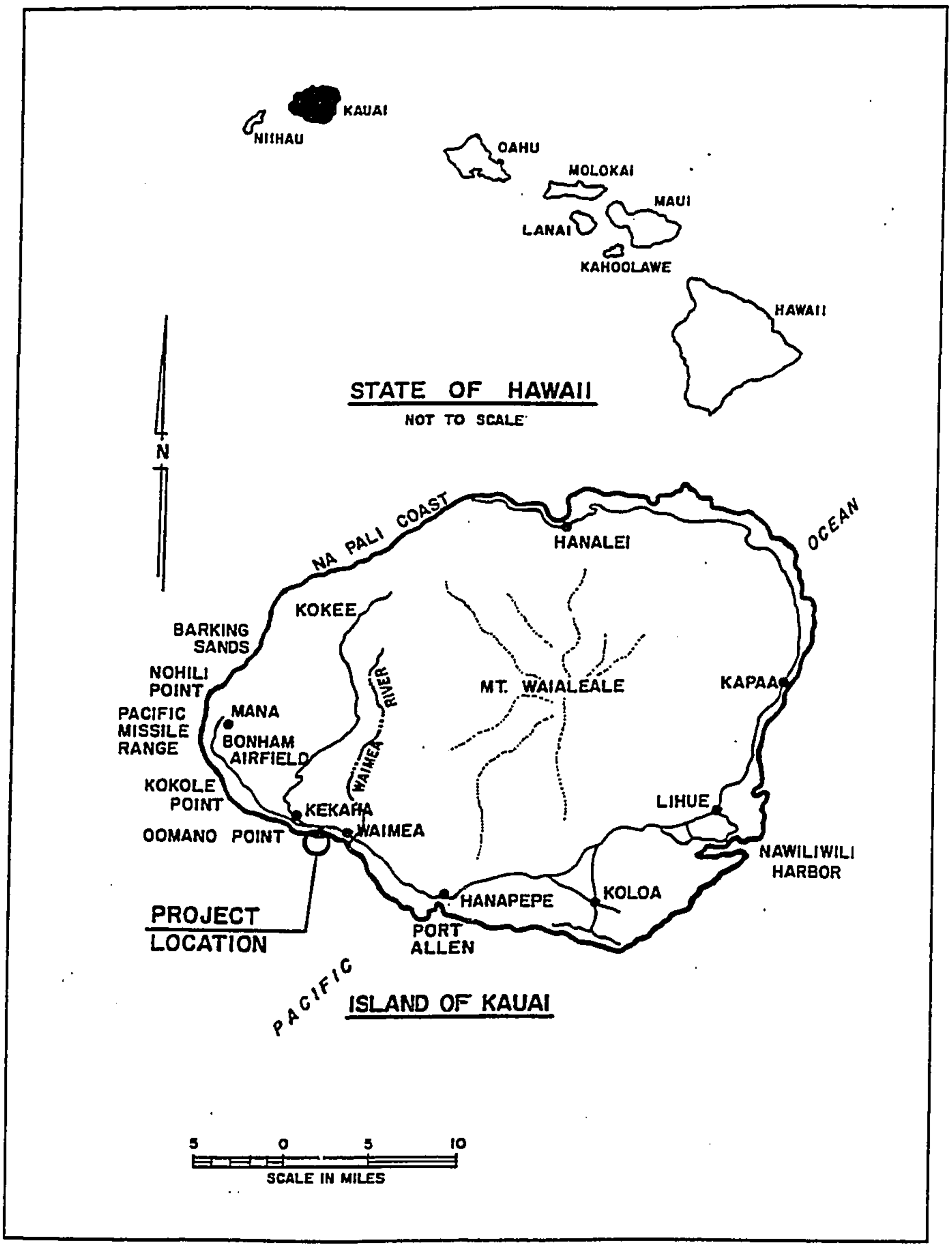


Figure 1. Location of Project Site

Considering the river as a point source of terrigenous sand, the decreasing percentage of terrigenous sand confirmed their theory of a net littoral drift to the west. The data was duplicated in 1977 by Hydro Physics Corporation to determine if Kīkīaola Harbor had disrupted the natural littoral drift in the area. The percentages of carbonate and terrigenous materials were approximately the same as those measured previously, and it was concluded at that time that the harbor was not influencing the littoral processes. The percentage of terrigenous material decreases from approximately 98 percent at the Waimea River, to 80 percent at Kīkīaola Harbor, to less than 10 percent at Kokole Point. This experiment is again being duplicated at present by TEOK Investigations, using a methodology based upon gamma ray emission by volcanic potassium-bearing minerals (TEOK,1996, pers. comm.) The Hydrophysics study also measured littoral currents using fluorescent dye tracer and found a net nearshore westward drift of 0.7 ft/sec. Sea Engineering, Inc. (SEI) and R.M. Towill Corporation (RMT) (1980) conducted field investigations at Kīkīaola Harbor that included sediment sampling and emplacement of sediment traps seaward of the harbor entrance to measure alongshore bedload sediment transport. Results of the transport study were for the most part not satisfactory because time and weather constraints caused the sediment traps to fill completely before retrieval was accomplished. However, an estimation of sedimentation rate was achieved by a short term (2 hour) deployment during mild conditions, giving a yearly gross transport of 52,000 cu yds over a 400 ft wide zone. The median grain size (d_{50}) for two sand samples seaward of the entrance channel was 0.34 mm. and 0.29 mm. The samples were composed of approximately 45 percent calcium carbonate material. The investigators also noted a large sand deposit offshore of the harbor (see Figure 2). The different carbonate percentages in the beach sands and the offshore sands may indicate significant mixing of carbonate and terrigenous sand off the harbor.

The U.S. Army Corps of Engineers, Pacific Ocean Division, issued a general design memorandum and final environmental impact statement for improvements to Kīkīaola Harbor in 1980 that incorporated the results of the SEI/RMT study and other design analysis parameters including wave exposure and refraction analysis. Kīkīaola Harbor was found to be exposed to deep water waves approaching from S 46°E clockwise to N 82° W. Refraction analysis was performed for waves from S 23° E, S 11.5° E, and due South. Refraction coefficients (K_R) ranged from 0.90 to 1.00.

Makai Ocean Engineering, Inc., and Sea Engineering, Inc., prepared an atlas of coastal erosion for the State of Hawai'i Office of State Planning based upon analysis of aerial

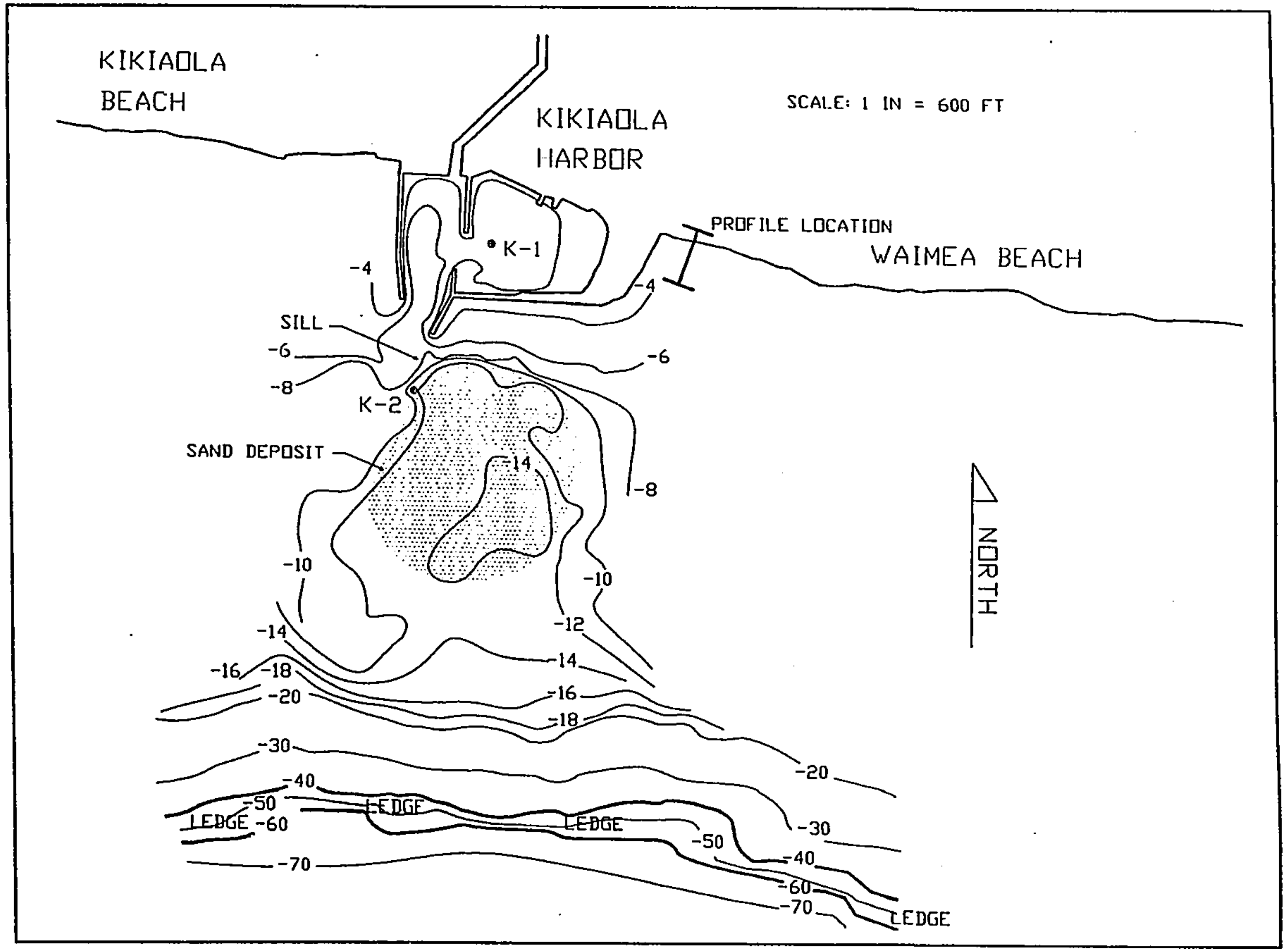


Figure 2. Smoothed Bathymetry and Sediment Sample Locations

photographs (1991) which included the reach from the Waimea River to ʻŌʻōmanō Point. Long term rates of erosion and accretion were calculated based upon the movement of the vegetation line with time.

WAVE CLIMATE

Current within the surf zone is the primary driving force for littoral transport, and is generated by waves shoaling and breaking at an angle to the beach. The quantity and direction of littoral transport are related to the wave height, period, approach direction, bottom depth, and sediment characteristics.

Four deep water wave types may reach the harbor area, and thus influence littoral transport:

1. Northeast trade wind waves are most prevalent, and reach the site after refracting around the southern tip of Kauaʻi. Hydro Physics Corporation (1977) noted that during normal trade wind weather the wave crests approach the coast at an angle of approximately 20 degrees, with a resultant drift to the west. Measurement of alongshore currents using fluorescent dye tracer indicated predominantly westward transport between the Waimea River and Kokole Point, except for localized eastward transport at Kīkīaola Harbor and ʻŌʻōmanō Point. Alongshore current speeds ranged from 0.2 to 3.7 ft/sec.

2. South swell approaches the project site directly from the southeast, south, and southwest. Alongshore transport measurements are not available for south swell conditions, but the direction of transport may be expected to vary with approach direction.

3. Kona storm waves approach the site from the sector southeast through southwest. Large kona waves occur infrequently, but may move large volumes of littoral material. The direction of transport would again be in either direction, depending upon the approach direction.

4. North Pacific swells are generated by winter storms in the North Pacific and approach from the northwest through northeast. These waves refract around the

west end of Kaua'i, and affect the areas just west of Kīkīaola Harbor. The resultant littoral transport is to the east.

North Pacific swells tend to be large in size, and they intermittently introduce large amounts of sediment to the Kekaha area from west. However, their effect is probably confined to the shoreline west of 'Ō'ōmanō Point. Sand east of the point has a high terrigenous content derived from the Waimea River, while sand west of the point is predominately carbonate. Sediment movement around the point is therefore believed to be small (USACE, 1978). Verbal reports from persons familiar with the Kīkīaola area indicate that there is little wave activity near the harbor due to North Pacific swell.

Refracted northeast tradewind waves and southern swell have the most effect on longshore transport in the vicinity of Kīkīaola Harbor. A characteristic wave height, period and approach direction is selected for each of these wave types for further transport analysis.

Tradewind waves occur approximately 75 percent of the time and tend to have short periods (6 to 10 seconds). There is no available wave data in the vicinity of Kīkīaola to give wave parameters characteristic of trade wind waves at the site. Trade wind wave parameters calculated for Waikīkī Beach in Gerritsen (1978) are used in this study, with the rationale that both shorelines similarly face to the southwest, and have similar deepwater wave climates. The deepwater significant wave height for tradewind waves is 4.8 ft, with a corresponding significant period of 8.6 seconds (from Marine Advisors, 1964). The refraction coefficient for Waikīkī was found to be 0.32, giving a deep water significant wave height of 1.5 ft, which is reasonable for the Kīkīaola area. The approach angle for trade wind waves is based upon the Hydro Physics Corporation (1977) observation of a 20° wave approach angle, which is further supported by the USACE (1980) refraction analysis.

South swell is generated by storms thousands of miles distant in the southern hemisphere, and is therefore typically low in height and long in period. It occurs approximately 50 percent of the time (Marine Advisors, 1964). SEI (1988) deployed a wave gauge in 35 ft of water at Waiokapua Bay, west of Kokole Point, and measured wave height and period for almost a year, from April 1987 to March 1988. The wave height data was the spectrally based significant wave height, H_s. Although the site was exposed to refracted North Pacific swell, data from the late spring through late summer, when these waves are rare, give a reasonable estimation of the south swell climate. Based on monthly histograms, the most probable significant wave height during the summer months for the area is between 2 and 3 feet, or 2.5 ft. By assuming a Raleigh distribution of wave heights, the average significant wave height can be calculated as 3.1 ft. The corresponding deep water wave height (H_0) is 2.9 ft, which is comparable to the 2.6 ft significant wave height found by Marine Advisors (1964). The distribution of spectral peak wave periods in the SEI study is somewhat evenly distributed, with a modal peak of about 13 seconds. A characteristic approach direction of due south (180°) is chosen based on the design analysis of the USACE (1980). As the shoreline trends approximately N 82°E, the approach angle (α) is 8°.

BATHYMETRY AND BOTTOM CHARACTERISTICS

A smoothed bathymetric plot of the harbor area, based on the June 6, 1996 survey done by Sea Engineering, Inc. is shown in Figure 2. In common with previous surveys, a large channel with a depth of 12 to 14 ft MLLW extends from just off the harbor entrance to the 16 ft depth contour. The channel is flanked on both sides by a wide zone with depths of 8 to 10 ft. At least the nearshore part of the channel was found by SEI/RMT (1980) to be covered by a sand deposit at least 3 ft in thickness.

Apart from the gross bathymetric trend, the bottom in the area is extremely uneven. Coral patch reefs and isolated coral heads are abundant. Shoal areas abound, and wave patterns seen in aerial photographs are complex. Kīkīaola Harbor has the reputation of being perhaps the most dangerous harbor in the State of Hawai'i, in large part due to the complex and shallow bathymetry. Lines of surf may break as far as 1,500 feet seaward of the harbor during moderate south swell or kona conditions, or even during strong easterly tradewinds. Waves frequently break across the entrance channel during such conditions. The bathymetry steepens at approximately the 16 ft contour, and then drops to a pronounced ledge between 40 and 60 ft. Any sand transported offshore past the 40 ft contour is therefore probably lost from the littoral system.

In the course of accomplishing the nearshore hydrographic surveys, SEI swimmers noted that the nearshore bottom was hard coralline rock, with occasional patches of sand. The sand deposit noted by SEI/RMT (1980) was sampled although it was not seen during the course of the survey due to extremely turbid water. The entrance channel of the harbor had only a thin veneer of sand over a hard bottom.

SEDIMENT SAMPLING AND ANALYSIS

Sediment in the vicinity of the harbor was examined in the field, and two samples, K-1 and K-2, Figure 2, were taken and analyzed for grain size distribution and carbonate content. Sample K-1 was taken just inside the inner harbor entrance, and sample K-2 was taken outside the harbor in the natural channel at about 12 ft depth. Grain size distributions are shown in Figure 3. Mean grain size for the inner harbor sample is 1.68 phi, or 0.31 mm. Mean grain size for the sand deposit sample is 1.34 phi, or 0.39 mm. Both samples contain similar carbonate contents of 43 percent (harbor) and 43.8 percent (channel). These figures are in general agreement with previous work (SEI/RMT, 1980). The water at the time of sampling was extremely turbid due to fine sediment suspended in the water column, however very little fine sediment was found deposited on the bottom. Sand from Kīkīaola Beach, adjacent and west of the harbor appears to be of similar composition and grain size as the offshore sand. Sand just east of the harbor has visibly less carbonate content, indicating that significant mixing of terrigenous and carbonate sediment may be occurring in the immediate vicinity of the harbor.

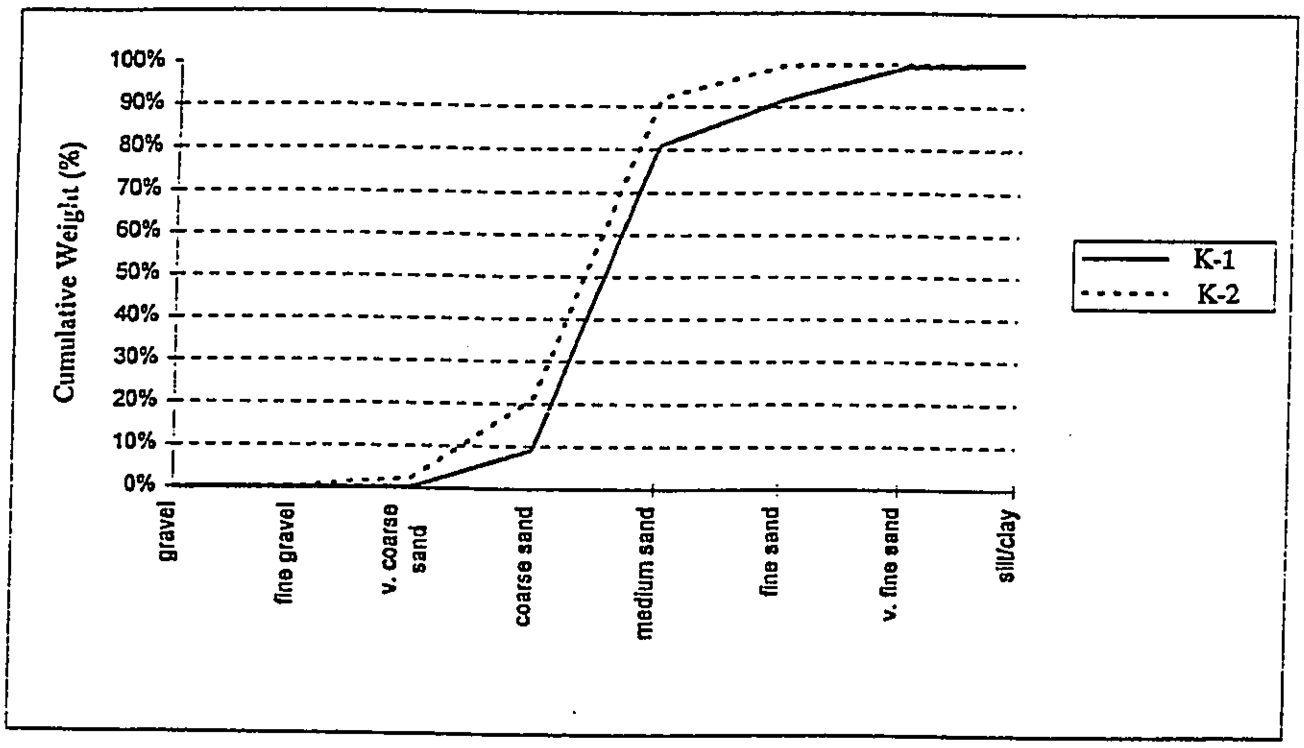
BEACH PROFILES AND SHOREFACE TRANSPORT

Makai Ocean Engineering, Inc (MOE) and Sea Engineering, Inc. (SEI), 1991, analyzed aerial photographs of the reach between the Waimea River and ʻŌʻōmanō Point. Photographs covered the time period from 1953 to 1988. Erosion and accretion patterns were determined by measuring relative positions of the vegetation line for each set of photographs. Migration of the vegetation line seaward indicates a long term pattern of accretion, while landward movement is indicative of erosion. The study by Hydro Physics corporation (1977) concluded that the construction of Kīkīaola did not affect littoral transport except in the immediate vicinity of the harbor. However, the MOE/SEI study

CUMULATIVE FREQUENCY PLOTS

Sample Type: sediment, marine

AECOS Log No.: 9627



ADDITIONAL DATA AND STATISTICS

Additional analyses

Sample	Organic (%)	CaCO3 (%)
K-1	—	43.0
K-2	—	43.8

Moment statistics

Mean (phi)	Std. Dev. (phi)	Skewness	Kurtosis
1.68	0.73	1.2	5.3
1.34	0.61	-0.9	6.9

Figure 3. Grain Size Distributions and Calcium Carbonate Content of Sediment Samples

NOTE: These are percent "coarser-than" frequency curves shows beach accretion prevailing east of the harbor and beach erosion prevailing west of the harbor.

Digitized vegetation line data from the MOE/SEI study were also used to calculate average beach plan form accretion east of Kīkīaola Harbor for this study. The increase in stabilized beach area (shoreward of the vegetation line) was measured from the harbor to approximately 3500 ft to the east. Dividing the area by the length of beach gave a net gain of 65 ft over the course of 28 years (1960 to 1988) for an average of 2.3 ft per year. Similar analysis west of the harbor to ʻŌʻōmanō Point gives a net beach loss of 62.3 ft, or 2.2 ft per year.

The conservation of mass for sediment moving as littoral drift along the shoreline provides the following continuity equation (from Gerritsen, 1978):

$$\frac{\delta y}{\delta t} = -\frac{1}{h}\frac{\delta Q}{\delta x} \tag{1}$$

where the x axis is oriented parallel to the beach, the y axis is shore normal, h is the depth of closure where shoreface sediment movement is negligible, and Q is the volume of sediment transport per unit time (Figure 4). The term $\delta y/\delta t$ represents the rate of accretion of the shoreline. The term $\delta Q/\delta x$ represents the change in sediment transport rate with distance along the beach.

Figure 5 is a beach profile taken just east of Kīkīaola Harbor. The berm height of the beach is +8 ft MLLW, while a reasonable closure depth is -4 ft MLLW (elevation), giving a value for h in equation (1) of 12 ft. The measured profile in Figure 5 is consistent with equilibrium profile theories of Dean (1991), who finds most beach profiles to be exponential of the form,

$$h = Ax^{2/3} \tag{2}$$

where in this case h is not constant and A is a function of grain size (Dean, 1991). For purposes here, however, the cross sectional area can be adequately represented by a simple prismatic form, such that equation (1) can be approximated (with finite operators) as

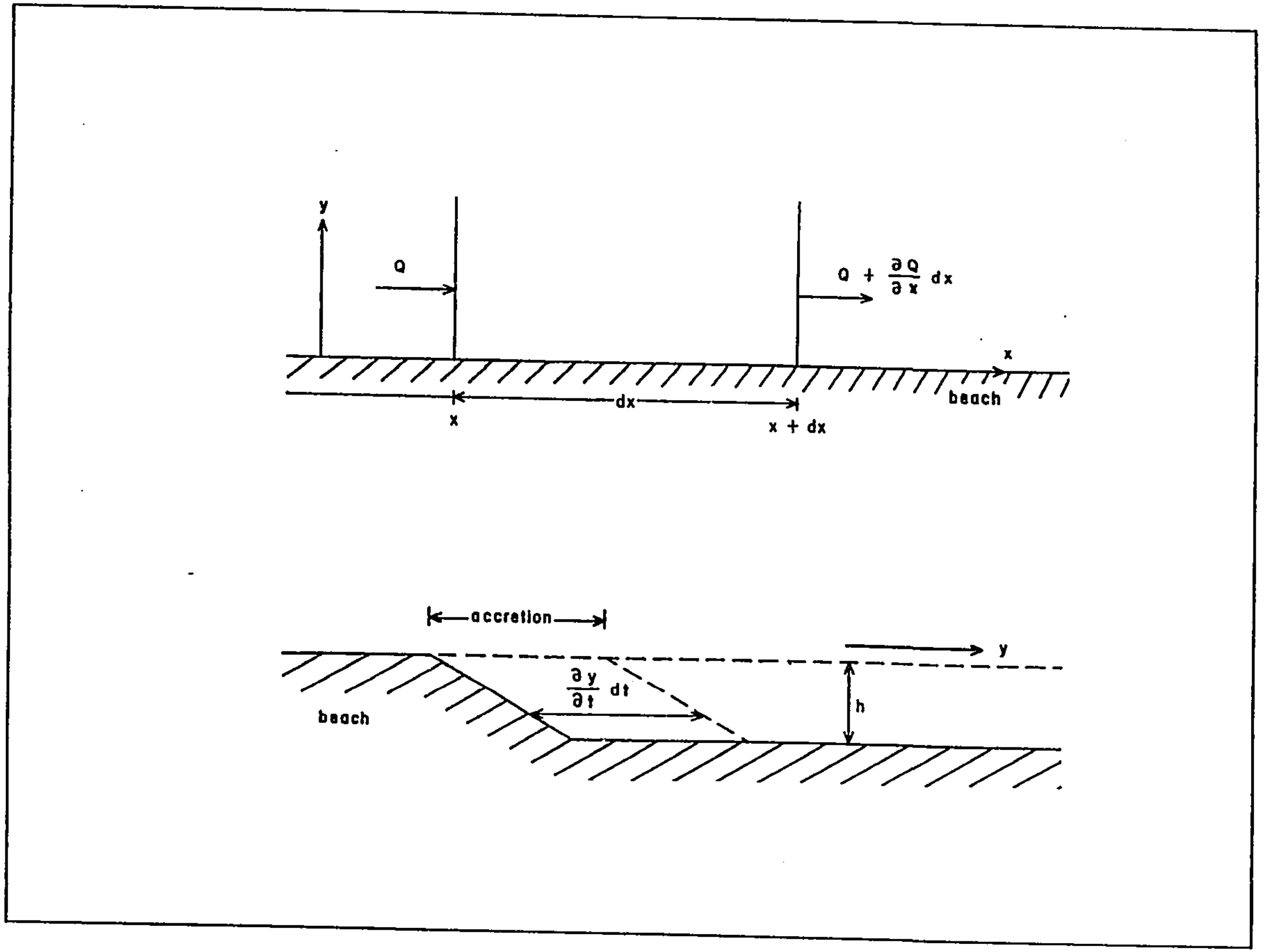


Figure 4. Conservation of Mass for Beach Profiles (from Gerritsen, 1978)

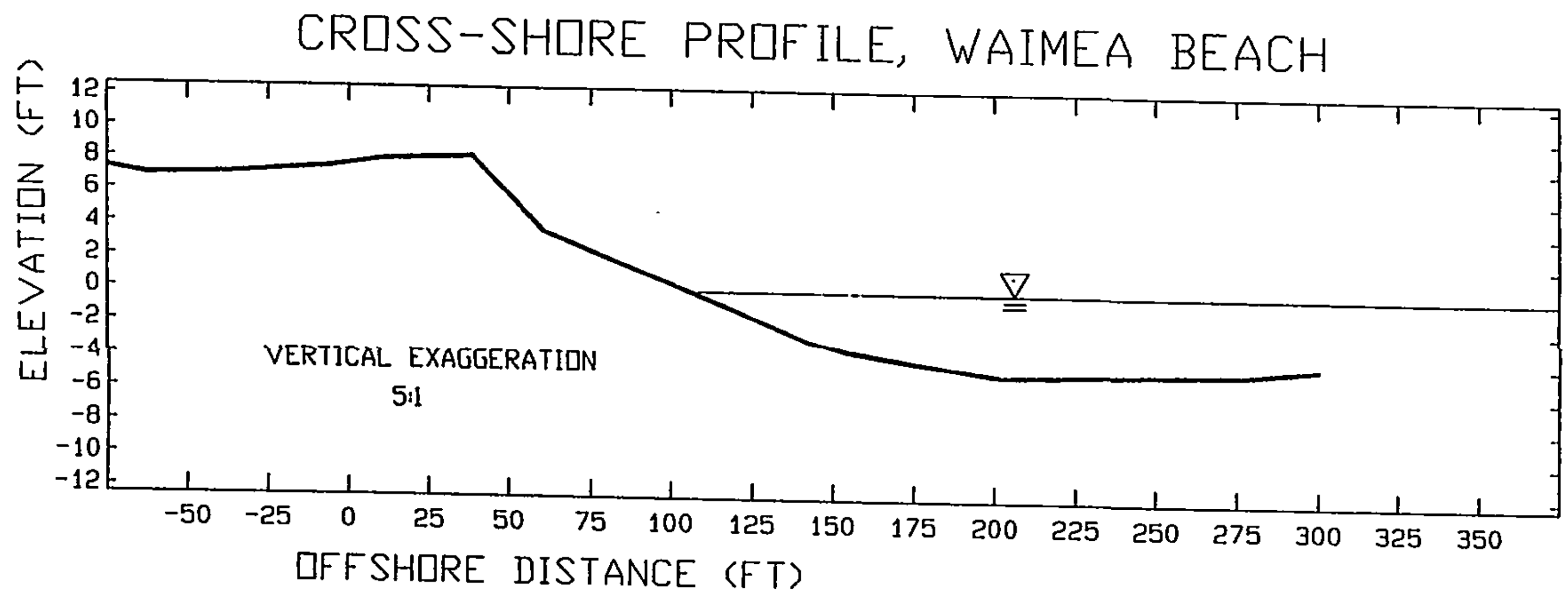


Figure 5. Beach Profile, Waimea Beach (North of Kīkīaola Harbor)

$$\frac{\Delta Q}{\Delta x} = 12\frac{\Delta y}{\Delta t} \tag{3}$$

or using the calculated beach accretion rate of 2.3 ft per year, $\Delta Q/\Delta x = 27.6$ cu ft per year per foot of beach length, or Q equals approximately 3,500 cu yds per year, assuming all littoral drift is blocked by the harbor. If the assumption is also made that equilibrium has been achieved with the passage of time, and that the beach is now stable, this value for Q can be used as a measure of littoral drift.

Although the latter assumption of equilibrium may be valid, the former is almost certainly not so. Although slowed by the harbor jetty, a certain amount of sand has probably always by-passed the harbor. Moreover, while these calculations may be representative of the drift occurring on and just offshore of the shore face, they do not include any longshore transport which may be occurring on shelf or reef regions offshore. Therefore, a value of $Q = 3500$ cu yds per year should be viewed as an absolute lower bound for westward sediment transport on the shore face.

ENERGETICS BASED TRANSPORT

Energetics based transport assumes that littoral drift is caused by the release of energy in the long shore direction due to wave breaking at an angle to the beach. Relatively simple formulas have been derived based on both theoretical considerations from linear wave theory and empirical values derived from field measurements. These are documented in the USACE *SHORE PROTECTION MANUAL* (1984), and are collectively known as the CERC formula.

The immersed weight transport rate I_l is calculated by

$$I_l = KP_{ls} \tag{4}$$

where K is known as the wave power coefficient, empirically determined to be 0.39. P_{ls} is the longshore energy flux factor based upon significant wave height.

The sediment transport rate, Q, can be substituted for the immersed weight using:

$$Q = \frac{I_l}{(\rho_s - \rho) g a'} \tag{5}$$

where ρ_s is the density of the sand grain, ρ is the density of sea water, g is gravitational acceleration and a' is a coefficient for pore space. The relation is then given in the *SHORE PROTECTION MANUAL*:

$$Q = 7.5 \times 10^3 \, P_{ls} \tag{6}$$

in cu yds per year.

The longshore energy flux factor is determined by:

$$P_{ls} = 0.0884 \, \rho g^{3/2} \, H_{sb}^{5/2} \, \sin 2\alpha_b \tag{7}$$

where H_{sb} is the significant breaking wave height, and α_b is the breaking wave angle to the shoreline.

The wave power coefficient was empirically determined from continental U.S. dissipative beaches that are typically long, wide, and flat sloped, with wide surf zones. Beaches in Hawai'i are generally short, are relatively narrow with steep foreshores and narrow surf zones. Recognizing this, SEI (1982), using data from Hawaiian beaches, determined the relation:

$$Q = 1.2 \times 10^3 \, P_{ls} \tag{8}$$

Bailard (1984) modified the wave power coefficient in the CERC formula to be a function of breaker angle and the ratio of the orbital velocity magnitude and the sediment fall velocity:

$$K = 0.05 + 2.6 \sin^2 2\alpha_b + 0.007 \frac{u_{mb}}{W} \tag{9}$$

where u_{mb} is the oscillatory velocity magnitude at the breaking point, and W is the fall velocity of the sediment.

The above methods were used to calculate gross sediment transport using characteristic wave parameters for southern swell and trade wind waves. Results are listed in Table 1, along with calculations from SEI/RMT sediment trap study, and calculations based upon beach profile changes:

Table 1.

	South Swell H_s = 2.9 ft T = 13 sec α_b = 8 ° f = 50%	Trade Wind Swell H_s = 1.5 ft T = 8.6 sec α_b = 20 ° f = 75%	Total Q cu yds/year x 10^3
$Q_{SEI/RMT\ 1980}$			52
$Q_{Profiles}$			3.5
Q_{CERC}	1,434	775	2209
$Q_{Bailard}$	612	1,177	3579
$Q_{SEI\ 1982}$	229	124	353

DISCUSSION

Figure 6 is a diagram illustrating key sediment transport features around Kīkīaola Harbor. The predominant transport direction shown is east to west, and includes shoreface transport of terrigenous sediment from the Waimea river, longshore transport on the offshore reefs, and carbonate production from offshore. Sediment by-passing the harbor and longshore drift on the offshore reefs is probably caught by the natural channel off of the harbor entrance. It is likely that during large swell events sand at the bottom of the channel is stirred up and moves onshore into the Harbor, alongshore, and also offshore where it may be lost. With shoals on both sides, the channel probably experiences strong offshore rip currents during large wave events. These currents, coupled with steep bathymetry past 16 ft and a sharp ledge at 40 ft, may serve to remove a large amount of sand from the littoral system.

The difficulties involved in providing an accurate quantitative estimation of littoral transport are evident. The complexities and uncertainties of wave climate, bathymetry, bottom conditions, sediment supply, and grain size parameters conspire to make accurate prediction difficult. Several approaches are included here that model the problem differently:

1. Sediment trap data from SEI/RMT (1980), while limited, is the only quantitative field data available.

2. Transport along the shore face is estimated by the change in historical beach profiles.

3. Energetics based calculations provide transport estimates for relatively simple littoral systems, such as dissipative beaches with sand bottoms, using available energy released in the surf zone by breaking waves.

The values for yearly sediment transport calculated and shown in Table 1 vary widely by orders of magnitude. The problem, then, is to select the most reasonable value for further application. The SEI/RMT (1980) value is based upon a short sampling of a sediment trap during mild conditions. During large wave events, sediment movement may increase by at least an order of magnitude. Transport rates based upon the profile measurements give an absolute lower bound based upon sediment trapped on the beach, but any transport on the

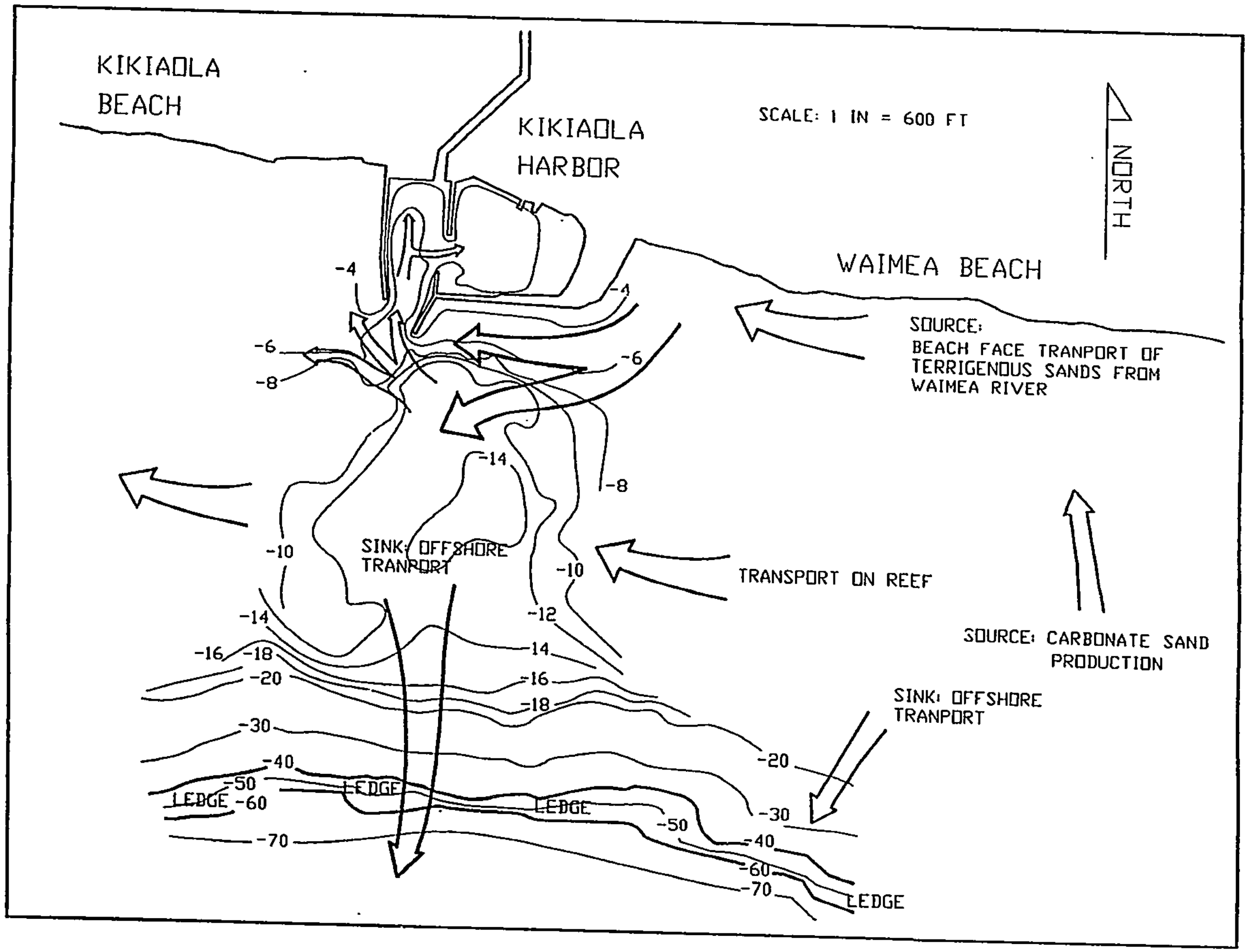


Figure 6. Sediment Flow Diagram, Kīkīaola Harbor

offshore reefs or by-passing the harbor is not represented. Both the CERC and Bailard formulas are based upon energy available to move sand, and rely on empirical data from beach systems wholly different from the project beach for calibration (note that the Bailard forumula for trade wind conditions is probably grossly in error due to the high angle of wave incidence). Hawaiian beaches typically have irregular bottom conditions with numerous limestone reefs that can both trap sand and dissipate energy available for longshore transport, so that one would expect less sediment tranport than calculated by the CERC or Bailard formulas. The modified CERC formula used by SEI (1982) is at least calibrated for Hawaiian beaches, and properly predicts less transport than both the CERC and Bailard formulas. It is therefore considered to be the most reasonable for this application.

As noted in SEI/RMT (1980) the harbor is now protected from direct bedload transport of sediment by reef acting as a sill between the harbor entrance and the sand deposit in the natural channel (see Figure 2). At present, only a thin veneer of sand was noted at the bottom of the entrance channel, which has a depth between 6 and 7 ft. On a day with mild wave conditions, waves at the entrance were noted to be steep and near breaking at times, suggesting that the bottom is scoured by oscillating wave motion. If the harbor entrance is deepened and connected with the natural channel, it is possible that more sand will be pushed into the harbor, and a shoaling problem may develop if sand accumulates at the entrance. On the other hand, assuming that conditions are now in equilibrium, it appears that the natural channel offshore is stable at a nominal depth of 12 ft. The vigorous wave climate at the site probaly maintains the channel depth. SEI/RMT (1980) calculated that a wave 1 ft in height, with a 5 second period would initiate motion in sediment with a typical grain size of 0.5 mm at a depth of 12 ft. Therefore, an access channel dredged no deeper than the natural channel may also be stable. Increased transport of sediment into the harbor due to deepening of the access and entrance channels would probably result in increased deposition in the inner harbor basin and also at the landward end of the entrance channel. Inner harbor sedimentation would most likely occur as drifts of sand deposited near the entrance to the inner harbor.

Due to the uncertainties involved with calculating sediment transport rate, it is difficult to give an accurate quantitative prediction of sediment transport into the harbor as a response to changes in harbor configuration. If the value used for Q is that given in Table 1 by the SEI modified CERC formula (353×10^3 cu yds per year) and the result is divided by a wide surf zone (1,500 ft), a value 235 cu yds of sediment per foot of surf zone per year is attained. As a worst case, assuming this value is valid across the 150 ft entrance channel, approximately 35.3 x 10^3 cu yds would move into the harbor per year. The inner harbor has an area of approximately 220 x 10^3 sq ft. These values would result in 4 ft of sediment filling the inner harbor every year.

A more reasonable estimate of inner harbor sedimentation is achieved by using the rate of littoral drift calculated from historical beach changes observed in aerial photographs, 3.5 x 10^3 cu yds per year (Table 1). Assuming that the sediment transport rate into the harbor is the same as the sediment accretion rate on beaches updrift of the harbor gives an annual shoaling rate for the inner harbor of 0.4 ft. Thus, for example, a 2 ft over draft allowance for sediment deposition would require minimum maintenance dredging every 5 years. Alternatively, modifications to the harbor could be designed to incorporate sediment catch basins that enable sand by-passing to the down drift beach.

REFERENCES

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2. Gerritsen, F., "Beach and Surf Parameters in Hawai'i," UNIHI-SEAGRANT-TR-78-02, June 1978.

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5. Makai Ocean Engineering, Inc., and Sea Engineering, Inc., "Aerial Phototgraph Analysis of Coastal Erosion on the Islands of Kaua'i, Moloka'i, Lāna'i, Maui and Hawai'i," report prepared for State of Hawai'i Office of State Planning, Coastal Zone Management Program, June 1991.

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.6 COST ESTIMATE

APPENDIX F

note

KIKIAOLA HARBOR
KAUAI, HAWAII

NARRATIVE REPORT FOR KIKIAOLA HARBOR

1. Contingency for mob and demob is 50% because of the uncertainty of marine equipment being available in Hawaii at the time of project award.

2. Estimate based on an Oahu contractor doing the work. Dredging of entrance channel is assum be by a sub contractor specializing in marine work. Entrance channel dredged by barge.

3. Access channel, turning basin and berthing area dredged by clamshell working off of causeway

4. Dredged disposal site located within 1 mile of project.

5. Source of stone is from fields within 3 miles of the project.

6. Award date Aug 2000.

KIKIAOLA HARBOR PLAN 1 (AUTH)
KAUAI, HAWAII

Designed By: PACIFIC OCEAN DIVISION
Estimated By: RONALD PANG

Prepared By: CEPOD-ED-CE

Preparation Date: 03/30/98
Effective Date of Pricing: 04/01/98

Sales Tax: 0.00%

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG CHK'D BY________

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
	AUTHORIZED PLAN (PLAN 1)							
	FEDERAL COSTS							
	NAVIGATION HARBOR							
1000—	MOB AND DEMOB	1	LS		$275,600	50%	$137,800	$413,400
120115-	MECHANICAL DREDGING							
12011502	ENTRANCE CHANNEL	26,200	CY	$44.20	$1,158,040	15%	$173,706	$1,331,746
12011502	ACCESS CHANNEL	3,900	CY	$21.50	$83,850	15%	$12,578	$96,428
	TOTAL NAVIGATION HARBOR				$1,517,490		$324,084	$1,841,574
100046-	BREAKWATERS & SEAWALLS							
	EAST BREAKWATER							
10004602	SITEWORK							
	2+50 TO 8+45							
10004602	ARMOR 3.5 TO 6 TON	11,420	TON	$47.60	$543,592	15%	$81,539	$625,131
10004602	BEDDING SP TO 200 LB	2,370	TON	$42.00	$99,540	15%	$14,931	$114,471
10004602	REMOVE EXSTG B/W	3,800	TON	$30.10	$114,380	15%	$17,157	$131,537
10004602	EXCAVATE	1,450	CY	$13.60	$19,720	15%	$2,958	$22,678
10004602	WORKROAD	330	CY	$41.30	$13,629	15%	$2,044	$15,673
10004602	REMOVE STUB B/W	4,260	TON	$30.10	$128,226	15%	$19,234	$147,460
	8+45 TO 9+85							
10004602	ARMOR 5.5 TO 9 TON	3,340	TON	$45.40	$151,636	15%	$22,745	$174,381
10004602	BEDDING SP TO 200 LB	1,330	TON	$42.00	$55,860	15%	$8,379	$64,239
10004602	REMOVE EXSTG B/W	650	TON	$30.10	$19,565	15%	$2,935	$22,500
10004602	EXCAVATE	760	CY	$13.60	$10,336	15%	$1,550	$11,886
					$1,156,484		$173,473	$1,329,957
	INNER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	4,260	TON	$45.40	$193,404	15%	$29,011	$222,415
10004602	U'LAYER 700 TO 1200 LB	1,090	TON	$47.60	$51,884	15%	$7,783	$59,667
10004602	BEDDING SP TO 200 LB	2,420	TON	$42.00	$101,640	15%	$15,246	$116,886
10004602	EXCAVATE	2,780	CY	$13.60	$37,808	15%	$5,671	$43,479
					$384,736		$57,710	$442,446
	REPAIR WEST BREAKWATER							
	SITEWORK							
10004602	ACCESS ROAD	1	LS		$73,500	15%	$11,025	$84,525
10004602	RESET ARMOR	1,970	TON	$73.70	$145,189	25%	$36,297	$181,486
					$218,689		$47,322	$266,011
	TOTAL BREAKWATER AND SEAWALLS				$1,759,909		$278,505	$2,038,414
	TOTAL FEDERAL COST				$3,277,399		$602,589	$3,879,988

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG   CHK'D BY________

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
AUTHORIZED PLAN (PLAN 1)								
NONFEDERAL COSTS								
	NAVIGATION HARBOR							
120115-- 12011502	MECHANICAL DREDGING BERTHING AREA	8,050	CY	$15.00	$120,750	15%	$18,113	$138,863
	TOTAL NONFEDERAL COST				$120,750		$18,113	$138,863
	TOTAL PROJECT				$3,398,149		$620,701	$4,018,850

PRICE LEVEL APRIL 2001

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
	PLAN 2							
	FEDERAL COSTS							
	NAVIGATION HARBOR							
1000—	MOB AND DEMOB	1	LS		$275,600	50%	$137,800	$413,400
120115–	MECHANICAL DREDGING							
12011502	ENTRANCE CHANNEL	25,500	CY	$44.20	$1,127,100	15%	$169,065	$1,296,165
12011502	TURNING BASIN	12,500	CY	$21.50	$268,750	15%	$40,313	$309,063
12011502	ACCESS CHANNEL	1,000	CY	$21.50	$21,500	15%	$3,225	$24,725
	TOTAL NAVIGATION HARBOR				**$1,692,950**		**$350,403**	**$2,043,353**
100046–	**BREAKWATERS & SEAWALLS**							
	EAST BREAKWATER							
10004602	SITEWORK							
	2+50 TO 8+45							
10004602	ARMOR 3.5 TO 6 TON	11,420	TON	$47.60	$543,592	15%	$81,539	$625,131
10004602	BEDDING SP TO 200 LB	2,370	TON	$42.00	$99,540	15%	$14,931	$114,471
10004602	REMOVE EXSTG B/W	3,800	TON	$30.10	$114,380	15%	$17,157	$131,537
10004602	EXCAVATE	1,450	CY	$13.60	$19,720	15%	$2,958	$22,678
10004602	WORKROAD	330	CY	$41.30	$13,629	15%	$2,044	$15,673
10004602	REMOVE STUB B/W	4,260	TON	$30.10	$128,226	15%	$19,234	$147,460
	8+45 TO 9+85							
10004602	ARMOR 5.5 TO 9 TON	3,340	TON	$45.40	$151,636	15%	$22,745	$174,381
10004602	BEDDING SP TO 200 LB	1,330	TON	$42.00	$55,860	15%	$8,379	$64,239
10004602	REMOVE EXSTG B/W	650	TON	$30.10	$19,565	15%	$2,935	$22,500
10004602	EXCAVATE	760	CY	$13.60	$10,336	15%	$1,550	$11,886
					$1,156,484		$173,473	$1,329,957
	INNER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	4,260	TON	$45.40	$193,404	15%	$29,011	$222,415
10004602	U'LAYER 700 TO 1200 LB	1,090	TON	$47.60	$51,884	15%	$7,783	$59,667
10004602	BEDDING SP TO 200 LB	2,420	TON	$42.00	$101,640	15%	$15,246	$116,886
10004602	EXCAVATE	2,780	CY	$13.60	$37,808	15%	$5,671	$43,479
					$384,736		$57,710	$442,446
	REPAIR WEST BREAKWATER							
	SITEWORK							
10004602	REMOVE CREST	1,070	TON		$73,500	25%	$18,375	$91,875
10004602	RESET ARMOR	1,970	TON	$73.70	$145,189	25%	$36,297	$181,486
					$218,689		$54,672	$273,361
	TOTAL BREAKWATER AND SEAWALLS				**$1,759,909**		**$285,855**	**$2,045,764**
	TOTAL FEDERAL COST				**$3,452,859**		**$636,258**	**$4,089,117**

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 2 CONT'D								
NONFEDERAL COSTS								
	NAVIGATION HARBOR							
120115-	MECHANICAL DREDGING							
12011502	BERTHING AREA	8,050	CY	$15.00	$120,750	15%	$18,113	$138,863
	TOTAL NONFEDERAL COST				**$120,750**		**$18,113**	**$138,863**
	TOTAL PROJECT				**$3,573,609**		**$654,370**	**$4,227,979**

PRICE LEVEL APRIL 2001

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 3								
FEDERAL COSTS								
	NAVIGATION HARBOR							
1000—	MOB AND DEMOB	1	LS		$275,600	50%	$137,800	$413,400
120115–	MECHANICAL DREDGING							
12011502	ENTRANCE CHANNEL	23,900	CY	$44.20	$1,056,380	15%	$158,457	$1,214,837
12011502	ACCESS CHANNEL	4,100	CY	$21.50	$88,150	15%	$13,223	$101,373
	TOTAL NAVIGATION HARBOR				$1,420,130		$309,480	$1,729,610
100046–	BREAKWATERS & SEAWALLS							
	EAST BREAKWATER							
10004602	SITEWORK							
	2+50 TO 8+45							
10004602	ARMOR 3.5 TO 6 TON	11,420	TON	$47.60	$543,592	15%	$81,539	$625,131
10004602	BEDDING SP TO 200 LB	2,370	TON	$42.00	$99,540	15%	$14,931	$114,471
10004602	REMOVE EXSTG B/W	3,800	TON	$30.10	$114,380	15%	$17,157	$131,537
10004602	EXCAVATE	1,450	CY	$13.60	$19,720	15%	$2,958	$22,678
10004602	WORKROAD	330	CY	$41.30	$13,629	15%	$2,044	$15,673
10004602	REMOVE STUB B/W	4,260	TON	$30.10	$128,226	15%	$19,234	$147,460
	8+45 TO 9+85							
10004602	ARMOR 5.5 TO 9 TON	3,340	TON	$45.40	$151,636	15%	$22,745	$174,381
10004602	BEDDING SP TO 200 LB	1,330	TON	$42.00	$55,860	15%	$8,379	$64,239
10004602	REMOVE EXSTG B/W	650	TON	$30.10	$19,565	15%	$2,935	$22,500
10004602	EXCAVATE	760	CY	$13.60	$10,336	15%	$1,550	$11,886
					$1,156,484		$173,473	$1,329,957
	INNER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	8,370	TON	$45.40	$379,998	15%	$57,000	$436,998
10004602	U'LAYER 700 TO 1200 LB	2,240	TON	$47.60	$106,624	15%	$15,994	$122,618
10004602	BEDDING SP TO 200 LB	4,600	TON	$42.00	$193,200	15%	$28,980	$222,180
10004602	EXCAVATE	4,880	CY	$13.60	$66,368	15%	$9,955	$76,323
					$746,190		$111,929	$858,119
	REPAIR WEST BREAKWATER							
	SITEWORK							
10004602	REMOVE CREST	1,070	TON		$73,500	25%	$18,375	$91,875
10004602	RESET ARMOR	1,970	TON	$73.70	$145,189	25%	$36,297	$181,486
					$218,689		$54,672	$273,361
	REMOVE INNER STUB BREAKWATER							
	SITEWORK							
10004602	REMOVE BREAKWATER	800	TON	$30.10	$24,080	15%	$3,612	$27,692
					$24,080		$3,612	$27,692
	TOTAL BREAKWATER AND SEAWALLS				$2,145,443		$343,685	$2,489,128
	TOTAL FEDERAL COST				$3,565,573		$653,165	$4,218,738

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 2 CONT'D								
NONFEDERAL COSTS								
	NAVIGATION HARBOR							
120115--	MECHANICAL DREDGING							
12011502	BERTHING AREA	8,050	CY	$15.00	$120,750	15%	$18,113	$138,863
	TOTAL NONFEDERAL COST				**$120,750**		**$18,113**	**$138,863**
	TOTAL PROJECT				**$3,686,323**		**$671,277**	**$4,357,600**

PRICE LEVEL APRIL 2001

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 4								
FEDERAL COSTS								
	NAVIGATION HARBOR							
1000---	MOB AND DEMOB	1	LS		$275,600	50%	$137,800	$413,400
120115--	MECHANICAL DREDGING							
12011502	ENTRANCE CHANNEL	26,200	CY	$44.20	$1,158,040	15%	$173,706	$1,331,746
12011502	ACCESS CHANNEL	3,900	CY	$21.50	$83,850	15%	$12,578	$96,428
	TOTAL NAVIGATION HARBOR				$1,517,490		$324,084	$1,841,574
100046--	BREAKWATERS & SEAWALLS							
	EAST BREAKWATER							
10004602	SITEWORK							
	2+50 TO 8+45							
10004602	ARMOR 3.5 TO 6 TON	11,420	TON	$47.60	$543,592	15%	$81,539	$625,131
10004602	BEDDING SP TO 200 LB	2,370	TON	$42.00	$99,540	15%	$14,931	$114,471
10004602	REMOVE EXSTG B/W	3,800	TON	$30.10	$114,380	15%	$17,157	$131,537
10004602	EXCAVATE	1,450	CY	$13.60	$19,720	15%	$2,958	$22,678
10004602	WORKROAD	330	CY	$41.30	$13,629	15%	$2,044	$15,673
10004602	REMOVE STUB B/W	4,260	TON	$30.10	$128,226	15%	$19,234	$147,460
	8+45 TO 9+85							
10004602	ARMOR 5.5 TO 9 TON	3,340	TON	$45.40	$151,636	15%	$22,745	$174,381
10004602	BEDDING SP TO 200 LB	1,330	TON	$42.00	$55,860	15%	$8,379	$64,239
10004602	REMOVE EXSTG B/W	650	TON	$30.10	$19,565	15%	$2,935	$22,500
10004602	EXCAVATE	760	CY	$13.60	$10,336	15%	$1,550	$11,886
					$1,156,484		$173,473	$1,329,957
	INNER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	4,260	TON	$45.40	$193,404	15%	$29,011	$222,415
10004602	U'LAYER 700 TO 1200 LB	1,090	TON	$47.60	$51,884	15%	$7,783	$59,667
10004602	BEDDING SP TO 200 LB	2,420	TON	$42.00	$101,640	15%	$15,246	$116,886
10004602	EXCAVATE	2,780	CY	$13.60	$37,808	15%	$5,671	$43,479
					$384,736		$57,710	$442,446
	OUTER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	5,810	TON	$45.40	$263,774	15%	$39,566	$303,340
10004602	U'LAYER 700 TO 1200 LB	1,550	TON	$47.60	$73,780	15%	$11,067	$84,847
10004602	BEDDING SP TO 200 LB	2,780	TON	$42.00	$116,760	15%	$17,514	$134,274
10004602	EXCAVATE	3,180	CY	$13.60	$43,248	15%	$6,487	$49,735
					$497,562		$74,634	$572,196

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 4 CONT'D								
100046–	BREAKWATERS & SEAWALLS							
	REPAIR WEST BREAKWATER							
	SITEWORK							
10004602	REMOVE CREST	1,070	TON		$73,500	25%	$18,375	$91,875
10004602	RESET ARMOR	1,970	TON	$73.70	$145,189	25%	$36,297	$181,486
					$218,689		$54,672	$273,361
	TOTAL BREAKWATER AND SEAWALLS				$2,257,471		$360,490	$2,617,961
	TOTAL FEDERAL COST				$3,774,961		$684,573	$4,459,534
NONFEDERAL COSTS								
	NAVIGATION HARBOR							
120115–	MECHANICAL DREDGING							
12011502	BERTHING AREA	8,050	CY	$15.00	$120,750	15%	$18,113	$138,863
	TOTAL NONFEDERAL COST				$120,750		$18,113	$138,863
	TOTAL PROJECT				$3,895,711		$702,686	$4,598,397

PRICE LEVEL APRIL 2001

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 5								
FEDERAL COSTS								
	NAVIGATION HARBOR							
1000—	MOB AND DEMOB	1	LS		$275,600	50%	$137,800	$413,400
120115–	MECHANICAL DREDGING							
12011502	ENTRANCE CHANNEL	43,400	CY	$44.20	$1,918,280	15%	$287,742	$2,206,022
12011502	ACCESS CHANNEL	4,300	CY	$21.50	$92,450	15%	$13,868	$106,318
	TOTAL NAVIGATION HARBOR				$2,286,330		$439,410	$2,725,740
100046–	BREAKWATERS & SEAWALLS							
	EAST BREAKWATER							
10004602	SITEWORK							
	2+50 TO 8+45							
10004602	ARMOR 3.5 TO 6 TON	11,420	TON	$47.60	$543,592	15%	$81,539	$625,131
10004602	BEDDING SP TO 200 LB	2,370	TON	$42.00	$99,540	15%	$14,931	$114,471
10004602	REMOVE EXSTG B/W	3,800	TON	$30.10	$114,380	15%	$17,157	$131,537
10004602	EXCAVATE	1,450	CY	$13.60	$19,720	15%	$2,958	$22,678
10004602	WORKROAD	330	CY	$41.30	$13,629	15%	$2,044	$15,673
10004602	REMOVE STUB B/W	4,260	TON	$30.10	$128,226	15%	$19,234	$147,460
	8+45 TO 9+85							
10004602	ARMOR 5.5 TO 9 TON	3,340	TON	$45.40	$151,636	15%	$22,745	$174,381
10004602	BEDDING SP TO 200 LB	1,330	TON	$42.00	$55,860	15%	$8,379	$64,239
10004602	REMOVE EXSTG B/W	650	TON	$30.10	$19,565	15%	$2,935	$22,500
10004602	EXCAVATE	760	CY	$13.60	$10,336	15%	$1,550	$11,886
					$1,156,484		$173,473	$1,329,957
	INNER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	4,260	TON	$45.40	$193,404	15%	$29,011	$222,415
10004602	U'LAYER 700 TO 1200 LB	1,090	TON	$47.60	$51,884	15%	$7,783	$59,667
10004602	BEDDING SP TO 200 LB	2,420	TON	$42.00	$101,640	15%	$15,246	$116,886
10004602	EXCAVATE	2,780	CY	$13.60	$37,808	15%	$5,671	$43,479
					$384,736		$57,710	$442,446
	WEST BREAKWATER EXTENSION							
10004602	SITEWORK							
10004602	REMOVE CREST	1,070	TON		$73,500	25%	$18,375	$91,875
10004602	RESET ARMOR	1,970	TON	$73.70	$145,189	25%	$36,297	$181,486
10004602	ARMOR 5.5 TO 9 TON	20,400	TON	$45.40	$926,160	15%	$138,924	$1,065,084
10004602	U'LAYER 700 TO 1200 LB	5,740	TON	$47.60	$273,224	15%	$40,984	$314,208
10004602	BEDDING SP TO 200 LB	12,010	TON	$42.00	$504,420	15%	$75,663	$580,083
10004602	EXCAVATE	4,400	CY	$13.60	$59,840	15%	$8,976	$68,816
					$1,982,333		$319,219	$2,301,552
	TOTAL BREAKWATER AND SEAWALLS				$3,523,553		$550,402	$4,073,955
	TOTAL FEDERAL COST				$5,809,883		$989,811	$6,799,694

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 5 CONT'D								
NONFEDERAL COSTS								
	NAVIGATION HARBOR							
120115--	MECHANICAL DREDGING							
12011502	BERTHING AREA	8,050	CY	$15.00	$120,750	15%	$18,113	$138,863
	TOTAL NONFEDERAL COST				$120,750		$18,113	$138,863
	TOTAL PROJECT				$5,930,633		$1,007,924	$6,938,557

PRICE LEVEL APRIL 2001

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 6								
FEDERAL COSTS								
	NAVIGATION HARBOR							
1000—	MOB AND DEMOB	1	LS		$275,600	50%	$137,800	$413,400
120115–	MECHANICAL DREDGING							
12011502	ENTRANCE CHANNEL	20,400	CY	$44.20	$901,680	15%	$135,252	$1,036,932
12011502	ACCESS CHANNEL	12,100	CY	$21.50	$260,150	15%	$39,023	$299,173
	TOTAL NAVIGATION HARBOR				$1,437,430		$312,075	$1,749,505
100046–	BREAKWATERS & SEAWALLS							
	EAST BREAKWATER							
10004602	SITEWORK							
	2+50 TO 8+45							
10004602	ARMOR 3.5 TO 6 TON	11,420	TON	$47.60	$543,592	15%	$81,539	$625,131
10004602	BEDDING SP TO 200 LB	2,370	TON	$42.00	$99,540	15%	$14,931	$114,471
10004602	REMOVE EXSTG B/W	3,800	TON	$30.10	$114,380	15%	$17,157	$131,537
10004602	EXCAVATE	1,450	CY	$13.60	$19,720	15%	$2,958	$22,678
10004602	WORKROAD	330	CY	$41.30	$13,629	15%	$2,044	$15,673
10004602	REMOVE STUB B/W	4,260	TON	$30.10	$128,226	15%	$19,234	$147,460
	8+45 TO 13+10							
10004602	ARMOR 5.5 TO 9 TON	18,330	TON	$45.40	$832,182	15%	$124,827	$957,009
10004602	BEDDING SP TO 200 LB	5,220	TON	$47.60	$248,472	15%	$37,271	$285,743
10004602	REMOVE EXSTG B/W	10,020	TON	$42.00	$420,840	15%	$63,126	$483,966
10004602	EXCAVATE	3,900	CY	$13.60	$53,040	15%	$7,956	$60,996
					$2,473,621		$371,043	$2,844,664
	INNER EAST STUB BREAKWATER							
10004602	SITEWORK							
10004602	ARMOR 5.5 TO 9 TON	4,260	TON	$45.40	$193,404	15%	$29,011	$222,415
10004602	U'LAYER 700 TO 1200 LB	1,090	TON	$47.60	$51,884	15%	$7,783	$59,667
10004602	BEDDING SP TO 200 LB	2,420	TON	$42.00	$101,640	15%	$15,246	$116,886
10004602	EXCAVATE	2,780	CY	$13.60	$37,808	15%	$5,671	$43,479
					$384,736		$57,710	$442,446
	REPAIR WEST BREAKWATER							
	SITEWORK							
10004602	REMOVE CREST	830	TON		$73,500	25%	$18,375	$91,875
10004602	RESET ARMOR	960	TON	$73.70	$70,752	25%	$17,688	$88,440
10004602	REMOVE EXSTG B/W	7,200	TON	$30.10	$216,720	15%	$32,508	$249,228
					$360,972		$68,571	$429,543
	TOTAL BREAKWATER AND SEAWALLS				$3,219,329		$497,325	$3,716,654
	TOTAL FEDERAL COST				$4,656,759		$809,399	$5,466,158

KIKIAOLA HARBOR
KAUAI, HAWAII
EST: R. PANG

15-Apr-98

ACCOUNT CODE		QTY	UNIT	UNIT PRICE	AMOUNT	CONT %	IN ACCT. 04.1.Z.-	PROJECT COST
PLAN 6 CONT'D								
NONFEDERAL COSTS								
	NAVIGATION HARBOR							
120115--	MECHANICAL DREDGING							
12011502	BERTHING AREA	8,050	CY	$15.00	$120,750	15%	$18,113	$138,863
	TOTAL NONFEDERAL COST				**$120,750**		**$18,113**	**$138,863**
	TOTAL PROJECT				**$4,777,509**		**$827,512**	**$5,605,021**

PRICE LEVEL APRIL 2001

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT KIK981: KIKIAOLA HARBOR PLAN 1 (AUTH) - KAUAI, HAWAII
KIKIAOLA HARBOR AUTH PLAN

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DETAILED ESTIMATE — DETAIL PAGE

BACKUP REPORTS — BACKUP PAGE

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** PROJECT OWNER SUMMARY - Bid Item **

		QUANTITY UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
1	MOB AND DEMOB		276,408	0	0	0	0	0	276,408	
2	FEDERAL DREDGING		1,245,677	0	0	0	0	0	1,245,677	
5	EAST B/W 2+50 TO 8+45		921,984	0	0	0	0	0	921,984	
6	EAST B/W 8+45 TO 9+85		238,056	0	0	0	0	0	238,056	
10	INNER EAST STUB BREAKWATE		385,822	0	0	0	0	0	385,822	
11	WEST BREAKWATER		219,348	0	0	0	0	0	219,348	
15	NON-FEDERAL DREDGING		120,734	0	0	0	0	0	120,734	
	KIKIAOLA HARBOR PLAN 1 (A	1.00 EA	3,408,030	0	0	0	0	0	3,408,030	3408030

	QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
1 MOB AND DEMOB										
1. A MOB AND DEMOB LAND EQU			148,821	0	0	0	0	0	148,821	
1. D MOB MARINE EQUIPMENT			127,588	0	0	0	0	0	127,588	
TOTAL MOB AND DEMOB			276,408	0	0	0	0	0	276,408	
2 FEDERAL DREDGING										
2. A ENTRANCE CHANNEL	26200.00	CY	1,161,560	0	0	0	0	0	1,161,560	44.33
2. F ACCESS CHANNEL	3900.00	CY	84,117	0	0	0	0	0	84,117	21.57
TOTAL FEDERAL DREDGING			1,245,677	0	0	0	0	0	1,245,677	
5 EAST B/W 2+50 TO 8+45										
5. A REMOVE EXISTING ARMOR	3800.00	TON	114,683	0	0	0	0	0	114,683	30.18
5. B EXCAVATION	1450.00	CY	19,760	0	0	0	0	0	19,760	13.63
5. D ARMOR 3.5 TO 6 TON	11420.00	TON	545,525	0	0	0	0	0	545,525	47.77
5. H BEDDING SP TO 200 LB	2370.00	TON	99,792	0	0	0	0	0	99,792	42.11
5. I ACCESS ROADS	330.00	CY	13,658	0	0	0	0	0	13,658	41.39
5. J REMOVE STUB BREAKWATER	4260.00	TON	128,566	0	0	0	0	0	128,566	30.18
TOTAL EAST B/W 2+50 TO 8+45			921,984	0	0	0	0	0	921,984	
6 EAST B/W 8+45 TO 9+85										
6. A REMOVE EXISTING ARMOR	650.00	TON	19,617	0	0	0	0	0	19,617	30.18
6. B EXCAVATION	760.00	CY	10,357	0	0	0	0	0	10,357	13.63
6. C ARMOR 5.5 TO 9 TON	3340.00	TON	152,081	0	0	0	0	0	152,081	45.53
6. H BEDDING SP TO 200 LB	1330.00	TON	56,002	0	0	0	0	0	56,002	42.11
TOTAL EAST B/W 8+45 TO 9+85			238,056	0	0	0	0	0	238,056	
10 INNER EAST STUB BREAKWATE										
10. B EXCAVATION	2780.00	CY	37,884	0	0	0	0	0	37,884	13.63
10. C ARMOR 5.5 TO 9 TON	4260.00	TON	193,972	0	0	0	0	0	193,972	45.53
10. D UNDERLAYER 700 TO 1200	1090.00	TON	52,068	0	0	0	0	0	52,068	47.77
10. G BEDDING SP TO 200 LB	2420.00	TON	101,898	0	0	0	0	0	101,898	42.11
TOTAL INNER EAST STUB BREAKW			385,822	0	0	0	0	0	385,822	
11 WEST BREAKWATER										

** PROJECT OWNER SUMMARY - FACILITY **

	QUANTITY	UOM	CONTRACT	OTHER	ESCALATN	OWN FURN	CONTINGN	SIOH	TOTAL COST	UNIT COST
11. G REMOVE/RESET EXST'G B/	1970.00	TON	145,597	0	0	0	0	0	145,597	73.91
11. I ACCESS ROADS			73,752	0	0	0	0	0	73,752	
TOTAL WEST BREAKWATER			219,348	0	0	0	0	0	219,348	
15 NON-FEDERAL DREDGING										
15. E BERTHING AREA	8050.00	CY	120,734	0	0	0	0	0	120,734	15.00
TOTAL NON-FEDERAL DREDGING			120,734	0	0	0	0	0	120,734	
TOTAL KIKIAOLA HARBOR PLAN 1	1.00	EA	3,408,030	0	0	0	0	0	3,408,030	3408030

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KIKIAOLA HARBOR AUTH PLAN SUMMARY PAGE 4

** PROJECT INDIRECT SUMMARY - Bid Item **

	QUANTITY UOM	DIRECT	DISTR	HOME OH	PROFIT	TAX	BOND	TOTAL COST	UNIT COST
1 MOB AND DEMOB		216,859	19,227	9,443	17,187	10,955	2,737	276,408	
2 FEDERAL DREDGING		977,308	86,650	42,558	77,456	49,372	12,333	1,245,677	
5 EAST B/W 2+50 TO 8+45		723,351	64,134	31,499	57,329	36,542	9,129	921,984	
6 EAST B/W 8+45 TO 9+85		186,769	16,559	8,133	14,802	9,435	2,357	238,056	
10 INNER EAST STUB BREAKWATER		302,700	26,838	13,182	23,990	15,292	3,820	385,822	
11 WEST BREAKWATER		172,092	15,258	7,494	13,639	8,694	2,172	219,348	
15 NON-FEDERAL DREDGING		94,723	8,398	4,125	7,507	4,785	1,195	120,734	
KIKIAOLA HARBOR PLAN 1 (AUT	1.00 EA	2,673,802	237,064	116,435	211,911	135,075	33,743	3,408,030	3408030

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Tri-Service Automated Cost Engineering System (TRACES)
PROJECT KIK981: KIKIAOLA HARBOR PLAN 1 (AUTH) - KAUAI, HAWAII
KIKIAOLA HARBOR AUTH PLAN
** PROJECT INDIRECT SUMMARY - FACILITY **

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SUMMARY PAGE 5

	QUANTITY UOM	DIRECT	DISTR	HOME OH	PROFIT	TAX	BOND	TOTAL COST	UNIT COST
1 MOB AND DEMOB									
1. A MOB AND DEMOB LAND EQUIP		116,759	10,352	5,084	9,254	5,898	1,473	148,821	
1. D MOB MARINE EQUIPMENT		100,100	8,875	4,359	7,933	5,057	1,263	127,588	
TOTAL MOB AND DEMOB		216,859	19,227	9,443	17,187	10,955	2,737	276,408	
2 FEDERAL DREDGING									
2. A ENTRANCE CHANNEL	26200.00 CY	911,313	80,799	39,684	72,226	46,038	11,501	1,161,560	44.33
2. F ACCESS CHANNEL	3900.00 CY	65,995	5,851	2,874	5,230	3,334	833	84,117	21.57
TOTAL FEDERAL DREDGING		977,308	86,650	42,558	77,456	49,372	12,333	1,245,677	
5 EAST B/W 2+50 TO 8+45									
5. A REMOVE EXISTING ARMOR	3800.00 TON	89,976	7,977	3,918	7,131	4,545	1,135	114,683	30.18
5. B EXCAVATION	1450.00 CY	15,503	1,374	675	1,229	783	196	19,760	13.63
5. D ARMOR 3.5 TO 6 TON	11420.00 TON	427,997	37,947	18,638	33,921	21,622	5,401	545,525	47.77
H BEDDING SP TO 200 LB	2370.00 TON	78,293	6,942	3,409	6,205	3,955	988	99,792	42.11
5. I ACCESS ROADS	330.00 CY	10,715	950	467	849	541	135	13,658	41.39
5. J REMOVE STUB BREAKWATER	4260.00 TON	100,868	8,943	4,392	7,994	5,096	1,273	128,566	30.18
TOTAL EAST B/W 2+50 TO 8+45		723,351	64,134	31,499	57,329	36,542	9,129	921,984	
6 EAST B/W 8+45 TO 9+85									
6. A REMOVE EXISTING ARMOR	650.00 TON	15,391	1,365	670	1,220	778	194	19,617	30.18
6. B EXCAVATION	760.00 CY	8,126	720	354	644	410	103	10,357	13.63
6. C ARMOR 5.5 TO 9 TON	3340.00 TON	119,317	10,579	5,196	9,456	6,028	1,506	152,081	45.53
6. H BEDDING SP TO 200 LB	1330.00 TON	43,937	3,895	1,913	3,482	2,220	554	56,002	42.11
TOTAL EAST B/W 8+45 TO 9+85		186,769	16,559	8,133	14,802	9,435	2,357	238,056	
10 INNER EAST STUB BREAKWATER									
10. B EXCAVATION	2780.00 CY	29,722	2,635	1,294	2,356	1,502	375	37,884	13.63
10. C ARMOR 5.5 TO 9 TON	4260.00 TON	152,182	13,493	6,627	12,061	7,688	1,921	193,972	45.53
10. D UNDERLAYER 700 TO 1200 L	1090.00 TON	40,851	3,622	1,779	3,238	2,064	516	52,068	47.77
10. G BEDDING SP TO 200 LB	2420.00 TON	79,945	7,088	3,481	6,336	4,039	1,009	101,898	42.11
TOTAL INNER EAST STUB BREAKWAT		302,700	26,838	13,182	23,990	15,292	3,820	385,822	

WEST BREAKWATER

** PROJECT INDIRECT SUMMARY - FACILITY **

	QUANTITY UOM	DIRECT	DISTR	HOME OH	PROFIT	TAX	BOND	TOTAL COST	UNIT COST
11. G REMOVE/RESET EXST'G B/W	1970.00 TON	114,229	10,128	4,974	9,053	5,771	1,442	145,597	73.91
11. I ACCESS ROADS		57,862	5,130	2,520	4,586	2,923	730	73,752	
TOTAL WEST BREAKWATER		172,092	15,258	7,494	13,639	8,694	2,172	219,348	
15 NON-FEDERAL DREDGING									
15. E BERTHING AREA	8050.00 CY	94,723	8,398	4,125	7,507	4,785	1,195	120,734	15.00
TOTAL NON-FEDERAL DREDGING		94,723	8,398	4,125	7,507	4,785	1,195	120,734	
TOTAL KIKIAOLA HARBOR PLAN 1 (	1.00 EA	2,673,802	237,064	116,435	211,911	135,075	33,743	3,408,030	3408030

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Tri-Service Automated Cost Engineering System (TRACES)
PROJECT KIK981: KIKIAOLA HARBOR PLAN 1 (AUTH) - KAUAI, HAWAII
KIKIAOLA HARBOR AUTH PLAN
** CONTRACTOR INDIRECT SUMMARY - Bid Item **

TIME 15:14:16

	DIRECT	DISTR	HOME OH	PROFIT	TAX	BOND	TOTAL COST	UNIT COST
MOB AND DEMOB								
AA PRIME CONTRACTOR								
DR DREDGING	77,000	23,100	0	0	0	0	100,100	
Subtotal Subcontract Work	77,000	23,100	0	0	0	0	100,100	
Indirect on Subcontracts	100,100	8,875	4,359	7,933	5,057	1,263	127,588	
Indirect on Own Work	116,759	10,352	5,084	9,254	5,898	1,473	148,821	
AA PRIME CONTRACTOR	216,859	19,227	9,443	17,187	10,955	2,737	276,408	
FEDERAL DREDGING								
AA PRIME CONTRACTOR								
DR DREDGING	701,010	210,303	0	0	0	0	911,313	
Subtotal Subcontract Work	701,010	210,303	0	0	0	0	911,313	
Indirect on Subcontracts	911,313	80,799	39,684	72,226	46,038	11,501	1,161,560	
Indirect on Own Work	65,995	5,851	2,874	5,230	3,334	833	84,117	
AA PRIME CONTRACTOR	977,308	86,650	42,558	77,456	49,372	12,333	1,245,677	
B/W 2+50 TO 8+45								
AA PRIME CONTRACTOR	723,351	64,134	31,499	57,329	36,542	9,129	921,984	
EAST B/W 8+45 TO 9+85								
AA PRIME CONTRACTOR	186,769	16,559	8,133	14,802	9,435	2,357	238,056	
INNER EAST STUB BREAKWATER								
AA PRIME CONTRACTOR	302,700	26,838	13,182	23,990	15,292	3,820	385,822	
WEST BREAKWATER								
AA PRIME CONTRACTOR	172,092	15,258	7,494	13,639	8,694	2,172	219,348	
NON-FEDERAL DREDGING								
AA PRIME CONTRACTOR	94,723	8,398	4,125	7,507	4,785	1,195	120,734	

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DETAILED ESTIMATE KIKIAOLA HARBOR AUTH PLAN DETAIL PAGE 1
Project Distributed Costs

PRIME CONTRACTOR	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
PRIME CONTRACTOR											
Overhead Items - AA											
SUPERINTENDANT	13.00	MO		0.00	0	113,360	0	0	0	113,360	8720.00
OFFICE CLERK	12.00	MO		0.00	0	15,696	0	0	0	15,696	1308.00
CONTRACTOR'S OFFICE TRAIL ER	12.00	MO		0.00	0	0	0	9,660	0	9,660	805.00
GOVERNMENT'S TRAILER	12.00	MO		0.00	0	0	0	8,280	0	8,280	690.00
CONTAINER	1.00	EA		0.00	0	0	0	2,300	0	2,300	2300.00
UTILITY TIE-IN	1.00	LS		0.00	0	0	0	1,150	0	1,150	1150.00
ELECTRICITY	12.00	MO		0.00	0	0	0	2,760	0	2,760	230.00
WATER	12.00	MO		0.00	0	0	0	2,070	0	2,070	172.50
PHONE	12.00	MO		0.00	0	0	0	1,380	0	1,380	115.00
PICK-UP	13.00	MO		0.00	0	0	0	11,960	0	11,960	920.00
FURNITURE	1.00	LS		0.00	0	0	0	3,450	0	3,450	3450.00
HOUSE RENTAL 3 BEDROOM	12.00	MO		0.00	0	0	0	16,560	0	16,560	1380.00
AIR FARE	36.00	RT		0.00	0	0	0	4,140	0	4,140	115.00
OFFICE SUPPLIES	12.00	MO		0.00	0	0	0	690	0	690	57.50
ENGINEERING SUPPLIES	12.00	MO		0.00	0	0	0	690	0	690	57.50
FIRST AID SUPPLIES	12.00	MO		0.00	0	0	0	207	0	207	17.25
SANITOI	12.00	MO		0.00	0	0	0	1,380	0	1,380	115.00
INSURANCE	1.00	LS		0.00	0	0	0	3,450	0	3,450	3450.00
'BSISTANCE 3 MEN	36.00	MO		0.00	0	0	0	37,881	0	37,881	1052.25
Overhead Items - AA					0	129,056	0	108,008	0	237,064	

1. MOB AND DEMOB

MOB AND DEMOB LAND EQUIPME	QUANTY UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MOB AND DEMOB										
MOB AND DEMOB LAND EQUIPMENT										
SITEWORK FOREMAN	32.00 HR	XUNLSFM	1.00	32	1,739	294	0	0	2,033	63.54
EQUIPMENT OPERATOR	160.00 HR	XUNLCAR	1.00	160	8,607	0	0	0	8,607	53.80
LABORER I	160.00 HR	XUNLLAB	1.00	160	6,408	0	0	0	6,408	40.05
D8	64.00 HR	XJMLF	0.23	0	0	1,611	0	0	1,611	25.18
CRANE 60T	64.00 HR	XJMLF	0.18	0	0	2,055	0	0	2,055	32.11
CRANE 125 T	64.00 HR	XJMLF	0.17	0	0	2,141	0	0	2,141	33.45
LOADER 3 CY	64.00 HR	XJMLF	0.54	0	0	684	0	0	684	10.68
LOADER 7 CY	64.00 HR	XJMLF	0.21	0	0	1,760	0	0	1,760	27.50
AIRFARE	4.00 RT		0.00	0	0	0	460	0	460	115.00
CARTAGE HONOLULU	5.00 RT		0.00	0	0	0	9,200	0	9,200	1840.00
CARTAGE KAUAI	5.00 RT		0.00	0	0	0	9,200	0	9,200	1840.00
FREIGHT AND WHARFAGE	881.85 TON		0.00	0	0	0	46,000	0	46,000	52.16
HEAVY LIFT ON CRANE AND D 8	225.00 RT		0.00	0	0	0	23,288	0	23,288	103.50
TRUCKS W/ ROCK BED	192.00 HR	XJMLF	0.33	0	0	3,312	0	0	3,312	17.25
MOB MARINE EQUIPMENT										
TOW	1.00 LS		0.00	0	0	0	59,800	0	59,800	59800.00
CRANEBARGE & CREW	8.00 DYS		0.00	0	28,340	11,960	0	0	40,300	5037.50
MOB AND DEMOB				352	45,094	23,817	147,948	0	216,859	

ENTRANCE CHANNEL	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
FEDERAL DREDGING											
ENTRANCE CHANNEL											
CRANE UNLOAD SCOW	26200	CY	XUNIC080A	125.00	419	27,733	33,881	0	0	61,614	2.35
DISPOSE 1 MILE HAUL	34060	LCY	XUNITK20A	100.00	341	22,766	17,822	0	0	40,588	1.19
D-8 AT DISPOSAL	26200	CY	XUNID8A	250.00	105	7,091	13,780	0	0	20,871	0.80
DREDGE SOFT MATERIAL	23580	CY	XDRDB	50.00	2,830	226,235	350,406	0	0	576,641	24.45
DREDGE ROCK	2620.00	CY	XDRDB2	12.00	1,092	87,336	124,264	0	0	211,600	80.76
ACCESS CHANNEL											
BUILD CAUSEWAY	2700.00	CY	XDRDF	80.00	68	3,452	4,986	31,050	0	39,488	14.63
REMOVE CAUSEWAY	2700.00	CY	XDRDF	100.00	54	2,762	3,989	0	0	6,750	2.50
DREDGE CAUSEWAY 80 TON	3900.00	CY	XDRDF	100.00	78	3,989	5,761	0	0	9,751	2.50
SITEWORK FOREMAN	3900.00	CY	XUNLSFM	200.00	20	1,060	179	0	0	1,239	0.32
HAUL FROM CAUSEWAY TO STOCKPILE	5070.00	LCY	XDRDI	250.00	61	3,134	5,632	0	0	8,766	1.73
FEDERAL DREDGING					5,066	385,558	560,700	31,050	0	977,308	

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DETAILED ESTIMATE KIKIAOLA HARBOR AUTH PLAN DETAIL PAGE 4
5. EAST B/W 2+50 TO 8+45

REMOVE EXISTING ARMOR	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
EAST B/W 2+50 TO 8+45											
REMOVE EXISTING ARMOR											
SITEWORK FOREMAN	3800.00	TON	XUNLSFM	40.00	95	5,162	874	0	0	6,036	1.59
REMOVE EXISTING STONE	3800.00	TON	XRKSG	20.00	760	37,056	46,884	0	0	83,940	22.09
EXCAVATION											
TOE EXCAVATION	1450.00	CY	XRKSC	37.50	135	6,478	7,796	0	0	14,274	9.84
SITEWORK FOREMAN	1450.00	CY	XUNLSFM	75.00	19	1,051	178	0	0	1,228	0.85
ARMOR 3.5 TO 6 TON											
SITEWORK FOREMAN	11420	TON	XUNLSFM	40.00	286	15,514	2,627	0	0	18,140	1.59
ARMOR 3.5 TO 6 TON	11420	TON	XRKSG	20.00	2,284	111,363	140,897	157,596	0	409,856	35.89
BEDDING SP TO 200 LB											
SITEWORK FOREMAN	2370.00	TON	XUNLSFM	60.00	40	2,146	363	0	0	2,510	1.06
BEDDING SP TO 200 LB	2370.00	TON	XRKSG	30.00	316	15,407	19,494	40,883	0	75,783	31.98
ACCESS ROADS											
SITEWORK FOREMAN	330.00	CY	XUNLSFM	100.00	3	179	30	0	0	210	0.64
ACCESS ROAD	330.00	CY	XRKSG	50.00	26	1,287	1,629	7,590	0	10,506	31.84
REMOVE STUB BREAKWATER											
REMOVE EXISTING STONE	4260.00	TON	XRKSG	20.00	852	41,542	52,559	0	0	94,101	22.09
SITEWORK FOREMAN	4260.00	TON	XUNLSFM	40.00	107	5,787	980	0	0	6,767	1.59
EAST B/W 2+50 TO 8+45					4,925	242,972	274,310	206,069	0	723,351	

REMOVE EXISTING ARMOR	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
EAST B/W 8+45 TO 9+85											
REMOVE EXISTING ARMOR											
SITEWORK FOREMAN	650.00	TON	XUNLSFM	40.00	16	883	150	0	0	1,033	1.59
REMOVE EXISTING STONE	650.00	TON	XRKSG	20.00	130	6,339	8,020	0	0	14,358	22.09
EXCAVATION											
TOE EXCAVATION	760.00	CY	XRKSC	37.50	71	3,395	4,086	0	0	7,482	9.84
SITEWORK FOREMAN	760.00	CY	XUNLSFM	75.00	10	551	93	0	0	644	0.85
ARMOR 5.5 TO 9 TON											
ARMOR 5.5 TO 9 TON	3340.00	TON	XRKSH	22.00	607	29,609	38,792	46,092	0	114,494	34.28
SITEWORK FOREMAN	3340.00	TON	XUNLSFM	44.00	76	4,125	698	0	0	4,823	1.44
BEDDING SP TO 200 LB											
SITEWORK FOREMAN	1330.00	TON	XUNLSFM	60.00	22	1,204	204	0	0	1,408	1.06
BEDDING SP TO 200 LB	1330.00	TON	XRKSG	30.00	177	8,646	10,939	22,943	0	42,528	31.98
EAST B/W 8+45 TO 9+85					1,110	54,752	62,982	69,035	0	186,769	-

10. INNER EAST STUB BREAKWATER

EXCAVATION	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
INNER EAST STUB BREAKWATER											
EXCAVATION											
TOE EXCAVATION	2780.00	CY	XRKSC	37.50	259	12,420	14,947	0	0	27,367	9.84
SITEWORK FOREMAN	2780.00	CY	XUNLSFM	75.00	37	2,014	341	0	0	2,355	0.85
ARMOR 5.5 TO 9 TON											
ARMOR 3.5 TO 5 TON	4260.00	TON	XRKSH	22.00	774	37,765	49,477	58,788	0	146,031	34.28
SITEWORK FOREMAN	4260.00	TON	XUNLSFM	44.00	97	5,261	891	0	0	6,152	1.44
UNDERLAYER 700 TO 1200 LB											
SITEWORK FOREMAN	1090.00	TON	XUNLSFM	40.00	27	1,481	251	0	0	1,731	1.59
ULAYER 700 TO 1200 LB	1090.00	TON	XRKSG	20.00	218	10,629	13,448	15,042	0	39,119	35.89
BEDDING SP TO 200 LB											
SITEWORK FOREMAN	2420.00	TON	XUNLSFM	60.00	40	2,191	371	0	0	2,562	1.06
BEDDING SP TO 200 LB	2420.00	TON	XRKSG	30.00	323	15,732	19,905	41,745	0	77,382	31.98
INNER EAST STUB BREAKWATE					1,776	87,494	99,631	115,575	0	302,700	-

REMOVE/RESET EXST'G B/W	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
WEST BREAKWATER											
REMOVE/RESET EXST'G B/W											
REMOVE EXISTING STONE	1970.00	TON	XRKSG	20.00	394	19,211	24,305	0	0	43,516	22.09
RESET STONE	1970.00	TON	XRKSG	13.75	573	27,943	35,353	0	0	63,296	32.13
SITEWORK FOREMAN	1970.00	TON	XUNLSFM	16.88	117	6,343	1,074	0	0	7,417	3.77
ACCESS ROADS											
REMOVE EXISTING STONE	3.00	TON	XRKSG	20.00	1	29	37	0	0	66	22.09
SITEWORK FOREMAN	1070.00	TON	XUNLSFM	16.88	63	3,445	583	0	0	4,029	3.77
RESET STONE	1070.00	TON	XRKSG	13.75	311	15,177	19,202	0	0	34,379	32.13
CHINK & REMOVE WORKROAD	430.00	CY	XRKSG	20.00	86	4,193	5,305	9,890	0	19,388	45.09
WEST BREAKWATER					1,545	76,341	85,861	9,890	0	172,092	

BERTHING AREA	QUANTY	UOM	CREW ID	OUTPUT	MANHOUR	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
NON-FEDERAL DREDGING BERTHING AREA											
BUILD CAUSEWAY	3150.00	CY	XDRDF	80.00	79	4,027	5,817	36,225	0	46,070	14.63
REMOVE CAUSEWAY	3150.00	CY	XDRDF	100.00	63	3,222	4,653	0	0	7,875	2.50
DREDGE CAUSEWAY 80 TON	8050.00	CY	XDRDF	100.00	161	8,234	11,892	0	0	20,126	2.50
SITEWORK FOREMAN	8050.00	CY	XUNLSFM	200.00	40	2,187	370	0	0	2,558	0.32
HAUL FROM CAUSEWAY TO STO CKPILE	10465	LCY	XDRDI	250.00	126	6,469	11,626	0	0	18,094	1.73
NON-FEDERAL DREDGING					469	24,140	34,359	36,225	0	94,723	
KIKIAOLA HARBOR PLAN 1 (A	1.00	EA			15,240	916,352	1,141,660	615,791	0	2,673,802	2673802

Wed 15 Apr 1998
Eff. Date 04/01/98

Tri-Service Automated Cost Engineering System (TRACES)
PROJECT KIK981: KIKIAOLA HARBOR PLAN 1 (AUTH) - KAUAI, HAWAII
KIKIAOLA HARBOR AUTH PLAN
** LABOR BACKUP **

TIME 15:14:16
BACKUP PAGE 1

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
USR	XCAR	CARPENTER	26.40	0.0%	36.0%	13.45	0.00	49.35	HR	02/14/97	0.00	160
USR	XDVSEM	TRUCK DRIVER SEMI GR7	25.92	0.0%	29.0%	13.73	0.00	47.17	HR	02/14/97	0.00	341
USR	XE03	OPERATOR GROUP 3	24.37	0.0%	29.0%	13.73	0.00	45.17	HR	02/14/97	0.00	2552
USR	XE07	OPERATOR GROUP 7	25.92	0.0%	29.0%	13.73	0.00	47.17	HR	02/14/97	0.00	2087
USR	XE08	OPERATOR GROUP 8	26.03	0.0%	29.0%	13.73	0.00	47.31	HR	02/14/97	0.00	124
USR	XE09A	OPERATOR GROUP 9A	26.37	0.0%	29.0%	13.73	0.00	47.75	HR	02/14/97	0.00	105
USR	XE11	OPERATOR GROUP 11	26.73	0.0%	29.0%	13.73	0.00	48.21	HR	02/14/97	0.00	343
USR	XE12	OPERATOR GROUP 12	27.09	0.0%	29.0%	13.73	0.00	48.68	HR	02/14/97	0.00	251
USR	XLAB1	LABORER 1	20.70	0.0%	29.0%	10.04	0.00	36.74	HR	02/14/97	0.00	2251
USR	XMBOAT	BOAT OPERATOR	26.58	16.7%	40.0%	13.73	0.00	57.15	HR	02/14/97	0.00	690
USR	XMCLAM	MARINE CLAM OPERATOR	27.09	16.7%	40.0%	13.73	0.00	57.98	HR	02/14/97	0.00	690
USR	XMCPT	CAPTAIN	26.73	16.7%	40.0%	13.73	0.00	57.39	HR	02/14/97	0.00	690
USR	XMMATE	MATE	26.03	16.7%	40.0%	13.73	0.00	56.25	HR	02/14/97	0.00	1162
USR	XMOIL	MARINE OILER(GR3)	24.37	16.7%	40.0%	13.73	0.00	53.54	HR	02/14/97	0.00	690
USR	XOPERFM	OPERATOR FOREMAN	28.00	0.0%	29.0%	13.73	0.00	49.85	HR	02/14/97	0.00	1147
USR	XRKS	ROCKSETTER	28.00	0.0%	29.0%	13.73	0.00	49.85	HR	02/14/97	0.00	1958

Wed 15 Apr 1998 Tri-Service Automated Cost Engineering System (TRACES) TIME 15:14:16
Eff. Date 04/01/98 PROJECT KIK981: KIKIAOLA HARBOR PLAN 1 (AUTH) - KAUAI, HAWAII

KIKIAOLA HARBOR AUTH PLAN BACKUP PAGE 1

** LABOR BACKUP **

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	**** TOTAL **** DEFAULT	HOURS
USR	XCAR	CARPENTER	26.40	0.0%	36.0%	13.45	0.00	49.35	HR	02/14/97	0.00	160
USR	XDVSEM	TRUCK DRIVER SEMI GR7	25.92	0.0%	29.0%	13.73	0.00	47.17	HR	02/14/97	0.00	341
USR	XE03	OPERATOR GROUP 3	24.37	0.0%	29.0%	13.73	0.00	45.17	HR	02/14/97	0.00	2552
USR	XE07	OPERATOR GROUP 7	25.92	0.0%	29.0%	13.73	0.00	47.17	HR	02/14/97	0.00	2087
USR	XE08	OPERATOR GROUP 8	26.03	0.0%	29.0%	13.73	0.00	47.31	HR	02/14/97	0.00	124
USR	XE09A	OPERATOR GROUP 9A	26.37	0.0%	29.0%	13.73	0.00	47.75	HR	02/14/97	0.00	105
USR	XE11	OPERATOR GROUP 11	26.73	0.0%	29.0%	13.73	0.00	48.21	HR	02/14/97	0.00	343
USR	XE12	OPERATOR GROUP 12	27.09	0.0%	29.0%	13.73	0.00	48.68	HR	02/14/97	0.00	251
USR	XLAB1	LABORER 1	20.70	0.0%	29.0%	10.04	0.00	36.74	HR	02/14/97	0.00	2251
USR	XMBOAT	BOAT OPERATOR	26.58	16.7%	40.0%	13.73	0.00	57.15	HR	02/14/97	0.00	690
USR	XMCLAM	MARINE CLAM OPERATOR	27.09	16.7%	40.0%	13.73	0.00	57.98	HR	02/14/97	0.00	690
USR	XMCPT	CAPTAIN	26.73	16.7%	40.0%	13.73	0.00	57.39	HR	02/14/97	0.00	690
USR	XMMATE	MATE	26.03	16.7%	40.0%	13.73	0.00	56.25	HR	02/14/97	0.00	1162
USR	XMOIL	MARINE OILER(GR3)	24.37	16.7%	40.0%	13.73	0.00	53.54	HR	02/14/97	0.00	690
USR	XOPERFM	OPERATOR FOREMAN	28.00	0.0%	29.0%	13.73	0.00	49.85	HR	02/14/97	0.00	1147
USR	XRKS	ROCKSETTER	28.00	0.0%	29.0%	13.73	0.00	49.85	HR	02/14/97	0.00	1958

** EQUIPMENT BACKUP **

SRC	ID.NO.	EQUIPMENT DESCRIPTION	DEPR	FCCH	FUEL	FOG	TR WR	TR REP	EQ REP	** TOTAL ** TOTAL RATE	HOURS
USR	XCRT060S	CRANE 60 TON TRACK SEV COND	120.84							120.84 HR	1613
USR	XCRT080A	CRANE 80 TON TRACK AVE COND	108.13							108.13 HR	210
USR	XCRT080S	CRANE 80 TON TRACK SEV COND	128.46							128.46 HR	730
USR	XEXBH2.0S	BACKHOE 2.A CY SEV CAT 235	126.70							126.70 HR	218
USR	XMAB1000	WORK BARGE 1000 TON	90.00							90.00 HR	218
USR	XMACB150	CRANE BARGE 150 TON 6 CY	265.00							265.00 HR	472
USR	XMASC1000	SCOW 1000 CY	100.00							100.00 HR	1162
USR	XMASC500	SCOW 500 CY	53.00							53.00 HR	218
USR	XMATG500	TUG 500 HP	32.00							32.00 HR	218
USR	XMAWB	WORK BOAT	32.00							32.00 HR	690
USR	XMIST	SMALL TOOLS	5.00							5.00 HR	2011
USR	XTKOH25S	OFF HIGHWAY 25 TON SEV	73.89							73.89 HR	124
USR	XTKPU	PICKUP	8.00							8.00 HR	1147
USR	XTKSEMA	SEMI 20 CY AVE	35.00							35.00 HR	341
USR	XTRD8A	D-8 AVE CONDITION	87.95							87.95 HR	105-
USR	XTRLW5.0S	LOADER 5.0 CY WHEEL SEV	93.73							93.73 HR	2087

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.7 REAL ESTATE PLANNING REPORT

APPENDIX G

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION
FORT SHAFTER
HONOLULU, HAWAII

PRELIMINARY ESTIMATE OF REAL ESTATE COSTS

FOR

KIKIAOLA HARBOR FEASIBILITY STUDY

KAUAI, HAWAII

MAY 1998

PREPARED BY : Craig H. Nakano
CRAIG NAKANO
Realty Specialist

APPROVED BY:
STEVE STOMBER
Director of Real Estate

TABLE OF CONTENTS

AUTHORITY. This preliminary estimate of real estate costs for the Kikiaola Harbor Navigation Project is under authority of the Water Resources Development Act of 1986.

PURPOSE. The objective of this report is to present the necessary real estate planning documentation for the proposed Kikiaola Harbor Project in Kauai, Hawaii.

INSPECTION. Mr. Craig Nakano, Realty Specialist, and Mr. Robert Abbott, Staff/Review Appraiser reviewed the properties being affected by the proposed project, in house, on 19 May 1997.

PROJECT GENERAL DESCRIPTION. When fully developed, Plan number I shown as EXHIBIT 'A", would provide berthing for about 45 boats. In its overall layout, it was developed in response to public input during an information meeting held with the users. Plan I consists of the following:

- Removing 150 feet from the existing outer east stub breakwater which extends into the proposed channel alignment.
- Raising the east breakwater's crest elevation by four feet from Station 8+70 to Station 9+85 and three feet from Station 2+50 to Station 8+20.
- Flattening the seaward slope of the east breakwater to one vertical on two horizontal from Station 8+70 to Station 9+85.
- Removing and constructing an 85-foot long inner east stub breakwater.
- Modifying 220 feet of the existing west breakwater by resetting the armor stone so that it is keyed and fitted from Station 3+80 to Station 6+00.
- Dredging a 700 foot long entrance channel to a depth of 11 feet and varying in width from 105 to 205 feet with maneuvering area to facilitate a 90 degree right turn into the access channel.
- Dredging a 320 foot long access channel to a depth of seven feet and varying in width from 70 to 105 feet.

Plan I would also include about 1.8 acres of water area for berthing and access. The U.S. Coast Guard will provide the necessary modifications to the existing navigation aids.

Approximately 40,000 CY of dredged material from the entrance channel, access channel and berthing area to be disposed.

ISLAND DATA. The subject property is located in the County of Kauai, on the Island of Kauai. The County of Kauai consists of the Island of Kauai, two uninhabited islands, Lehua and Kaula, and the 73 square mile, privately owned Niihau.

The island of Kauai is the fourth largest and the chain's oldest geologically. It has a land area of 558.2 square miles and is located 103 air miles from Honolulu. Kauai has two natural wonders: Mount Waialeale (5,148 feet), reputed to be the nation's wettest spot with almost 500 inches of rainfall per year and Waimea Canyon, a little Grand Canyon. It also boasts the States only navigable river, a two-mile stretch of the Wailua.

The Waimea Canyon, the Kilauea National Wildlife Refuge and the spectacular Na Pali Coast were among the many natural wonders that attracted 929,000 + visitors in 1992 to Kauai before Hurricane Iniki struck the island.

The Island of Kauai is characterized by many small towns running along the southern, eastern, and part of the northern coastline. Lihue, located along the southeastern coast, is the principal population and civic center.

Kauai has a population of 51,900 residents, with the county seat in Lihue.

The economy of Kauai is based in most parts on agriculture and tourism. On September 11, 1992, Kauai farmland was devastated and tourism was all but eliminated by Hurricane Iniki. Agricultural and tourism loss due to Hurricane Iniki exceeded 500 million dollars. Property damage reached close to 400 million dollars.

GOVERNMENT - OWNED FACILITIES. Section III of the Act of Congress approved July 8, 1958 (PL 85-500) authorized the protection, realteration, reconstruction, relocation or replacement of municipally-owned facilities. A preliminary inspection of the property area indicated no Government-owned facilities were affected.

PROTECTION AND ENHANCEMENT OF CULTURAL ENVIRONMENT. In accordance with the instruction set forth in teletype DA (DAEN) R 191306A, dated October 1971, Subject: "EO11593, May 13, 1971, Protection and Enhancement of Cultural Environment", a study was accomplished covering the subject areas. The study revealed that no local, State, Federally owned nor Federally controlled property of historical significance would fall within the provisions of EO11593.

ENDANGERED SPECIES. No known Federally listed endangered species are known to occupy the project area.

ZONING. The zoning regulations presently in effect for the proposed project are as follows:

COMMERCIAL. Varies in size throughout the project within the City and County of Kauai.

AGRICULTURAL. Varies in size throughout the project within the City and County of Kauai.

RIGHTS TO BE ACQUIRED. The Local Sponsor will be required to provide all lands, easements, rights-of-way, relocations, and disposal areas (LERRDS) necessary for project purposes.

FEE ACQUISITION. The highest type of interest in real estate is complete ownership, known as ownership in fee simple, or in fee simple absolute. Since this is a Navigational Project, the sponsor is not required to acquire any land in fee.

PERMANENT EASEMENT AREAS. Compensation for permanent easements for construction and maintenance purposes is not necessary. Preliminary investigation indicates only "Temporary Easement" areas will be needed for the project. Preliminary investigations indicate that after the imposition of the permanent easement interest, the highest and best use of the remainders of the properties affected will not be materially affected. However, it is historically known that the mere knowledge and existence of the imposition infers a restrictive aspect. Therefore, the cost to acquire the permanent easement interest would be equivalent to the underlying fee value since those uses would be for project purposes. However, lands would remain in their private ownership's to maintain conformity of their existing lot areas. The estimated costs for the easement rights are predicated on the assumption that construction methods will be of the excavation and placement methods and would not adversely affect surface or near-surface improvements. If it is determined and found that selected methods of construction would cause damage to the surface or the near-surface improvements, then the estimated costs for easement rights would not remain valid and a new in-depth real estate study of the proposed taking would be required.

TEMPORARY CONSTRUCTION EASEMENTS. The land areas to be encumbered by temporary easements require approximately 15 acres of land for staging and disposal areas and are available in the immediate vicinity. Both parcels are privately owned and the property owners have given the State permission to use the subject properties for project purposes until completed. One disposal site is owned by the State and the other is owned by the Kikiaola Land Co.

CONTINGENCIES. A contingency allowance of 25 percent is considered to be reasonably adequate to provide for possible appreciation of property values from the time of preparation of this estimate to the acquisition date. The contingency amount is to be used for possible minor property line adjustments or for additional hidden ownership which may be developed by refinement made to taking lines, for adverse condemnation awards and to allow for practical and realistic negotiations.

ACQUISITION COSTS. Acquisition costs will include Sponsor's costs for mapping, surveying, legal description, title evidence, appraisals, negotiations, closing and administrative costs for possible condemnations. The acquisition costs are based upon this office's experience in similar civil works projects in the general area and are estimated at $7,000 per ownership. A total of three (3) ownership's will be affected by the project. Two areas for disposal material (10 acre and 3 acre parcels) and one area for contractor storage and material site. One disposal area is owned privately by the Kikiaola Land Co. and the other by the State. The storage area is also owned by the Kikiaola Land Co.

RELOCATION COSTS. Public Law 91-646, Uniform Relocations Assistance Act of 1970, provides for uniform and equitable treatment of persons displaced from their homes, businesses, or farms by a Federally Assisted Program. It also establishes uniform and equitable land acquisitions policies for these projects. Included among the items under PL 91-646 are the following:

- Moving Expenses
- Relocation Allowance (Business)
- Replacement Housing (Tenants)
- Relocation Advisory Services
- Recording Fees
- Transfer Taxes
- Mortgage Prepayment Costs
- Real Estate Tax Refunds (Pro-Rata)

Preliminary investigations indicate that no tenants will require relocation. However, should the existing preliminary taking lines be modified to include improvements, then the State agency would not be able to proceed with any phase of the project which will cause the displacement of any person until it has been determined, that within a reasonable period of time prior to displacement, there will be available on a basis consistent with the requirements of Title VIII of the Civil Rights Act of 1968 (Public Law 90-284), in areas generally not less desirable in regard to public utilities and public and commercial facilities and at rents or prices within the financial means of the families and individuals displaced, decent, safe, and sanitary dwellings, equal in number to the number of, and available to, such displaced persons who require such dwellings and reasonably accessible to their places of employment.

There are three properties owned by separate entities affected by the temporary easement interests. Therefore, the following estimates are included for planning purposes and are limited to expenses of $200 per ownership incidental to the transfer of the real estate interests.

SEVERANCE DAMAGES. Severance damages usually occur when partial takings are acquired which restrict the remaining portion from full economic development. The severance damages are measured and estimated on the basis of a "Before" and "After" appraisal method and will reflect actual value loss incurred to the remainder as a result of partial acquisition. Detailed appraisals will reflect these losses.

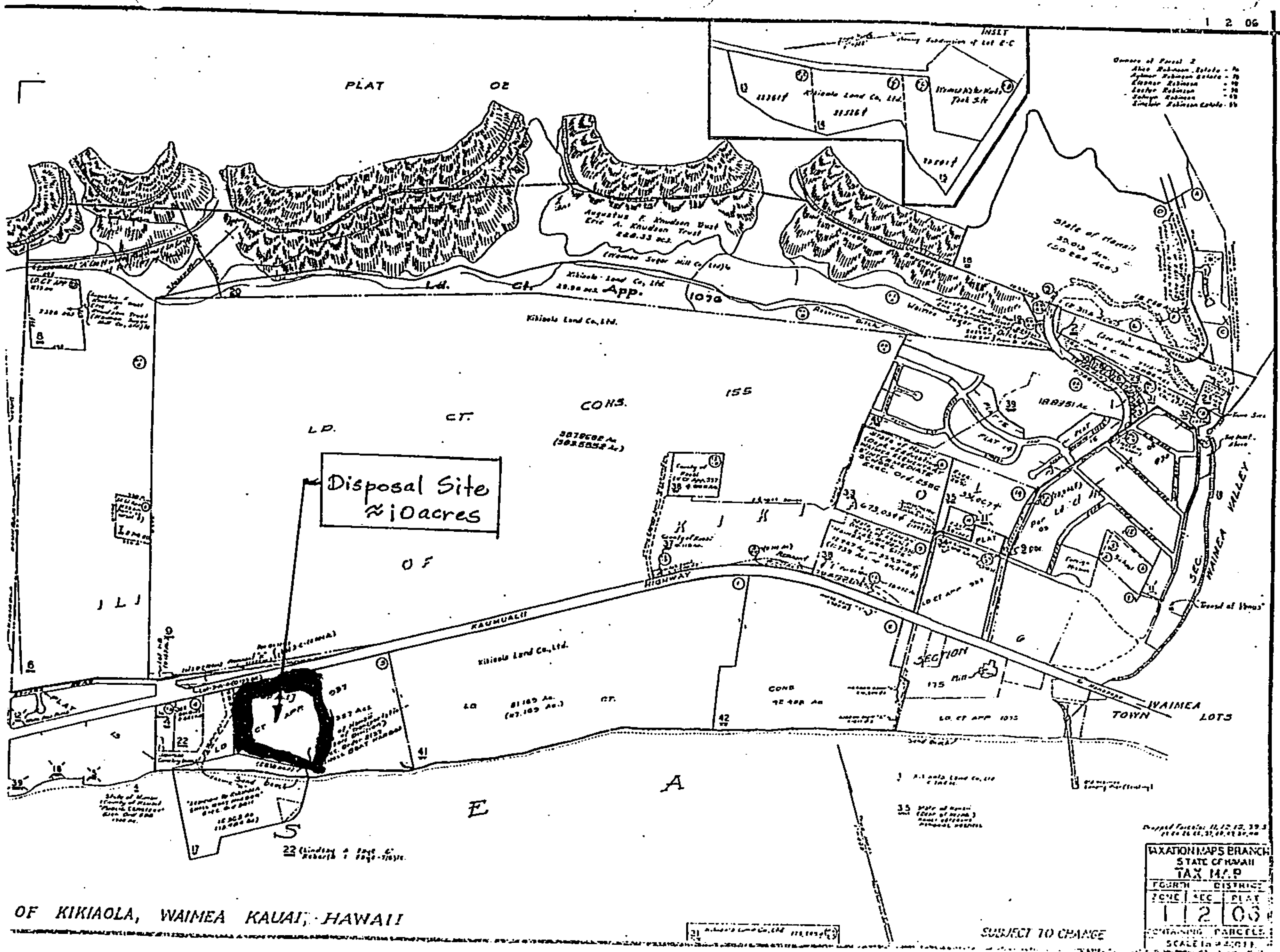
EVALUATION AND CONCLUSION. A careful and thorough search of the City and County of Kauai records was made to obtain sales data. Those sales considered to be similar in nature and character to the properties which will be affected by the proposed project are listed in the addenda of this report. Considerable effort was made to interview either grantor or grantee to establish the authenticity of each transaction. The sales were inspected in the field. Real Estate appraisers, brokers and knowledgeable officials of the City and County of Kauai were interviewed to obtain sales data used in arriving at the estimated values for this study, which ranged from $39,300.00 to $ 40,000.00 per acre based on topography and location.

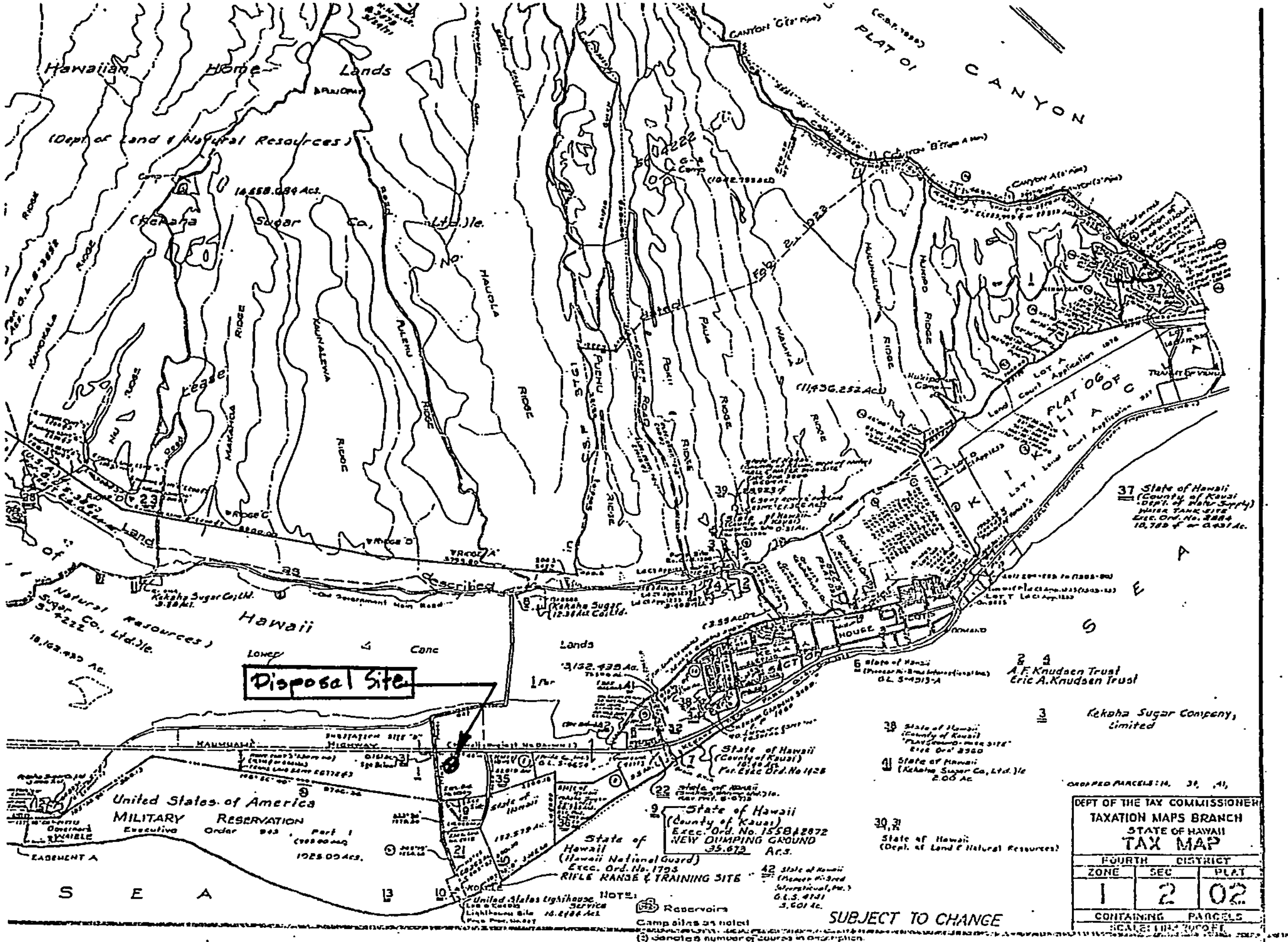
SUMMARY OF REAL ESTATE COSTS. The following is a preliminary estimate of the real estate costs for the interests being considered for the proposed Kikiaola Harbor Project:

PRELIMINARY ESTIMATE OF REAL ESTATE COST

FEE ACQUISITION: (NONE)	$ 0
PERMANENT EASEMENTS: (NONE)	$ 0
TEMPORARY EASEMENTS (15 ACRES X $39,300.OO PER/ACRE X 10%Return) ($ 589,500.00 X 10% Return)	$ 58,950.00
CONTINGENCY= 25%	$ 14.737.50
SUBTOTAL	$ 73,687.50
ACQUISITION COSTS: (3 Ownerships x $7,000 each)	$ 21,000.00
RELOCATION COSTS: (Cost limited to expenses of $200 per ownership incidental to transfer of real estate interest)	$ 600.00
SEVERANCE DAMAGES (NONE)	$ 0
TOTAL ESTIMATED REAL ESTATE COSTS	**$ 95,287.50**
SAY	$ 95,300.00

ADDENDA


1 2 06
PLAT OF
INSET
Kikiaola Land Co. Ltd.
Augustus F. Knudsen Trust
Eric A. Knudsen Trust
State of Hawaii
L.D. CT. CONS. 155
Ld. Ct. App. 1076
Kikiaola Land Co., Ltd.
Disposal Site
≈10acres
OF
ILI
KAUMUALII HIGHWAY
WAIMEA VALLEY
SECTION
WAIMEA TOWN LOTS
A
E
S
OF KIKIAOLA, WAIMEA KAUAI, HAWAII
SUBJECT TO CHANGE
TAXATION MAPS BRANCH
STATE OF HAWAII
TAX MAP
FOURTH DISTRICT
ZONE SEC. PLAT
1 1 2 06



Hawaiian Home Lands
(Dept. of Land & Natural Resources)
Kekaha Sugar Co., Ltd.
PLAT 01
CANYON
Disposal Site
Hawaii
United States of America
MILITARY RESERVATION
State of Hawaii
(County of Kauai)
NEW DUMPING GROUND
State of Hawaii
(Hawaii National Guard)
RIFLE RANGE & TRAINING SITE
A.F. Knudsen Trust
Eric A. Knudsen Trust
Kekaha Sugar Company, Limited
S E A
SUBJECT TO CHANGE
DEPT OF THE TAX COMMISSIONER
TAXATION MAPS BRANCH
STATE OF HAWAII
TAX MAP
FOURTH DISTRICT
ZONE 1
SEC 2
PLAT 02
CONTAINING PARCELS

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.8 PROJECT MANAGEMENT PLAN

APPENDIX H

PROJECT MANAGEMENT PLAN
KIKIAOLA SMALL BOAT HARBOR, KAUAI, HAWAII

This plan has been prepared in accordance with ER 5-7-1, subject: Project Management, dated 30 September 1992.

Presented for approval by:	Project Manager	4/9/96 Date
Approved by:		
Deputy Director of Engrg and Technical Services	John R. Pelowski	4/5/96 Date
Deputy Director of Resource Management	Rollie Laberge	4/15/96 Date
Asst Director of Contracting	Florence Nii	4/19/96 Date
Director of Real Estate	Steven Stomber	4/22/96 Date
Deputy Division Counsel	Robert Sundberg	May 14 '96 Date
Chief, Plng and Operations Director of Engr & Tech Svc	H. Paul Mizue	5/14/96 Date
Chief, Civil Programs Br, Prog Mgmt Div, PPMD	David Lau	4/9/96 Date
Deputy District Engineer for Programs and Proj Mgmt	Gary Kitkowski	5/16/96 Date
Ch, Engineering Division of Boating and Ocean Recreation, DLNR	Manuel Emiliano	5/24/96 Date
District Engineer/Chairman, HED Project Review Board	LTC Ralph H. Graves	31 May 96 Date

KIKIAOLA SMALL BOAT HARBOR, KAUAI, HAWAII
PROJECT MANAGEMENT PLAN

CONTENTS

KIKIAOLA SMALL BOAT HARBOR
PROJECT MANAGEMENT PLAN

EXECUTIVE SUMMARY

This Project Management Plan (PMP) provides a detailed plan for management and execution of the Kikiaola Small Boat Harbor (SBH) Project through completion of construction. It includes work breakdown structure, organization structure, budgets, and schedules, project cooperation, contracting, real estate, quality management, safety, security, environmental and cultural resources, operation and maintenance, management control, reporting, and change control. All plans developed in the PMP have been reviewed and concurred in by the appropriate Staff chiefs. The PMP will be periodically updated as the project progresses.

KIKIAOLA SMALL BOAT HARBOR
PROJECT MANAGEMENT PLAN

1. WORK SCOPE

Introduction

This Project Management Plan (PMP) has been prepared in accordance with Engineering Regulation (ER) 5-7-1, Project Management. The Kikiaola SBH project was authorized under the Rivers and Harbors Act of 1968. The authorized plan of improvement consists of modifying the existing State of Hawaii small boat harbor to provide for berthing for 105 boats. The plan of improvement consists of dredging a 725-foot long, 105 to 205-foot wide and 12-foot deep entrance channel, dredging a 320-foot long 70 to 105-foot wide, 8-foot deep access channel, removing 150 feet from the existing outer east stub breakwater, raising the east breakwater crest by 3-4 feet and resloping the seaward face of the east breakwater, removal and reconstruction of the 85-foot long inner east stub breakwater, and modification of 220 feet of the existing west breakwater.

This PMP provides management information on the recommended plan for the completion of preconstruction, engineering and design efforts including the decision document, environmental documents and permitting, finalization of plans and specifications, construction contract procurement, construction, and financial closeout.

The PMP is intended to be a "living document" subject to change as conditions warrant.

2. WORK BREAKDOWN STRUCTURE

The work breakdown structure (WBS), a product-oriented hierarchy of the scope of work, provides a system for organizing the scope in a logical manner. A WBS is provided for the project. The WBS is in the following format:

Level 1. The Project
- Level 2. Major Elements of the Project
  - Level 3. Elements Subordinate to Level 2
    - Level 4. Elements Subordinate to Level 3

Kikiaola Small Boat Harbor Work Breakdown Structure

Decision Document
- Economic analysis
- Design
- Cost Estimate
- Formulation review
- Review and Revisions

Environmental Assessment (EA)
- Draft EA
- Final EA
- Finding of No Significant Impact (FONSI)

Permits
- Conservation District Use Application (CDUA)
- Water Quality Certification (WQC)
- Special Management Area (SMA)
- Coastal Zone Management (CZM) Consistency
- Other permits

Plans & Specifications
- Final Plans & Specifications
  - Plans and Design
  - Design Analysis
  - Specifications
  - Cost Estimate
- BCO Certification
- Real Estate Clearances

Construction Contract Procurement
- Commerce Business Daily announcement
- Contract advertising
- Bid Opening
- Contract award

Contract
- Construction Contract
- Construction Management
- Engineering During Construction

Project Cooperation Agreement
- Draft PCA
- Review draft PCA
- Execute PCA

Local Funds
- Draft Escrow Agreement
- Review Escrow Agreement
- Execute Escrow Agreement
- Escrow Account
- Deposit of local funds

Project Management
- Fiscal Closeout

3. ORGANIZATIONAL BREAKDOWN STRUCTURE

The organizational breakdown structure (OBS) identifies all of the elements which contribute to products. Element titles and office symbols are listed below.

RESOURCE NAME	RESOURCE CODE
District Engineer	DE

Directorate of Engineering and Technical Svc	ET
Construction Division	ET-C
Hawaii Area Office	ET-CH
Cost Engineering Division	ET-S
Technical Division	ET-T
Planning Division	ET-PP
Directorate of Contracting	CT
Office of Counsel	OC
Directorate of Programs & Project Management	PP
Directorate of Real Estate	RE
Directorate of Resource Management	RM
Department of Land and Natural Resources	DLNR
Headquarters, Corps of Engineers	HQUSACE
Assistant Sec. of Army, Civil Works	ASA(CW)
National Marine Fisheries Service	NMFS
U.S. Fish & Wildlife Service	USFWS
Construction Contractor	KTR

Project Management Team

The project management team (PMT) will be established to provide for consistent and effective communication and prosecution of items in this PMP. The PMT for the Kikiaola SBH project team will coordinate on all matters relating to execution of the project through the preconstruction phase, through construction and fiscal closeout. The team will consist of:

- Project manager
- Engineering Technical Manager
- Representative from the Construction Division
- Representatives from other Directorates on as needed basis
- Representative from DLNR, the local sponsor

4. RESPONSIBILITY ASSIGNMENT MATRIX

The responsibility assignment matrix (RAM) is a representation of the organizational responsibility for the performance of the Work Breakdown Structure elements of the project. It is the intersection of the Organizational Breakdown Structure and the Work Breakdown Structure. The RAM is shown below.

WORK UNIT DESCRIPTION	RESOURCE CODE
Decision Document	
Economic analysis	ET-PP

CORRECTION

THE PRECEDING DOCUMENT(S) HAS
BEEN REPHOTOGRAPHED TO ASSURE
LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

Directorate of Engineering and Technical Svc	ET
Construction Division	ET-C
Hawaii Area Office	ET-CH
Cost Engineering Division	ET-S
Technical Division	ET-T
Planning Division	ET-PP
Directorate of Contracting	CT
Office of Counsel	OC
Directorate of Programs & Project Management	PP
Directorate of Real Estate	RE
Directorate of Resource Management	RM
Department of Land and Natural Resources	DLNR
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WORK UNIT DESCRIPTION	RESOURCE CODE
Decision Document	
Economic analysis	ET-PP

Design	ET-PP
Cost Estimate	ET-C
Formulation Review	ET-PP
Review and Revision	ET-PP
EA	
Draft EA	ET-PP
Final EA	ET-PP
Sign FONSI	DE
Permits	
CDUA	DLNR
Water Quality Certification	ET-PP
SMA	DLNR
CZM Consistency	ET-PP
Other permits	ET-PP
Plans & Specifications	
Final Plans	ET-PP
Final Specifications	ET-T
Design Analyssis	ET-PP
VE Study	ET-C
Cost Estimate	ET-S
BCO Certification	ET-C
Real Estate Clearances	RE
Construction Contract Procurement	
CBD announcement	ET-PP/CT
Contract advertising	CT
Bid Opening	CT
Contract award	CT
Contract	
Construction Contract	KTR
Construction/S&A Management	ET-CH
Engrg During Construction	ET-PP
Project Cooperation Agreement	
Draft PCA	OC
Review draft PCA	DLNR
Execute PCA	DE/DLNR
Local Funds	
Draft Escrow Agreement	OC
Review Escrow Agreement	DLNR
Execute Escrow Agreement	DE/DLNR
Escrow Account Setup	DLNR
Deposit of local funds	DLNR
Project Management	PP
Fiscal Closeout	PP

5. SCHEDULES

The major milestone dates are as follows:

Completion of decision document	Sep 97
FONSI	May 97
State request funds (biennual FY99/00)	FY97
PCA executed	Jul 98
Escrow agreement	Dec 98
Construction contract award	Jan 99
Construction completed	Mar 00

Detailed schedule is shown in Appendix A.

6. BUDGETS AND COST ESTIMATES

A summary of the baseline project cost estimate is shown below. The fully funded project cost estimate for the general navigation features is $7,399,000 which includes contingencies of $735,00. The cost breakdown is as follows (all cost in $000):

Feature	Item	Cost
01	Lands and Damages	$ 115
10	Breakwater and Seawalls	2,800
12	Navigation Harbor	2,052
19	Grounds (Beautification)	43
59	Contingencies	735
30	Engineering and Design	1169
31	Construction Management	385
	TOTAL PROJECT FIRST COST	$7,399

Costs are based on Project Cost Estimate (PB-3) prepared 26 Jun 95. Costs are based on Design Memorandum No. 1, September 1980 and approved 28 August 1981, escalated to June 2000 price level.

Contingencies are based on the current state of the engineering detail. The contingency factor will be adjusted as the engineering and design features are refined.

The local share of the project first cost, in accordance with the provisions of the Water Resources Act of 1986 (PL 99-662). Since the project depth is less than 10 feet, the State of Hawaii will pay for 10% of the cost of the general navigation features (GNF) at the start of construction. In addition, a year after completion of construction, the State will pay an additional 10% of the cost of the GNF over a period of not to exceed 30 years. Since there are no lands, easement, rights-of-way, and relocations, or dredged material disposal areas (LERRD) to be acquired, there will no lands credit. Current first cost estimates for the local share is $781,000 which includes some real estate cost.

Latest indications from the local sponsor is that they will request their total requirement, including the deferred 10%, upfront. Currently, the upfront 10% with lands comes out to $801,000 and the deferred 10% with the lands credit amounts to $571,000. This totals $1,372,000. Their intent is to place the entire amount, currently estimated at $1,372,000 into the escrow account.

The Engineering and Design budget amount of $1,169,000 is broken down and shown in Section 8, Resource Allocation Plan.

A scope of work for each remaining task has been completed for the estimate. A contingency factor has been applied based upon the level of uncertainty of each item. The estimates in each scope of work will be the budgets for completion of the task. Funds in accordance with that budget will be allocated to the task manager in accordance with the schedule. Changes to the budget will be handled in accordance with the procedures outlined in the Management Control and Change Control sections (sections 19 and 21, respectively).

7. CURRENT BENEFITS PLAN

ER 1105-2-100 requires that feasibility reports include a plan delineating how current project benefits will be obtained in the future. The benefit analysis will be kept current by monitoring elements material to the benefits and conducting partial to full benefit reanalysis, as required. At a minimum, a reevaluation of benefits will be conducted every 2 years up to award.

8. RESOURCE ALLOCATION PLAN

The Resource Allocation Plan for preaward activities is shown below. The post award Resource Allocation Plan will be completed after award.

Figure 1
Resource Allocation Plan

Work Item	Cost Thru FY96	FY97	FY98
Economic Studies		5,000	
Environmental Studies		50,000	5,000
Cost Engineering			5,000
Hydraulic Studies/Design		149,000	38,000
Drafting/Specs			50,000
Tech Management		147,000	88,000
Technical Review			12,000
Public Involvement		7,000	
Real Estate		7,000	
Preaward Actions			30,000
Total	576,000	365,000	228,000

9. PROJECT COOPERATION PLAN

The Project Cooperation Plan is represented by the Project Cooperation Agreement (PCA). A PCA is required for all new construction starts. The PCA must be executed between the sponsor and the Assistant Secretary of the Army for Civil Works (ASA[CW]) or designee, prior to advertisement of the construction contract for the project.

The local sponsor, the State of Hawaii Department of Land and Natural Resources, has not yet appropriated its share of the local share. Funds required for project construction will be paid to the Federal Government, as agreed upon in the PCA. The timeline for the sponsor to appropriate funds are covered in paragraph 5. Since no land acquisition or disposal areas are required for the project, the State of Hawaii will not receive any credit for lands, easements, rights-of-way, relocations, and disposal sites (LERRD).

10. ACQUISITION PLAN

The Kikiaola Small Boat Harbor project will be solicited utilizing full and open competition procedures and the contract type will be firm fixed price.

11. REAL ESTATE PLAN

The general navigation features are to be constructed on lands subject to navigational servitude. Therefore no real estate acquisition is required for this portion of the project. No disposal areas will be utilized since dredged spoil will be utilized for mole construction.

Easements and rights-of-entry may be required for construction of the project. All real estate involved with the construction of harbor facilities (including staging and parking areas) is not creditable for LERRD under Section 101 of Public Law (PL) 99-662.

12. TOTAL QUALITY MANAGEMENT PLAN

Quality assurance is the process by which the Government assures end product quality. The Quality Assurance Plan will be based on ER 1110-1-12, Quality Management, dated 1 June 1993, and ER 1180-1-6, Construction Quality Management, dated 1 April 1991.

The design documents will be reviewed by Construction Division, Engineering and Technical Services Directorate to insure that the project is biddable, operable, and constructable. A Quality Assurance (QA) Plan will be prepared to identify personnel by name who will be responsible for the construction management of the project. This plan will outline all responsibilities assigned to the Quality Assurance personnel, as well as list procedures necessary to insure contract compliance.

After contract award, the contractor will be required to submit a Quality Control (QC) Plan for Contracting Officer approval. The QC Plan will describe the QC organization, list its responsibilities, and contain detailed explanations of how the QC organization will function. Test and inspection procedures will be included. For each feature of the work, detailed inspections will be held prior to starting the construction and at the time construction begins on the feature, as well as a final followup inspection when the construction of the feature is complete.

Formal partnering is not a requirement of this project but may be urged by either the Corps, sponsor, contractor, or other interested party. Another alternative may be an informal workshop following construction contract award that will proactively bring all interested parties together to air concerns.

Through QA surveillance of the contractor QC program, the Government will assure that a quality product is attained, in strict conformance with the contract.

13. VALUE ENGINEERING PLAN

Section 911 of PL 99-662 requires that a review of the cost-effectiveness of design be conducted for each water resources project with a cost exceeding $10,000,000. The cost of the general navigation features for Kikiaola Small Boat Harbor is less than $10,000,000, so a Section 911 certificate will not be required. However, the Corps of Engineers also requires a Value Engineering study for all projects exceeding $2,000,000 in cost.

14. SAFETY PLAN

All safety procedures and requirements for this project will be performed in accordance with EM 385-1-1. Each contractor working on the site will be required by the contract specifications to provide a safety plan before commencing work.

15. SECURITY PLAN

This project does not involve any sensitive military information, classified information, or computer equipment that processes such information. There is no need for a security plan apart from provisions already in place within the District office as part of normal business. Security of the construction site from theft and vandalism will be the responsibility of the contractor.

16. CULTURAL RESOURCES PLAN

This element has been reviewed and is not applicable.

17. ENVIRONMENTAL PLAN

An Environmental Analysis (EA) will be prepared for the project. The EA should cover the proposed Federal project as well as the State's proposed shoreside facilities. Commitments made during the prosecution of the EA will be documented in this PMP to assure that those commitments are honored in later phases of the project.

One aspect of the environmental plan includes construction scheduling to avoid sensitive calving periods for humpback whales. No blasting (if required) in the water would take place during the time period of December 15 through May 31.

Another aspect is a comprehensive harbor management plan which is part of the environmental plan to insure water quality in the harbor meets State standards.

Various permits will be obtained for construction of the project. Specifically, CDUA, SMA, and Water Quality Certfication permits will be obtained. We anticipate that an NPDES will not be requied for this project.

18. OPERATION AND MAINTENANCE PLAN

The Honolulu Engineer District will be responsible for maintaining the general navigation features include the breakwaters and channel depths. Estimates of breakwater maintenance quantities are based on recurrence intervals of wave heights, practical experience with existing projects in Hawaii, and guidance provided in the Shore Protection Manual. The estimated annual costs for operation and maintenance of the general navigation features will be determined in the decision document.

The State of Hawaii will be responsible for maintenance of shoreside facilities. The estimated annual costs for operation and maintenance of the shoreside facilities will be determined in the decision document.

19. MANAGEMENT CONTROL PLAN

Upon completion of this PMP and signed concurrence by affected offices within the Honolulu Engineer District and the local sponsor, the information provided herein will become the basis for completion of the project. The technical organizations will assign a manager who will be responsible for completing each assigned task within the agreed-upon budget and schedule requirements. Technical division supervisors are responsible for providing the resources necessary to accomplish the task in accordance with the approved scope of work.

Physical progress and financial data will be used to monitor overall project costs and schedules. Each task has interim milestone dates (and completion percentages) that have been identified in the scope of work to aid in monitoring work progress. Any project issues or variances from the agreed-upon information will be communicated to the appropriate organizations. All alternatives identified will be analyzed to limit impacts upon the project. The State of Hawaii is the "customer" of this project, and the project manager will ensure that the customer participates in the resolution process. Issues will be elevated to the appropriate level outlined in ER 5-7-1 for resolution.

The key to effective control and execution of the project is open communication between the various organizations involved, the accountability and responsibility that each member of the team has to perform work tasks within the agreed-upon limits, and the early identification and resolution of project issues (including analyzing impacts before the decision has been made). Methods for handling and approving changes are discussed in section 21.

20. REPORTING REQUIREMENTS

Project reports, including LRS, will be completed as required by the project manager.

Reports (PB-2a, PB-3, justification sheets, etc.) will be prepared for the annual budget process in accordance with the requirements specified in the yearly budget EC. Programs and Project Management Directorate programming personnel are responsible for preparing these reports.

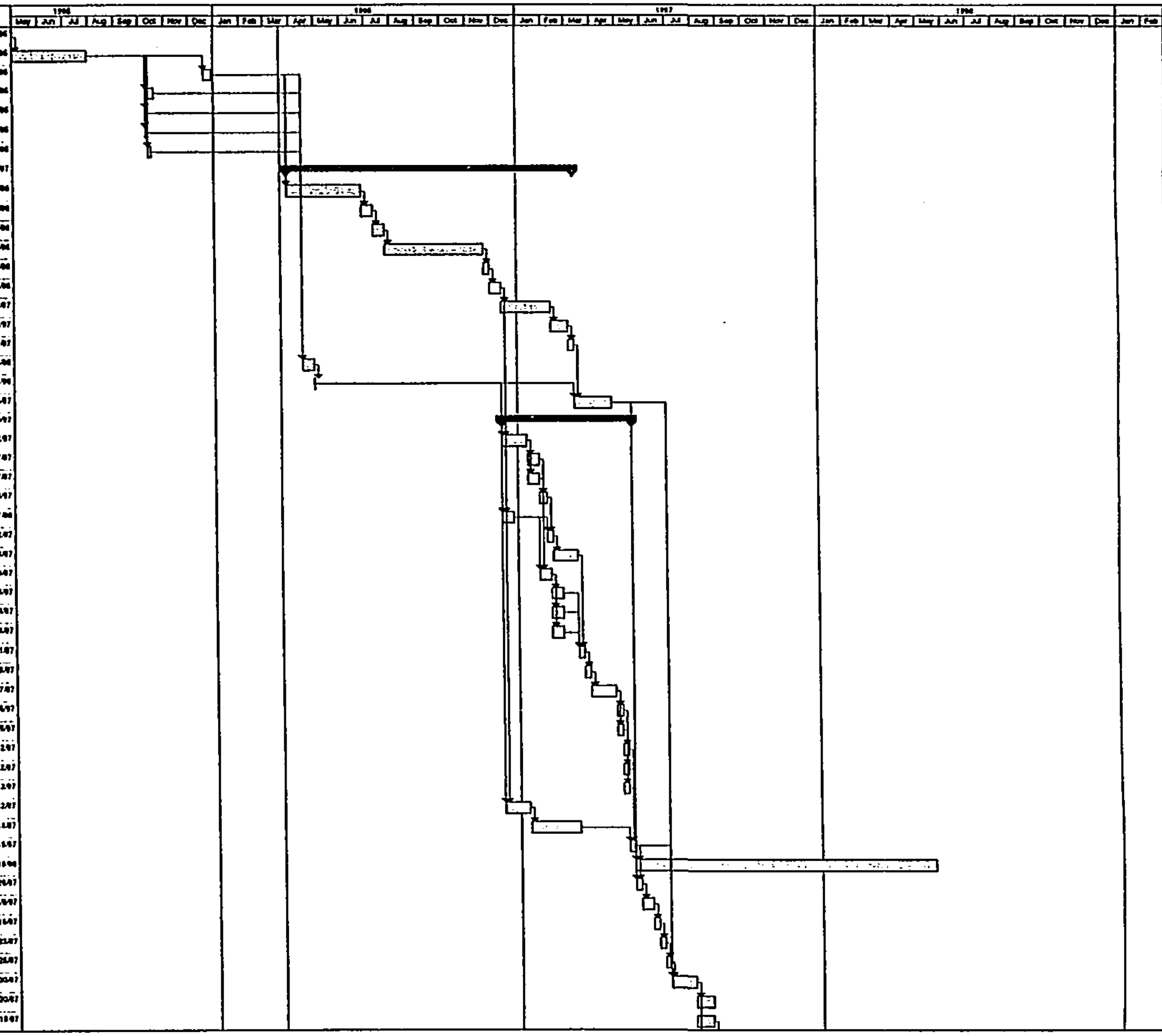
Other reports may be required by higher Corps headquarters or the local sponsor. Details of such reports, such as frequency, contents, and format, will be coordinated with the requesting office.

21. CHANGE CONTROL PLAN

The District Directorate or Division chiefs are responsible for identifying and justifying the need for changes to the project schedule and cost identified herein, and for initiating requests for approval of such changes. A schedule and cost change request (SACCR) form will be prepared by the office requesting the change, and will include the anticipated impact of the requested change. The project manager is responsible for proper evaluation, approval, and managing of project schedule and cost change requests, and is accountable for documenting impacts resulting from the change.

Contingencies will be managed by the project manager/technical manager in accordance with ER 5-7-1. The project manager/technical manager has approval authority over certain limited cost/contingency changes, as outlined in ER 5-7-1. Larger cost/contingency changes must be elevated as outlined in the ER for approval. The project manager is responsible for identifying any inflation changes in the estimate obtained through the annual budget cycle. Changes to the current approved estimate will be made as necessary during the remaining life of the project, in accordance with the ER. The project manager shall coordinate with the Cost Engineering Division for all baseline cost estimate updates.

ID	Task Name	Duration	Start	Finish
1	Study Initiation	1d	6/1/95	6/1/95
2	Economic Analysis	60ed	6/2/95	7/31/95
3	Initiate FWS Ltr	10ed	12/20/95	12/30/95
4	Initiate NMFS Ltr	10ed	10/10/95	10/20/95
5	Initiate SHOPO Ltr	1ed	10/10/95	10/11/95
6	Initiate F&WL-EX Ltr	3ed	10/10/95	10/13/95
7	Initiate CZM Ltr	4ed	10/13/95	10/17/95
8	Hydraulic Design	317d	3/28/96	3/11/97
9	Hydro/Topo Survey/Littoral D	90ed	3/28/96	6/27/96
10	In-house review	14ed	6/27/96	7/11/96
11	Initial Design Analysis	14ed	7/11/96	7/25/96
12	Wave Response Study	120ed	7/25/96	11/22/96
13	Review Wave Response Stu	7ed	11/22/96	11/29/96
14	Review alternatives	14ed	11/29/96	12/13/96
15	Complete Hydraulic Appendix	60ed	12/13/96	2/11/97
16	In house review of Hyd App	21ed	2/11/97	3/4/97
17	Finalize Hyd App	7ed	3/4/97	3/11/97
18	Public Notice	14ed	4/16/96	4/30/96
19	Public Workshop	1ed	4/30/96	5/1/96
20	Prepare LRR	46ed	3/11/97	4/26/97
21	Environmental Activities	111d	12/13/96	5/19/97
22	Prepare 404(b)(1) Eval	30ed	12/13/96	1/12/97
23	Ops Review	14ed	1/13/97	1/27/97
24	Counsel Review	14ed	1/13/97	1/27/97
25	Revisions	7d	1/27/97	2/4/97
26	EO 11988 Flood Plain Mgt Eval R	14ed	12/13/96	12/27/96
27	Prepare Public Notice	7ed	2/5/97	2/12/97
28	Public Review	30ed	2/12/97	3/14/97
29	Complete Prelim DEA	14ed	1/27/97	2/10/97
30	Planning Review	14ed	2/10/97	2/24/97
31	Tech Review	14ed	2/10/97	2/24/97
32	Counsel Review	14ed	2/10/97	2/24/97
33	Complete DEA	7ed	3/14/97	3/21/97
34	Print and Mail DEA	7ed	3/21/97	3/28/97
35	Public Review DEA	30ed	3/28/97	4/27/97
36	Revise EA	7ed	4/28/97	5/4/97
37	Draft Res to Ltrs	7ed	4/28/97	5/5/97
38	Planning Review	7ed	5/5/97	5/12/97
39	Tech Review	7ed	5/5/97	5/12/97
40	Counsel Review	7ed	5/5/97	5/12/97
41	Prepare CZM Rpt	30ed	12/13/96	1/12/97
42	Submit to State for review & c	60ed	1/13/97	3/14/97
43	Finalize EA/FONSI	7ed	5/12/97	5/19/97
44	401WQC	365ed	5/16/97	5/16/98
45	Complete LRR	7ed	5/19/97	5/26/97
46	In-house Review of LRR	14ed	5/26/97	6/9/97
47	Revisions	7ed	6/9/97	6/16/97
48	Reproduce LRR/EA	7ed	6/16/97	6/23/97
49	Forward LRR/EA to HQ	5ed	6/23/97	6/28/97
50	HQ LRR Review	30ed	6/30/97	7/30/97
51	Revise LRR	21ed	7/30/97	8/20/97
52	Req State Appropriations	15d	7/30/97	8/15/97

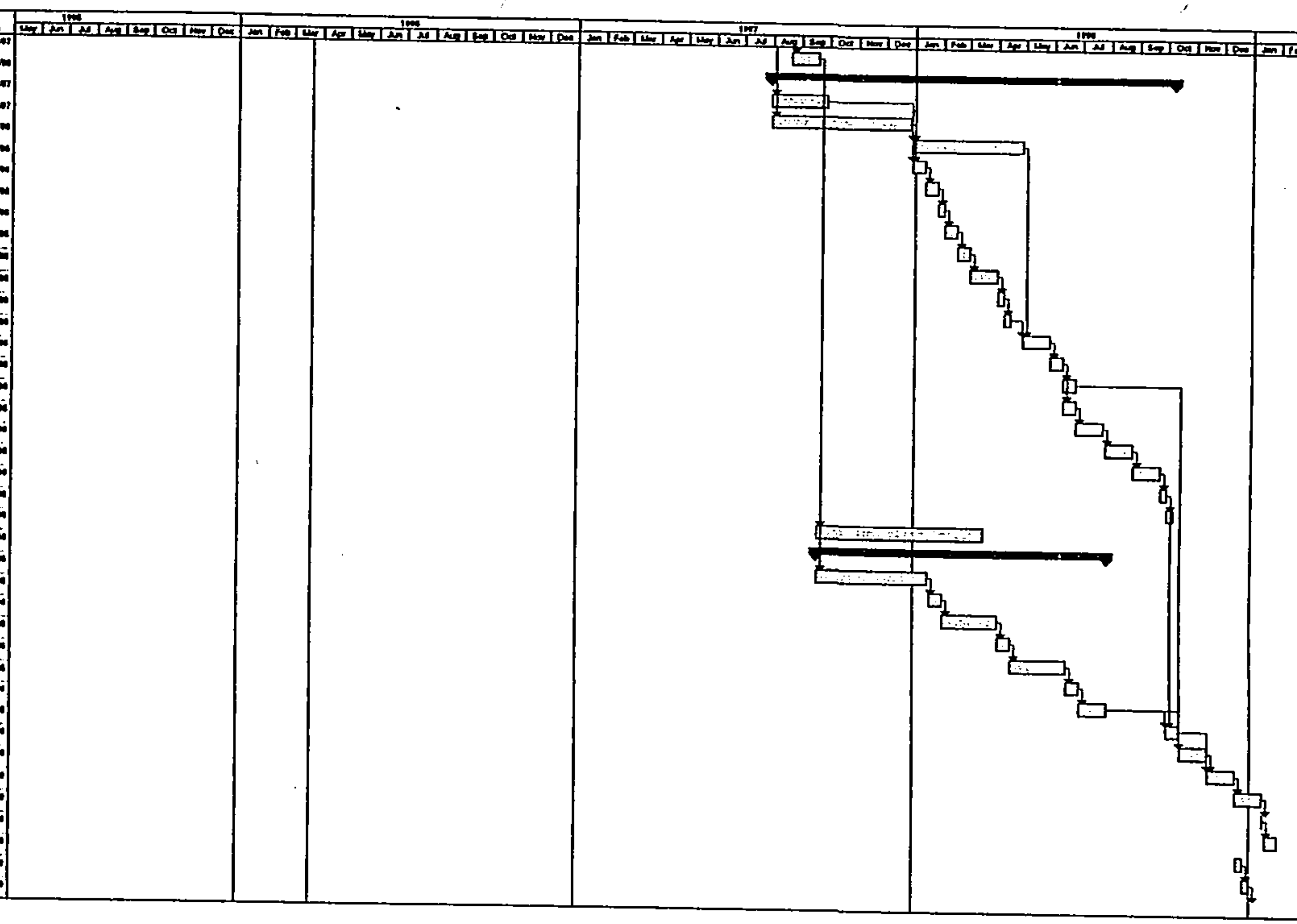


Project:
Date: 3/21/96

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Page 1

ID	Task Name	Duration	Start	Finish
53	HQ LRR Approval	30ed	8/30/97	9/19/97
54	Plans & Specifications	313d	7/30/97	10/4/98
55	Topo/Hydro Survey	60ed	7/30/97	9/28/97
56	Borings	150ed	7/30/97	12/27/97
57	ID Contractor Storage Area	120ed	12/28/97	4/25/98
58	Site Layout	14ed	12/29/97	1/12/98
59	Grading Plan	14ed	1/12/98	1/26/98
60	Establish Baseline	7ed	1/26/98	2/2/98
61	Develop Typical Section	14ed	2/2/98	2/16/98
62	Take Sections	14ed	2/16/98	3/2/98
63	Develop Details	30ed	3/2/98	4/1/98
64	Phasing Plan	7ed	4/1/98	4/8/98
65	Traffic Control	7ed	4/8/98	4/15/98
66	Drafting	30ed	4/25/98	5/25/98
67	Specs	14ed	5/28/98	6/11/98
68	Cost Estimate	14ed	6/11/98	6/25/98
69	IH Review	14ed	6/11/98	6/25/98
70	Revisions	30ed	6/25/98	7/25/98
71	Backcheck	30ed	7/27/98	8/26/98
72	Revisions	30ed	8/26/98	9/25/98
73	BCO Cert	7ed	9/25/98	10/2/98
74	Forward Contr Docs to Contr	7ed	10/2/98	10/9/98
75	Local Permits	180ed	9/18/97	3/18/98
76	PCA Activities	334d	9/18/97	7/30/98
77	Revise Draft PCA	120ed	9/18/97	1/17/98
78	Draft PCA to HQ	14ed	1/18/98	2/2/98
79	HQ Review & Appr PCA	60ed	2/2/98	4/3/98
80	Draft PCA to Local Sp	14ed	4/3/98	4/17/98
81	Local SP Review	60ed	4/17/98	6/16/98
82	Revisions	14ed	6/16/98	6/30/98
83	Execute PCA	30ed	6/30/98	7/30/98
84	Await Fed Funds	14ed	10/2/98	10/16/98
85	Prepare Escrow Agreement	30ed	10/16/98	11/15/98
86	Issue CBD/FB	30ed	11/16/98	12/16/98
87	Solicitation Period	30ed	12/16/98	1/15/99
88	Bid Opening	1ed	1/15/99	1/16/99
89	Bid Eval	14ed	1/16/99	2/1/99
90	Finalize Escrow Agreement	8d	12/15/98	12/24/98
91	Prep Award Pkg	7ed	12/25/98	1/1/99
92	Award Contract	1ed	1/1/99	1/2/99



Project:
Date: 3/21/98

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.9 EXECUTIVE ORDER 11988 ON FLOODPLAIN MANAGEMENT

APPENDIX I

APPENDIX I

EXECUTIVE ORDER 11988 ON FLOODPLAIN MANAGEMENT

1. OBJECTIVE. The objective of Executive Order 11988 on Floodplain Management is to avoid to the extent possible, long and short term impacts associated with the occupancy and modification of the base floodplain and to avoid direct and indirect support of development in the base flood plain wherever there is a practicable alternative. Under the Order, the Corps is required to provide leadership and take action to:

a. Avoid development in the base flood plain unless it is the only practicable alternative;
b. Reduce the hazard and risk associated with floods;
c. Minimize the impact of floods on human safety, health and welfare; and
d. Restore and preserve the natural and beneficial values of the base flood plain.

2. EXECUTIVE ORDER 11988 EVALUATION. The following paragraphs describe the actions taken and the determinations made during the evaluation steps outlined under Engineering Regulation 1165-2-26, dated 30 March 1984.

a. Flood Plain Determination. The proposed harbor improvement project and existing and future shoreside facilities are located within the base flood plain. According to the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Map, Community-Panel Number 150002 0156 D dated September 30, 1995, the proposed project site lies in Zone VE, defined as areas that are inundated by the 100-year coastal flood having a base elevation of 11.0 feet above mean sea level datum, with associated velocity hazards due to wave action.

b. Public Review. Since the proposed action is within the 100-year flood hazard zone, public review of the proposed plan will be accomplished as part of the National Environmental Protection Agency Review process.

c. Practicable Alternatives. The proposed project is considered to be functionally dependent on its location within the 100-year floodplain and cannot perform its intended purpose otherwise. There is no practicable alternative to locating harbors within the tsunami inundation zone in the State of Hawaii. All of Hawaii's low lying shorelines are subject to potential tsunami inundation and coastal flooding from hurricanes. As discussed in the main report, the nonstructural alternative was deemed to be impractical and nonresponsive in meeting the planning objectives.

d. Impacts from the Action. The primary natural and beneficial value of the coastal inundation zone is to serve as a buffer zone between the ocean and inland areas not subject to potential tsunami or hurricane surge inundation. The harbor improvement project will not impact on the natural and beneficial value of the coastal inundation zone.

f. Recommendation. Although the harbor improvement project will require development within the coastal inundation zone, implementation of harbor improvements is in the National interest because the developed harbor will provide for safe navigation and berthing conditions, and will enhance boating opportunities.

NAVIGATION IMPROVEMENTS
AT KIKIAOLA
LIGHT DRAFT HARBOR
Kekaha, Kauai, Hawaii

12.10 PERTINENT CORRESPONDENCE

APPENDIX J

JH 4/17
Tim —

KIKIAOLA LAND COMPANY, LIMITED

16 April, 1998

Civil Works Branch
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, HI 96858-5440

Attention: Mr. Ray H. Jyo, P.E.
Chief Engineering Division

Dredge Material Disposal
Kikiaola Light-Draft Harbor
Waimea, Kauai, Hawaii

Kikiaola Land Company, Ltd. (KLCo) will allow disposal of the dredge material from Kikiaola Harbor on KLCo owned land in Waimea. It is KLCo's understanding that the quality of the material will be non-hazardous and similar in composition to the material sample analysis included with your letter of April 2, 1998. The material accepted for disposal is to be soil and silt, free of organic debris, rubbish, inorganic wastes, large rocks and boulders.

Prior to finalizing the terms of the disposal agreement, we are requesting information on the likely odors and time for dewatering associated with the dredge material disposal activities. A test area for assessing such potential impacts from the disposal activities can be coordinated with you if necessary. Please contact me if you wish to arrange for establishing a test site.

We look forward to working with you on developing a mutually beneficial disposal solution in support of this important project for the community of Waimea.

Very truly yours,

KIKIAOLA LAND COMPANY, LTD.

Linda F. Collins

Linda F. Collins
Chief Operating Officer

P.O. Box 367 / 9600 Kaumualii Hwy. / Waimea - Kauai, Hawaii 96796 • Telephone (808)/338-1900 FAX (808)/338-1619

Sanifill

Quality Service with Integrity

SH98-26

April 27, 1998

Mr. Ray H. Jyo, PE
Civil Works Branch
Department of the Army
US Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858-5440

RE: Disposal of dredged material from Kikiaola Harbor

Dear Mr. Jyo,

This is to acknowledge that as the agent for the County of Kauai to manage the operation of the Kekaha Landfill-Phase II, Sanifill of Hawaii has committed to accept approximately 16,000 cubic yards of non-hazardous dredged material from the Kikiaola Harbor on or around the year 2001. Further, Sanifill will accept any additional non-hazardous dredged material from Kikiaola Harbor until the Kekaha Landfill-Phase II anticipated closing in the year 2007.

Please feel free to call me at (808) 337-1416 if you have any questions.

Sincerely,

Jeffrey K. Kaohi

Jeffrey K. Kaohi
Site Manager

JKK/dr

cc: Troy Tanigawa, County of Kauai

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A Sanifill Subsidiary
Sanifill of Hawaii, Inc. • P.O. Box 1259 • Kekaha, Kauai, HI 96752 • (808) 337-1416 • FAX (808) 337-9614

BENJAMIN J. CAYETANO
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF BOATING AND OCEAN RECREATION
333 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813

MICHAEL D. WILSON
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY DIRECTOR
GILBERT S. COLOMA-AGARAN

May 22, 1998

BOR-E 0943.98

LTC Ralph H. Graves
District Engineer
U.S. Army Corps of Engineers
Honolulu Engineer District
Building 230
Ft. Shafter, Hawaii 96858-5440

Dear Colonel Graves:

This letter expresses the intent of the State of Hawaii, Department of Land and Natural Resources (DLNR) to cooperate with the Federal Government in initiating construction of navigation improvements at the Kikiaola Light Draft Harbor in Kekaha on the Island of Kauai. We understand that the State of Hawaii, DLNR, will be required to pay the non-Federal share of the costs of construction of general navigation features as specified by section 101 of the Water Resources Development Act of 1986 (Public Law 99-662). We further understand that the non-Federal share of these features, based on the above law and the General Reevaluation Report and Environmental Assessment, is currently estimated at $1.0 million. In addition, other non-Federal costs currently estimated at $700,000 would be required for dredging of the berthing area, construction of a dock system and lands, easements, rights-of-way, relocations and disposal site. The total non-Federal share's project first costs is currently estimated at $1.7 million.

We also understand that the State of Hawaii, DLNR, will be required to comply with various requirements that will be developed and outlined as part of the Project Cooperation Agreement.

I believe the State of Hawaii, DLNR, has the ability to obtain the required non-Federal portion of the estimated project cost. The State of Hawaii will submit this project before the State Legislature for approval and budget appropriation in Fiscal Year 1999. It is anticipated that project funds will be obtained and secured through the State's general obligation bond authority.

It is further understood that if this letter of intent is acceptable, you as District Engineer will recommend that funds for the Federal share of this project be procured.

BOR-E 0943.98

Should you have any questions, please call me at 587-1966, or contact Manuel Emiliano of our Boating Engineering Branch at 587-0122.

Very truly yours,

Howard B. Gehring
Acting Administrator