HILO AREA
COMPREHENSIVE STUDY

VOLUME 4 OF 5

Reeds Bay Small Craft Harbor

DRAFT

A REEVALUATION REPORT AND DRAFT ENVIRONMENTAL IMPACT STATEMENT

US Army Corps of Engineers
Pacific Ocean Division

APRIL 1983

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

REEDS BAY HARBOR, HAWAII

A REEVALUATION REPORT AND DRAFT ENVIRONMENTAL IMPACT STATEMENT

FOR

SMALL-CRAFT NAVIGATION IMPROVEMENTS

PACIFIC OCEAN DIVISION

April 1983

REEDS BAY SMALL CRAFT HARBOR

A DRAFT REEVALUATION REPORT

AND

ENVIRONMENTAL IMPACT STATEMENT

VOLUME IV REEDS BAY SMALL CRAFT HARBOR

A DRAFT REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

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VOLUME IV - REEDS BAY SMALL CRAFT HARBOR

A DRAFT REEVALUATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT (CONT)

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SYLLABUS

This report was prepared under Section 144 of the Water Resources Development Act of 1976. The purpose of this report is to reevaluate the Reeds Bay Small Craft Harbor project, authorized for construction under Section 107 of the River and Harbor Act of 1965 in light of current conditions and criteria.

The revised plan calls for construction of a recreational small boat harbor in Reeds Bay to accomodate approximately 100 boats 25 to 35 feet in length. There are no significant long-term environmental effects or changes.

The total first cost of the project is $3.3 million. Average annual benefits are estimated to be $0.34 million for a benefit to cost ratio of 2.3.

AUTHORITY

This report was prepared under Section 144 of the Water Resources Development Act of 1976, which authorized the Corps of Engineers in cooperation with the State of Hawaii and County of Hawaii to study methods to develop, utilize and conserve water and land resources in the Hilo Bay area including the consideration of the need for navigation facilities, enhancement and conservation of water quality, enhancement of economic and human resources development.

PURPOSE AND SCOPE

The purpose of this report is to reevaluate the Reeds Bay Small Craft Harbor project, authorized for construction under Section 107 of the River and Harbor Act of 1965, in light of current conditions and criteria. Changes in the project design are necessary to preserve two popular recreation areas, Reeds Bay Beach and Ice Pond. An alternative alignment and capacity to the original design evolved from workshops.

This report presents a plan for the implementation of the study findings to develop, utilize and conserve light-draft navigation facilities at Reeds Bay.

The investigations described in this report are within Hilo Bay (Figures 1 & 2). Investigations were made of the immediate and future regional needs for expansion of light-draft navigation facilities; measures or combinations thereof capable of satisfying such needs; the accompanying economic, environmental, and social considerations; and coordination with concerned agencies and the public. These studies provide the depth and detail required to determine plan feasibility.

PRIOR STUDIES, REPORTS AND EXISTING WATER PROJECTS

Reeds Bay Small Craft Harbor was one of eight projects recommended by the District Engineer through the "Interim Report on Survey of the Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels" prepared in 1963 and authorized in 1965. The project held a low priority in the Harbors Division

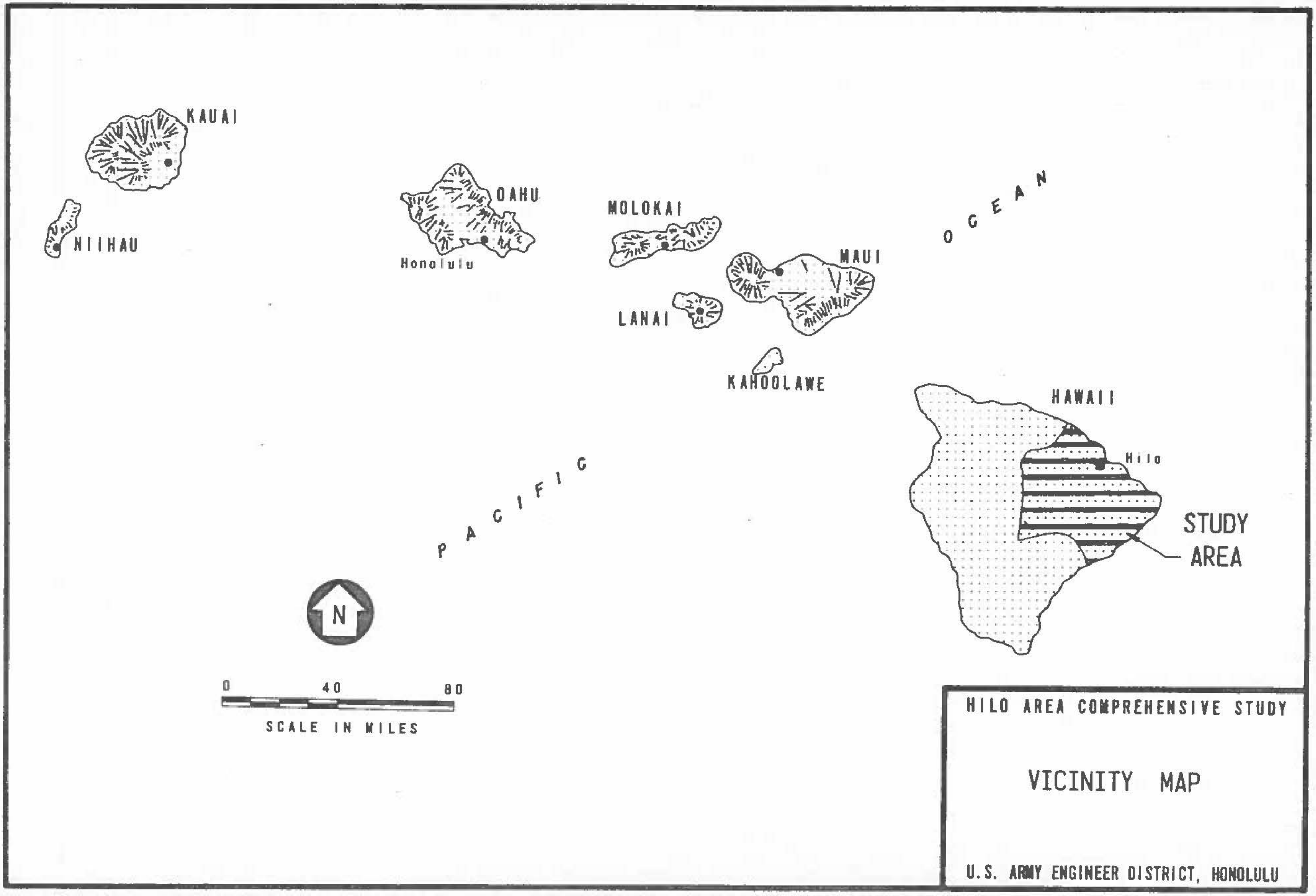
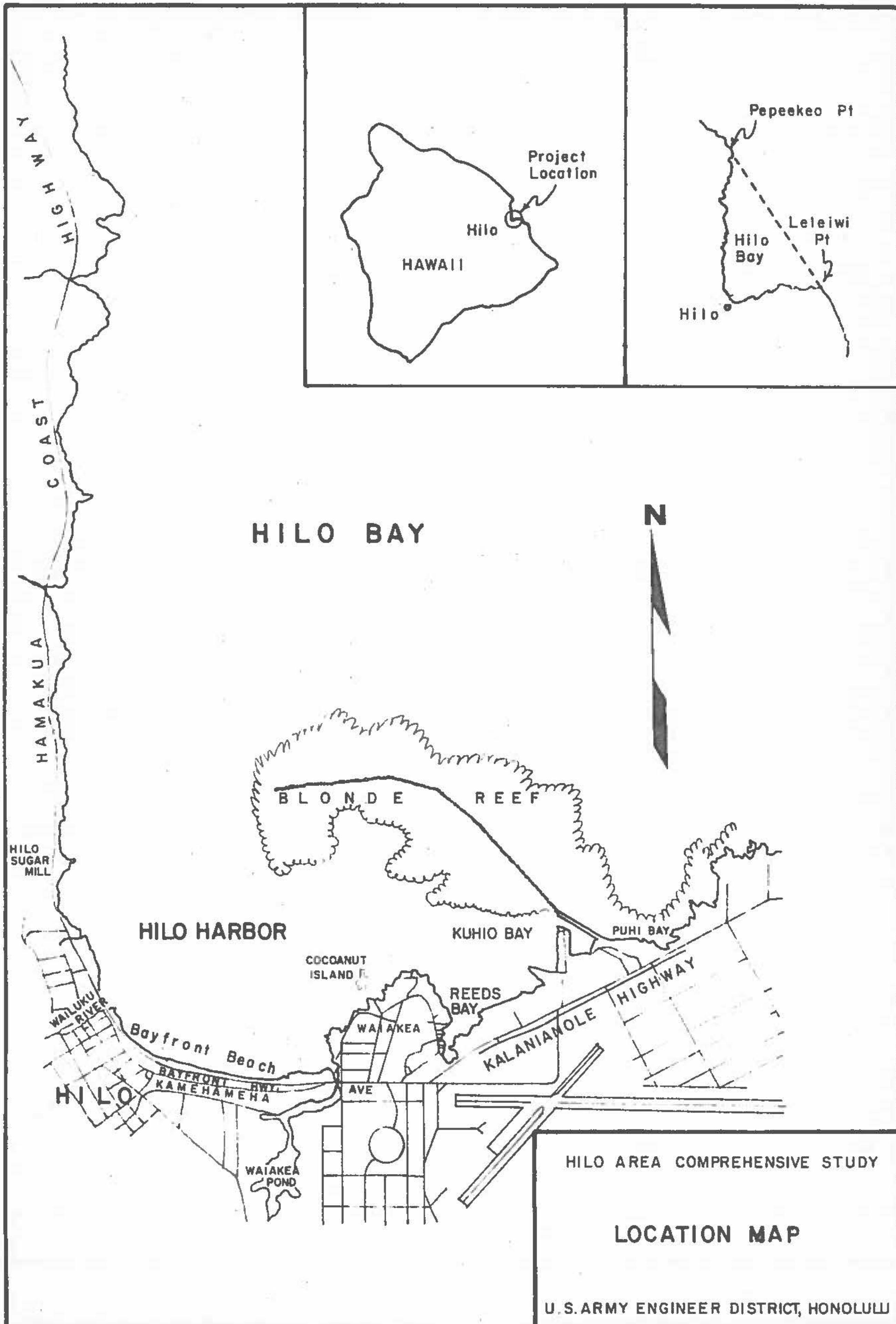

KAUAI
NIIHAU
OAHU
Honolulu
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
Hilo
STUDY AREA
PACIFIC
OCEAN
N
0
40
80
SCALE IN MILES
HILO AREA COMPREHENSIVE STUDY
VICINITY MAP
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1



HILO AREA COMPREHENSIVE STUDY

LOCATION MAP

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 2

capital improvements programs because local interests were concerned that water contact recreation for children not be lost at the site due to construction of the harbor. On January 15, 1976 a public meeting for deauthorization of the project was held. Local interests requested that the authorization for Reeds Bay project should be retained, but that the project be relocated or reconfigured.

PLAN FORMULATION

Existing Conditions

Reeds Bay is a relatively shallow bay with rock out-croppings along the outer edges. An artificial coral beach composed of dredge material from the 1920's excavation of Hilo Harbor lines the inner bay. The strata in Reeds Bay is anticipated to be a thin sediment layer of silts and residue, underlain by basalt. The area provides a picturesque view for both pedestrians and passers-by in automobiles traveling on Banyan Drive. The site is situated within tsunami inundation limits.

Existing facilities in Reeds Bay are approximately 16 anchor moorina in additon to restrooms and one picnic area.

Without Conditions

Presently the only permanent mooring facilities for large sailing vessels (under 25 feet) are the 16 mooring buoys in Reeds Bay, provided by the State Department of Transportation. Larger vessels must anchor at temporary moorages in Radio Bay or Hilo Harbor at the mouth of Reeds Bay because Reeds Bay is too shallow for deep keels. Other than the subject project there are no plans for facilities in the immediate Hilo area which would accommodate these vessels.

Problems and Opportunities

As population, income and leisure time increase, a greater demand is being put on the existing recreational facilities in Hawaii County. Excess demand for wet storage in the Hilo area was over 90 recreational craft in 1980. This figure is projected to increase to approximately 123 craft in 1985.

A small craft harbor could be constructed at this site to satisfy the recreational boating needs in Hilo for wet storage as well as trailered boats. Berthing spaces could be used by both motor and sailboats.

Objectives

The following objectives were established for the study:

a. Provide appropriate facilities to meet the berthing needs for power or sailing craft up to 40 feet in length, 15' beam and 7-foot draft.

b. Minimize environmental modifications to terrestrial and marine environments.

Constraints

The existing site at Reeds Bay constrains the berthing capacity of the proposed project. The number of berths would be less than authorized because of this and also because larger boats than originally projected would occupy the berths.

ALTERNATIVES

Available Measures

Nonstructural

Dry storage is a nonstructural alternative consisting of providing a large land area to store boats and a shoreside dock crane or launch ramp to place the boats in the water. Operation of dry storage could handle the 25- to 40-foot design vessels. However, since the boating season in Hawaii is year round and not seasonal, boats are used constantly and permanent wet storage is considered appropriate here.

Structural Measures

Boat launching ramps as an alternative to a harbor do not meet the projected need for wet storage of 25- to 40-foot craft for protected anchorage and for the growth of recreational boating in the project area. Launch ramps would satisfy the project objectives only for craft under 25 feet in length and would not provide for larger vessels which cannot be trailered.

AUTHORIZED PLAN

Description

The original plan contained in the 1963 Survey Report for the Coast of the Hawaiian Islands, and later approved by Congress contains the following features:

a. Dredging of the seaward portion of Reeds Bay to -12 feet MLLW.

b. Construction of a protective breakwater approximately 900 feet long extending eastward from the existing shoreline.

c. A berthing area to accomodate approximately 270 boats less than 25 feet in length.

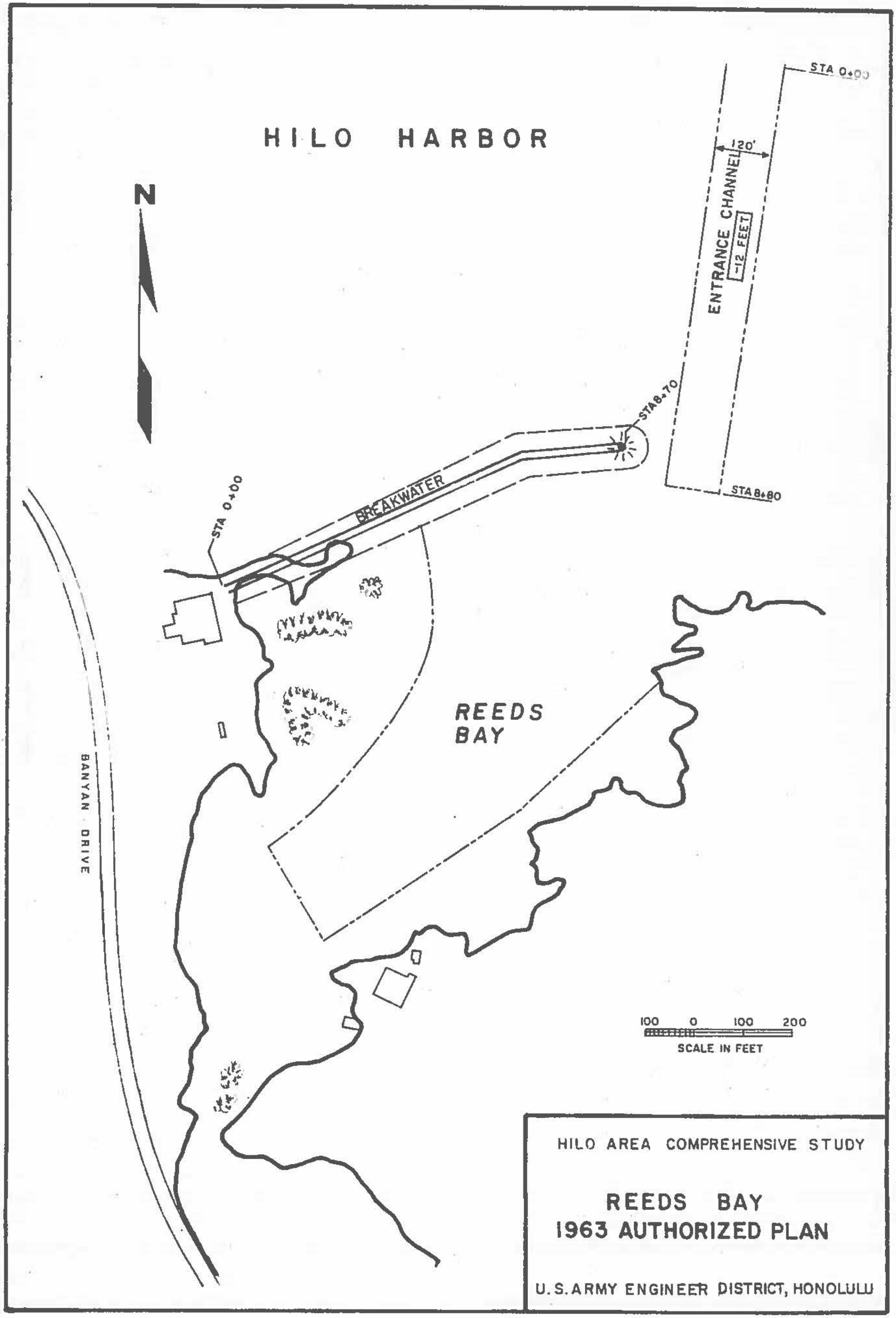
Figure 3 shows the authorized configuration as presented in the 1963 report. A berthing layout was not included.

Evaluation

The original plan, as formulated, is unacceptable to the local sponsors and the public because of its adverse impacts on two popular recreation areas, the Reeds Bay Beach and Ice Pond. Tables 1 through 4 display and evaluate the alternatives and effects of the original and reformulated plan.

Reformulation

A revised configuration shown on Figure 4, was prepared to accommodate local concerns that the west bank of Reeds Bay not be physically affected by



HILO AREA COMPREHENSIVE STUDY

REEDS BAY
1963 AUTHORIZED PLAN

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3

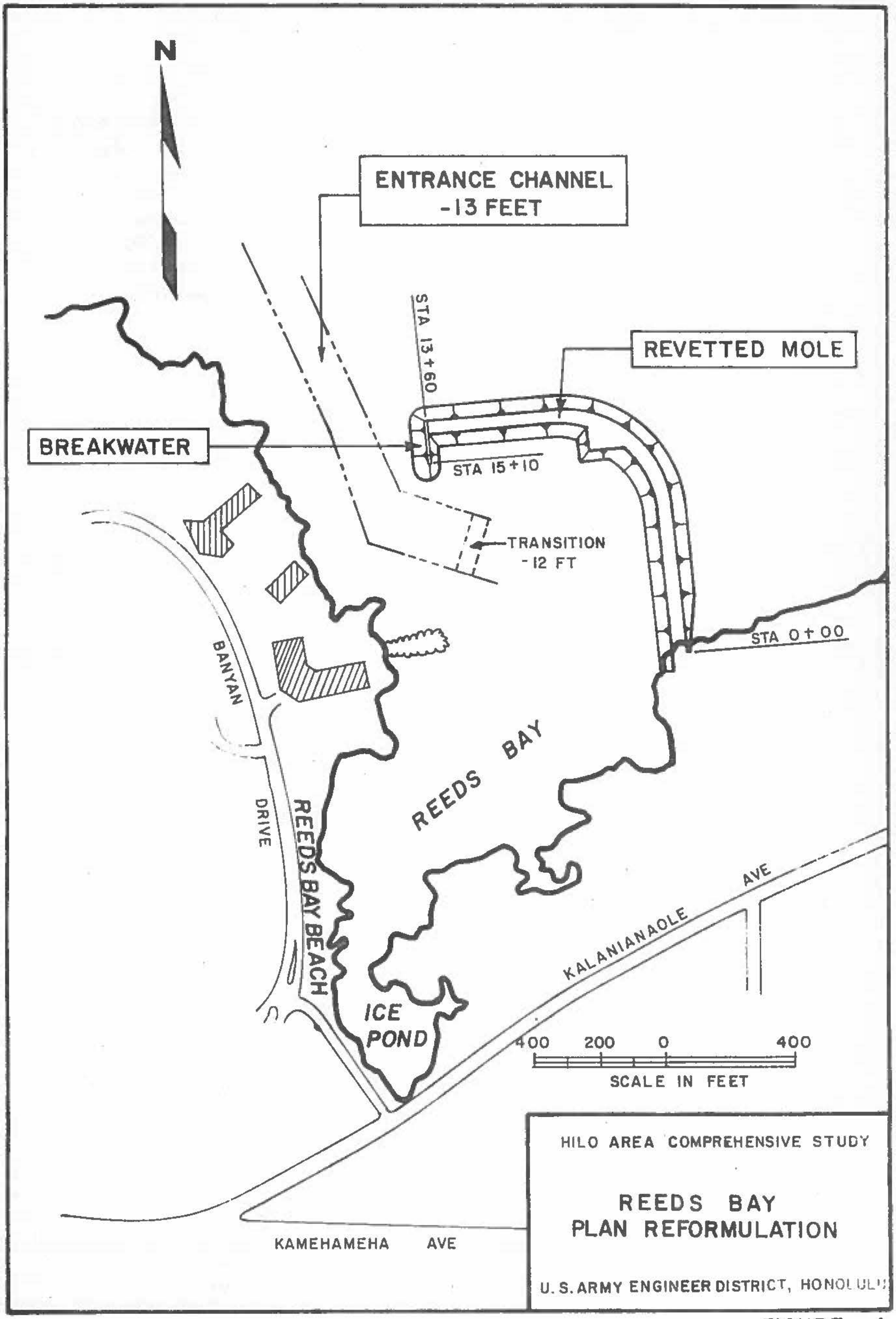

N
ENTRANCE CHANNEL
-13 FEET
STA 13+60
REVETTED MOLE
BREAKWATER
STA 15+10
TRANSITION
-12 FT
STA 0+00
BANYAN
DRIVE
REEDS BAY BEACH
REEDS BAY
ICE POND
KALANIANAOLE AVE
400 200 0 400
SCALE IN FEET
KAMEHAMEHA AVE
HILO AREA COMPREHENSIVE STUDY
REEDS BAY
PLAN REFORMULATION
U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 4

construction of the harbor in order to protect water contact recreation and the natural beauty of the site. The changes would move the shoreside facilities and boating activities from the west bank to the east bank of Reeds Bay, away from the recreational swimming beach.

The authorized plan provided berthing for 270 boats under 25 feet in length; the revised plan includes berthing for 100 boats between 25 and 40 feet in length.

REVISED PLAN DESCRIPTION

Components

The revised plan contains the following components:

a. Dredging the seaward portion of Reeds Bay to -12 feet MLLW; dredging of an entrance channel to -13 feet MLLW.

b. Construction of a protective breakwater approximately 1360 feet long extending from the east side of the existing shoreline.

c. A berthing area to accommodate approximately 100 boats between 25 and 35 feet in length.

Design and Construction

Design and construction work can each be accomplished in less than one year. Some blasting may be required in conjunction with dredging to complete excavation. Excavated material may be used for the core of the breakwater, if found to be of suitable quality. The remainder will be spoiled in waste areas to be determined.

Operation and Maintenance

The Federal Government would be responsible for maintenance of the breakwater, entrance channel and turning basin. Local Government would operate the facility and maintain the berthing areas and shore side facilities.

Accomplishments

The revised plan provides additional berths to meet the immediate needs of recreational and commercial boaters in the Hilo area.

Summary of Economic, Environmental and Other Social Effects

Economics

In accordance with ER-1105-2-40, dated 8 Jan 82, paragraph 3-7b, interest rates for projects authorized before 3 Jan 69, an interest rate of 3-1/4 percent was used to derive the average annual cost and the benefit-cost ratio.

Total Project First Cost (including E&D, S&A)	$ 3.3 million
Federal Share	1.3 million
Local Share	2.0 million
Investment Cost (Project Firat Cost plus IDC)	3.4 million

Interest and Amortization (3¼%, .04073)	$ 140,000
Annual Operation and Maintenance (Federal cost)	10,000
Total Average Annual Cost	150,000
Average Annual Benefits	340,000
Benefit-Cost Ratio	2.3
Net NED Benefits	190,000

Environment

o Temporary turbidity during dredging.

o Dredging in Reeds Bay would not be extensive since much of the bay is -12 feet already.

o No significant long-term effects or changes.

Social

o Benefits to the community are provided by with an increase in recreational boating opportunities.

o No significant adverse effects.

IMPLEMENTATION

Institutional Requirements

Following approval of this reevaluation report, the Honolulu District Engineer would perform final preconstruction engineering and design work. The District would administer construction. The Division of Harbors, Department of Transportation, State of Hawaii is the local sponsor.

Federal and Non-Federal Responsibilities

Cost sharing as authorized is based on recreational use and requires a 50-50 split between the Federal and local shares for construction of the protective works, entrance channel and turning basin. Shoreside facilities for parking and support activities would be a local responsibility.

SUMMARY OF COORDINATION, PUBLIC VIEWS AND COMMENTS

The public involvement program has consisted of meetings and workshops with the public at large, meetings and workshops with members of the Federal, State, and County agencies. In total, 10 public meetings or workshops have been held concerning the various components of the Hilo Comprehensive Study.

Concerns relating to Reeds Bay are the lack of recreational slips and the need to preserve the swimming beach.

The following coordination must be completed with the following agencies:

State and County Approvals. The State of Hawaii, Department of Transportation, is responsible for obtaining all necessary local permits and approvals.

A letter of support has been received from the Hilo Bay Sailing Club and the State of Hawaii Department of Transportation.

TABLE 1

EXISTING AND FUTURE CONDITIONS
WITHOUT THE
ALTERNATIVE PLANS

	Existing	Future
DESCRIPTION	Presently, the only berthing or mooring facilities for larger sail boats (over 25 feet) are the 16 mooring buoys in Reeds Bay.	The situation would continue to degrade due to the increase in mooring needs.
PROBLEMS	Larger vessels must anchor in Radio Bay or Hilo Harbor at the mouth of Reeds Bay since the bay is too shallow for deep keels. These vessels are not protected from wind-generated waves and constitute a hazard to other vessels operating in the harbor basin.	Without the plan, the problem of inadequate mooring will continue to grow.
OPPORTUNITIES	Increase the berthing area and turning basin to accommodate a greater number of boats.	None. The situation would remain basically the same as it is today.

TABLE 2

ALTERNATIVES WHICH WERE CONSIDERED BUT NOT DEVELOPED INTO PLANS

Measures	Effects	Reasons for Not Proceeding Further
1963 Authorized Plan. This was the original plan for Reeds Bay, authorized in 1963. It consisted of dredging the seaward portion of Reeds Bay to -12 feet MLLW; constructing a 900-foot long breakwater; and, a berthing area to accommodate approximately 270 boats less than 25 feet in length.	The plan has adverse impacts on the Reeds Bay Beach and Ice Pond.	As formulated, it was found unacceptable to the local sponsor and the public.

TABLE 3

ALTERNATIVES AND EFFECTS

	EFFECTS	
	NED	Other
1963 Authorized Plan. Dredge the seaward portion of Reeds Bay to -12 feet MLLW; construct a protective breakwater approximately 900 feet long, extending eastward from the existing shoreline; a berthing area to accommodate 270 boats less than 25 feet in length.	The plan was unacceptable to the local sponsors and the public because of its adverse impacts on Reeds Bay Beach and Ice Pond.	
Reformulated Plan. Dredge the seaward portion of Reeds Bay to -12 feet MLLW; dredging an entrance channel to -13 feet MLLW; construct a breakwater approximately 1400± feet long; a berthing area to accommodate approximately 100 boats 25 to 35 feet in length.	The plan has a benefit-to-cost ratio greater than unity 2.3 and will meet the immediate needs of recreational and commercial boaters in the Hilo area.	Economics Total First Cost 3,300,000 Average Annual Benefits 340,000 Average Net Benefits 190,000 Benefit to Cost Ratio 2.3 Environment Temporary turbidity during dredging. Dredging would not be extensive since much of the bay is already -12 feet. No long term effects or changes. Social Benefits to the community with increase in recreational boating. No significant adverse effects.

TABLE 4

EXISTING OR EXPECTED FEDERAL AND
NONFEDERAL PROJECTS
WHICH AFFECT THE
RECOMMENDED PLAN

Project	INTERACTIONS		
	Economic	Environmental	Physical
FEDERAL			
Breakwater Change	No effect.	Would improve the water quality in the bay while increasing recreational use.	No effect.
NONFEDERAL			
None			

DRAFT

ENVIRONMENTAL IMPACT STATEMENT

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
PROPOSED PLAN FOR SMALL CRAFT NAVIGATION IMPROVEMENTS
AT
REEDS BAY, HAWAII
AS PART OF THE
HILO AREA COMPREHENSIVE STUDY, HILO, HAWAII

The responsible local cooperating agency is the State of Hawaii, Department of Transportation.

The responsible lead federal agency is the US Army Engineer District, Honolulu, Hawaii.

The US Fish and Wildlife Service is a cooperating federal agency.

Information, displays and figures referred to in the Main Report and Appendices are incorporated as a part of this Environmental Impact Statement.

Abstract: As part of the continuing Hilo Area Comprehensive Study, the need for facilities to serve recreational boaters was investigated, as well as the needs of commercial fishing interests. The latter needs are addressed in the report of Small Craft Navigation Improvements at Cape Kumukahi, Hawaii. This report addresses the needs of recreational boaters, and is a resurvey of the Reeds Bay Harbor Project, approved by Congress in 1965 but not yet funded. The changes in the project design are necessary to avoid destruction of a popular recreation area, the Reeds Bay Beach, and to accommodate the changed boat size requirement. One alternative alignment and capacity was considered, in addition to the original design. No significant adverse environmental impacts are anticipated, although sediments to be dredged may be lightly contaminated with arsenic and other toxic substances.

SEND YOUR COMMENTS TO THE DISTRICT ENGINEER BY:

If you would like further information on this environmental impact statement please contact:

Dr. James Maragos, Chief
Environmental Resources Section
U.S. Army Engineer District, Honolulu
Building T-1
Fort Shafter, HI 96858
Phone: (808) 438-2263

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1. SUMMARY.

1.1 MAJOR CONCLUSIONS AND FINDINGS. Two plans were evaluated for the Reeds Bay Navigation Improvements Study which is a part of the Hilo Area Comprehensive Study. These plans were Plan A - the authorized 250 boat facility; and Plan B - the reformulated plan for a 100 boat facility.

TABLE 1. PLAN FEATURES

Plan A - Authorized	Dredge the seaward portion of Reeds Bay to -12 feet MLLW. Dredged material will be used in the breakwater construction unless found not suitable. Construction of breakwater from West side. Capacity 250 boats.
Plan B - Reformulation	Dredge the seaward portion of Reeds Bay to -13 feet MLLW. The dredged material will be used in the breakwater construction unless found not suitable. Construction of Breakwater from East side. Capacity 100 boats.

No wetlands are involved, but the site is in a flood plain and tsunami inundation area. Bioassay and bioaccumulation tests and approval from the US Environmental Protection Agency will be required before ocean disposal if required, can be implemented. The effects of the discharge of dredged and fill material were evaluated under Section 404(b)(1) of the Clean Water Act. For either Plan, the dredged material not used in construction of the breakwater would be disposed of in the EPA designated deep water disposal area nearest Hilo Harbor after approval of the disposal plan by the Environmental Protection Agency, or in an upland site. Other fill material is expected to be clean quarry stone, classified as Category 5, not requiring testing. No prime agricultural lands are located in the project area. Because of its lower cost and least enviromental damage, Plan B is the recommended plan for implementation.

1.2 AREAS OF CONTROVERSY. None

1.3 UNRESOLVED ISSUES.

OCEAN DUMPING. If ocean disposal of dredged material is necessary, the requirements for bioassay and bioaccumulation testing and US Environmental Protection Agency approval need to be completed prior to discharge of the dredged material at the ocean dump site. If the Environmental Protection Agency disapproves the ocean disposal of the dredged material, other methods of disposal will have to be evaluated.

1.4 RELATIONSHIP TO ENVIRONMENT REQUIREMENTS: (See Table 2).

1.5 ADOPTION OF AN EIS. The probable environmental impacts of ocean disposal of the dredged material at the disposal site are discussed in the US Army Corps of Engineers "Final Environmental Impact Statement for Maintenance Dredging in the State of Hawaii," 1975, and the US Environmental Protection Agency "Final Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation," 1980, and are adopted for the purposes of this statement. If ocean disposal is required, the results of the bioassay and bioaccumulation tests will be documented in a supplement to this environmental impact statement.

TABLE 2. RELATIONSHIP OF THE PLANS TO ENVIRONMENT PROTECTION STATUTES AND OTHER ENVIRONMENTAL REQUIREMENTS

Federal Statutes	Plan A	Plan B
Archaeological Resources Protection Act	Full	Full
Clean Air Act	Full	Full
Clean Water Act (See Section 6.2)	Partial	Partial
Coastal Zone Management Act (See Section 6.2)	Partial	Partial
Endangered Species Act (See Section 6.2)	Partial	Partial
Estuaries Protection Act	N/A	N/A
Federal Water Project Recreation Act	Full	Full
Fish and Wildlife Coordination Act	Full	Full
Land and Water Conservation Act	N/A	N/A
Marine Protection, Research and Sanctuaries Act	N/A	N/A
National Historic Preservation Act	Full	Full
National Environmental Policy Act	Full	Full
Rivers and Harbors Act	N/A	N/A
Watershed Protection and Flood Prevention Act	N/A	N/A
Wild and Scenic Rivers Act	N/A	N/A
Executive Orders, Memoranda		
Flood Plain Management	N/A	N/A
Protection of Wetlands	N/A	N/A

TABLE 2. RELATIONSHIP OF THE PLANS TO ENVIRONMENT PROTECTION STATUTES AND OTHER ENVIRONMENTAL REQUIREMENTS

Executive Orders, Memoranda (Cont)	Plan A	Plan B
Environmental Effects Abroad of Major Federal Actions	N/A	N/A
Analysis of Impacts on Prime and Unique Farmlands	N/A	N/A
State and Local Policies		
State NEPA (See Section 6.2)	Partial	Partial
State Coastal Zone Management Program (See Section 6.2)	Partial	Partial
County Special Management Area Permit	Full	Full
State Conservation District Use Application Permit	Full	Full
County General Plan	Full	Full
State Land Use Plan	Full	Full
Required Federal Entitlements (Permits)		
None required		

NOTES:

a. Full (Full Compliance). Having met all requirements of the statute, Executive Order or other environmental requirements for the current stage of planning (either pre- or post-authorization).

b. Partial (Partial Compliance). Not having met some of the requirements that normally are met in the current stage of planning. Partial compliance entries should be explained in appropriate places in the report and/or EIS and referenced in the table.

c. Non-Compliance. Violation of a requirement of the Statute, Executive Order, or other environmental requirement. Non-compliance entries should be explained in appropriate places in the report and/or EIS and referenced in the table.

d. N/A (Not applicable). No requirements for the statute, Executive Order or other environmental requirement for the current stage of planning.

2. NEED FOR AND OBJECTIVES OF THE ACTION.

2.1 STUDY AUTHORITY. The study of small craft navigation needs in the Hilo Area was performed under Section 144 of the Water Resources Development Act of 1976, which authorized the Corps of Engineers in cooperation with the State of Hawaii and County of Hawaii to study methods to develop, utilize and conserve water and land resources in the Hilo Bay area including the consideration of the need for navigation facilities, enhancement and conservation of water quality, enhancement and economic and human resources development. The Corps of Engineers has studied the need for small craft navigation at the request of and in cooperation with the State of Hawaii, Department of Transportation, Harbors Division.

2.2 PUBLIC CONCERNS. The public has expressed the need for: (a) small craft facilities, (b) launch ramps and harbors to increase navigation safety along the Puna Coast, (c) boat haul-out and maintenance facilities, (d) fish processing and marine stores and other support facilities, (e) reducing travel time from Hilo to the Puna fishing grounds, by locating the facility near the fishing grounds. The needs of the commercial fishing community are addressed in the Kumukahi Small Boat Harbor Report.

2.3 PLANNING CONSIDERATIONS. The following considerations for small craft navigation improvements were derived from the consideration of public concerns, and management needs expressed during public and agency coordination of the project.

a. Provide appropriate facilities to meet the needs of recreational boaters who use 25 to 40-foot power or sailing craft.

b. Locate new facilities so that small craft have less distance to travel to launch or to take refuge in case of emergency.

c. Improve commercial fishing opportunities (see Vol 4, Hilo Comp Study).

d. Minimize environmental modifications to terrestrial and marine environments.

e. Minimize potential natural hazard damages or losses.

f. Protect significant archaeological and historic sites.

g. Improve socio-economic opportunities for the people of East Hawaii.

h. Increase or maintain recreational diversity.

3. ALTERNATIVES, INCLUDING THE PROPOSED ACTION.

3.1 PLANS ELIMINATED FROM FURTHER STUDY.

a. The Study included the districts of South Hilo and Puna within the Hilo Area Comprehensive Study, and the search for possible harbor sites has covered the entire coastline from Hilo to Kalapana. Sites selected for closer inspection were chosen based upon geological features that offered natural protection along the shoreline, the availability of land at low costs, i.e., public lands or lands where landowners expressed interest in supporting a harbor, and a preliminary estimate on construction costs. Based on this evaluation Kapoho and Pohoiki sites were eliminated from further study. Kapoho was a sheltered embayment which had a relatively large community along the shoreline. At a public meeting residents and the principal landowner objected to the construction of a harbor at the site. Since the land was privately owned, further investigations of the site were terminated due to lack of landowner support. Pohoiki, the site of the Pohoiki launch ramp, was considered because the area appeared to offer the opportunity of constructing a harbor using breakwaters with a minimum of inland excavation. However, the water depth forced the siting of a breakwater near shore with extensive inland excavation. Since the harbor would also destroy a surfing site, a plan to construct the harbor entirely by excavation from the shoreline was evaluated. Due to the topography, the harbor would have had to be excavated from lava rock raising to a height of 20-35 feet above sea level. The large amount of rock that would have to be removed in order to build the harbor would have resulted in extremely high construction costs. Thus, the site was eliminated from further consideration. Berthing for commercial fishing vessels is covered in Volume 5 of the Hilo Comprehensive Study.

b. Launching Ramps: The construction of boat launching ramps in the Puna and South and North Hilo Districts is being studied under small project authorities, and is not a part of this draft environmental impact statement. Boat launching ramps are incorporated into the harbor design. However, boat launching ramps as an alternative to the harbor did not meet the projected need for wet storage of 25- to 40-foot craft, for protected anchorage and for the growth of recreational boating in the project area. The launch ramp would satisfy only part of the project objectives and would not provide for larger vessels which cannot be trailered.

c. Dry Storage: This alternative consisted of providing a large land area to store boats and a shoreside dock crane or launch ramp to place the boats in the water. Operation of dry storage could not handle the 25- to 40-foot design vessels, but could more appropriately accommodate smaller recreational craft.

3.2 WITHOUT CONDITIONS: Presently the only berthing or mooring facilities for large sailing vessels (over 25 feet) are the 16 mooring Buoys in Reeds Bay, provided by the State Department of Transportation. Larger vessels (over 25 feet) must anchor in Radio Bay or Hilo Harbor at the mouth of Reeds Bay because Reeds Bay is too shallow for deep keels. These vessels are not protected from wind generated waves, and constitute a hazard to other vessels operating in the habor basin. The State has no plans for other berthing facilities for the Hilo area which would accommodate these vessels.

3.3 PLANS CONSIDERED IN DETAIL:

a. Plan A - This plan is the original plan contained in the 1963 Survey Report for the Coast of the Hawaiian Islands, and later authorized by Congress. The plan calls for an entrance channel dredged to -12 feet MLLW, with a protective breakwater approximately 900 feet long extending eastward from the existing shoreline. The berthing area would be large enough to accomodate approximately 270 boats.

2798.11

b. Plan B - This plan is a new design, consisting of an entrance channel dredged to -13 feet MLLW with a revetted mole approximately 1400± feet long protecting the berthing area. The turning basin and berthing area are to be dredged to a depth of -12 feet MLLW and are to have a capacity for 100 boats.

3.4 COMPARISION OF ALTERNATIVE IMPACTS: See Table 3

TABLE 3. COMPARISON OF ALTERNATIVE IMPACTS

Resource	Base Condition	Plan A	Plan B
Recreation			
Beach Parks	Mooheau Park eroding	No effect	No effect
	Bayfront Park eroding canoeing	"	"
	Wailoa River Park	"	"
	Liliuokalani Gardens and adjacent areas	"	"
	Coconut Island	"	"
	Banyan Drive shoreline	"	"
	Reeds Bay swimming	"	"
	Baker's Beach	"	"
	Radio Bay	"	"
	Radio Bay Park	"	"
	Hilo Breakwater fishing	No effects	No effect
Surfing	Coconut Island area	No effect	No effect
	Wailuku River Mouth	"	"
	Tip of Hilo Breakwater	"	"
Fishing	Hilo Breakwater	No effect	No effect
	Shoreline areas	Adds new breakwater to shoreline	Adds new breakwater to shoreline

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TABLE 3. COMPARISON OF ALTERNATIVE IMPACTS (Contd)

Resource	Base Condition	Plan A	Plan B
Boating	Wailoa River shoaling	No effect	No effect
	Radio Bay	"	"
	Reeds Bay	Add new boat harbor	Add new boat harbor
Natural Hazards			
Volcanic	High risk	No effect	No effect
Tsunami	Very high risk	Increase potential damages.	Increased potential damages.
Endangered Species			
Humpback Whale (endangered)	No critical habitat in Hilo harbor, seasonal migration offshore.	No jeopardy	No jeopardy
Hawksbill Turtle (endangered)	No critical habitat, but seen in Hilo harbor.	No jeopardy	No jeopardy
Green Sea Turtle (threatened)	No critical habitat seen in Hilo harbor possibly foraging.	No jeopardy	No jeopardy
Hawaiian Coot (endangered)	Two nests in Waiakea Pond	No effect	No effect
Migratory Waterbirds			
Ducks	Winter population in Waiakea Pond.	No effect	No effect

TABLE 3. COMPARISON OF ALTERNATIVE IMPACTS (Contd)

Resource	Base Condition	Plan A	Plan B
Estuaries			
Waiakea Pond		No effect	No effect
Wailoa River		No effect	No effect
Wailuku River		No effect	No effect
Terrestrial Area	None	None created	None created
Marine Resources			
Blonde Reef	16% coral cover, 220 acres.	No effect	No effect
Coconut Island Reef	10% coral cover 40 acres.	No effect	No effect
Fishery Resources	Recreational value high. Number of fish species high.		No effect
Water Quality	Data incomplete to compare with State Water Quality Standards.	Increase in petrochemicals and other boating related contaminants	Increase in petrochemicals and other boating related contaminants
	High salinity gradient.	No effect	No effect

TABLE 3. COMPARISON OF ALTERNATIVE IMPACTS (Contd)

Resource	Base Condition	Plan A	Plan B
Water Quality (Contd)	High turbidity, high nutrient concentra tion.	No effect	No effect
	High sedimentation in Hilo Bay Low sedimentation in Reeds Bay	No effect on sedi- mentation rates.	No effect on sedimentation rates.
	Pollution discharges terminated.	No pollution dis- charges.	No pollution discharges.
Sediment Quality	Sediments contami- nated with Arsenic, PCB and Pesticides. in Hilo Bay	No change	No change
Ocean Dumping	Approved site available.	Unknown at this time.	Unknown at this time.
Historic Properties Hilo Breakwater	Hilo Breakwater eligible for in- clusion to National Register of Historic Places.	No effect.	No effect.
Discharge of Fill or Dredged Material	Not applicable.	Unknown, not specified in authorizing document.	48,000 tons of stone for breakwater, including dredged material.

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4. AFFECTED ENVIRONMENT.

4.1 ENVIRONMENTAL CONDITIONS.

a. Hilo is the capital and business center of the County of Hawaii. The 1980 population of Hilo was 42,320 (State of Hawaii, 1980), and continues to grow at a slow rate in comparison to the Kona side (western side) of the island. Hilo is considered a mildly depressed area with disproportionately higher unemployment than the State and has one of the lowest visitor counts in a State where tourism is a major industry. Hilo's principal industry is sugar production, which is stable but not growing. The principal employers in Hilo are government, services and trades. The city of Hilo is situated along the shoreline of Hilo Bay and is a fully developed urban area. A University of Hawaii extension campus is located in the city together with the main county hospital, modern shopping centers and a variety of other commercial establishments. Hilo Harbor is the principal port-of-call and handles the most of cargo, agricultural and petroleum shipments in the County.

b. Hilo Bay shoreline is developed park open space as a result of local land use zoning in the tsunami hazard area. Residences are located along Baker's Beach and on Waiakea Peninsula along Banyan Drive. The developed nature of the shoreline and the high urbanized nature of the area precludes significant vegetation and wildlife habitats, except in Waiakea Pond and Wailuku River. The breakwater, Wailoa and Wailuku Rivers, and groundwater seepage into Hilo Bay are the principal factors influencing water quality in the bay. The breakwater traps freshwater discharged into the bay and reduces water circulation and exchange creating a significant salinity gradient in the bay. Sediment, cane and vegetation trash carried into the harbor by the tributaries discourage water contact recreation in the bay. Boating, recreational fishing, canoeing, and surfing are the significant water contact recreational activities in the bay. Commercial fishing in the bay has declined although the principal commercial fishing facility in the region is located at Suisan Harbor in the mouth of the Wailoa River.

4.2 SIGNIFICANT RESOURCES.

a. Recreation. Recreation occurs all along the bay shoreline. Mooheau and Bayfront beach parks extend along the bay shoreline from the Wailuku River to the Wailoa River. There are both small boat berthing and open space recreation in Wailoa River Park. Liliuokalani Gardens and Coconut Islands provide open space along the Waiakea Peninsula. Reeds Bay and Baker's Beach are swimming areas relatively free of trash from the Wailuku and Wailoa Rivers. Radio Bay is used for berthing of large recreational craft and the Radio Bay Park provides additional open space within the harbor area. Hilo Breakwater is a popular fishing site, despite signs warning fishermen of the hazardous conditions on the breakwater. The breakwater is frequently overtopped during high surf conditions, and waves can sweep fishermen from the breakwater. Recreational fishing is the most significant recreational activity in the bay. Fishermen use every location in the bay as a fishing site, including the harbor facilities. Boating and canoeing are also important recreational activities together with wading. Swimming is not a major recreational activity, possibly due to the highly turbid waters, and the trash in the water and on the shoreline. Five surf sites in the bay were identified by Kelly, 1981 (See Appendix B for details).

b. Natural Hazards.

(1) Volcanic Hazards. Hilo is located in a high risk volcanic area exposed to lava flow threats, earthquakes and subsidence (See Appendix B). The risk generally decreases with distance from the northeast rift zone of Mauna Loa volcano. During the past 15 years the island of Hawaii has experienced 11 earthquakes with Richter magnitude ratings of 6 or more. The most recent in 1975 resulted in an estimated $4 million dollars of damage island wide. Most lava flows from Mauna Loa have stopped short of the Hilo suburbs. Public fears of volcanic damages and losses are still significant. At the present time, the Corps of Engineers is seeking Congressional authorization at the request of the State of Hawaii to react to threatening lava flows under emergency conditions.

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(2) Riverine and Tsunami Flood Hazards. Hilo is subject to riverine flooding principally due to high intensity rainfall and surface runoff in undefined drainage ways. The flood prone areas are located within the Alenaio Stream floodplain, which is a tributary to the Wailoa River. Hilo is also subject to tsunami flood hazards. The tsunamis of 1946 and 1960 were particularly destructive resulting in the loss of 234 lives and about $52 million in property damage. After the 1960 tsunami, vulnerable waterfront areas were rezoned to open space, such as the Bayfront and Wailoa River Parks, and structural design regulations were imposed in order to reduce tsunami damages. The Reeds Bay area is located within the tsunami flood hazard area.

c. Water Quality.

(1) Hilo Bay inside the breakwater is classified as an embayment with Class A waters according to the State of Hawaii water quality standards of 1979. It is the objective of this class of waters that their use for recreational purposes and aesthetic enjoyment be protected. There are nine parameters whose standards are applicable to Hilo Bay. The geometric means of three parameters did not meet State standards, and three others exceeded the maximum values specified in the standards during the 1980 study done for the Corps by M&E Pacific, Inc. (Table 4).

(2) In general, water inside and outside the breakwater is vertically stratified due to the discharge of ground and riverine water into the ocean. The salinity gradient inside the harbor is greater than that outside due to the reduced mixing behind the breakwater. The depth of the freshwater layer in the bay reaches 20 feet indicating that mixing is occurring between surface and bottom layers, but not sufficient to reduce the salinity gradient. The depth of freshwater on Blonde Reef reaches 10 feet inside the breakwater. The primary water column mixing forces are wind and occassional ship traffic. Nutrient concentrations and suspended solids and turbidity vary with the volume of surface runoff and groundwater discharge entering. Fecal strep bacteria tend to survive longer in the bay due to the freshwater layer in the bay than other areas in the State. Chlorophyll-a concentration vary with water turbidity increasing during periods of low riverine flow and decreasing during periods of high flow. Water temperature in the surface layer is warmer

than the bottom layer due to solar heating, but is colder near the source of groundwater discharge. During periods of low freshwater discharge, solar heating can warm the bottom layer because the depth of the freshwater layer is reduced.

(3) Estuaries. Reeds Bay, Waiakea Pond, Wailoa River and Wailuku River are estuaries within the Hilo Bay and Harbor area. Approximately 1000 mgd of freshwater are discharged into the harbor from the tributaries and spring. The estuaries are important recreational fishing areas within the bay and are planned for open space. The land around Reeds Bay, Wailoa River and Waiakea Pond are planned by the local government for park use, and Wailuku River is planned as a natural wilderness area.

d. Sedimentation and Sediment Quality. The sediment in the Hilo Bay consists of silty-clays. The low wave energy environment behind the breakwater allows much of the water-borne sediment to settle out in the harbor and on Blonde Reef where the sediment is smothering and destroying the reef ecosystem. The rate of sedimentation may be slow based upon the frequency of maintenance dredging in Hilo Harbor -- once every ten years. In 1977, about 54,000 cubic yards of material were removed from the harbor during the maintenance cycle and the material was disposed of by ocean dumping at the EPA approved Hilo ocean disposal site. However, about 35,000 tons of silt per year are deposited in the bay from the Wailuku River, the quantity may be less than in the past, because a 1881 lava flow, covered up erodible soils within the Wailuku River drainage basin and the discharge of 20,000 tons of sediment a year from the Wainaku Sugar Mill was terminated in 1976. Based upon sediment analysis by the State Department of Health, Hilo Bay sediments are contaminated with arsenic, PCB and chlordane. Arsenic trioxide was discharged into Waiakea Pond by the Canec Plant during the 1930's to the 1960's and served as a wood preservative and termicide. The PCB's probably orginated from the Shipman Power Plant near the Wailoa River. Chlordane probably occurs due to agricultural activities and use as a termicide in home construction in Hilo. The sediments in Reeds Bay are expected to contain similar concentrations of contaminants.

TABLE 4
COMPARISON OF AMBIENT WATER QUALITY
OF HILO HARBOR WITH WATER QUALITY STANDARDS
(Adapted from M&E Pacific, Inc. 1980)

Parameter	Geometric Mean Ambient Water Quality (March-June 1980)	Geometric Mean Water Quality Storm Period March 18, 1980	State Water Quality Geometric Mean	State Water Quality Maximum Value
pH	8.12	7.86	*	*
Temperature (°C)	23.4	21.6	**	**
Dissolved Oxygen (mg/l)	7.07	7.61	***	***
Suspended Solids (mg/l)	7.9	18.7	25	50
Turbidity (NTU)	1.55	7.42	1.5	5.0
Total Kjeldahl Nitrogen (Ug N/l)	166.3	232.1	200	500
Nitrate + Nitrite Nitrogen (ug N/l)	19.7	34.9	8.0	35
Chlorophyll-a (ug/l)	0.79	-	1.5	8.5
Total Phosphorus (ug/l)	30.0	17.8	25.0	75.0

* ±.5 from 8.1
**Not more than 1°C from ambient conditions
***Not less than 75% saturation

TABLE 5

Contaminant Concentration in Hilo Harbor Sediments.

Total Arsenic concentration: Range from 33-104 ppm

PCB concentration: a mean value of 200 ppb

Chlordane concentration: a mean value of 2-84 ppb

Source: State of Hawaii 1978

Tests of crab and fish tissue indicate that arsenic and PCB are not bioconcentrating in the tissue. Fish viscera contained chlordane residue in concentrations 3-4 times higher than the flesh, where concentrations ranged from 80-160 ppb.

e. Ocean Disposal Site for Dredged Material. In 1981, the US Environmental Protection Agency designated a permanent ocean disposal site for dredged material of Hilo Harbor. The site is located 8 miles northeast of Hilo Harbor in ocean depths ranging from 330 to 340 meters. The surface currents in the area ranged in velocity from 15 to 36 cm/sec in a predominantly northwesterly direction. The bottom sediment was silty clay, and the site is also located outside of the major commercial fishing grounds.

In 1977, about 54,000 cubic yards of dredged material from Hilo Harbor were discharged at the dump site. In 1962, approximately 85,000 cubic yards of dredged material were removed from Hilo Harbor and disposed of in the ocean offshore from Hilo.

TABLE 6

EPA Dredged Material Disposal Site for Hilo Harbor

Location: Center Point Latitude 49° 48' 30" N
Longitude 154° 50' 30" W

Size: Circular with radius of 1,000 yds (approximately 920 meters)

Primary Use: Dredged Material

Period of Use: Continuing use

Restriction: Disposal shall be limited to dredged material

Source: Federal Register, (46)115: June 16, 1981 (31412).

f. Air Quality. Air quality in Hilo is good, lacking major industrial emissions. The sulfur dioxide concentration in 1980 was less than 5 micrograms per cubic meter. Volcanic gases, agricultural fires, sugar mills, both aircraft and automotive engines and the power plant are the only major sources of air pollution in the Hilo area.

g. Noise. Hilo is a quiet urban area with the exception of aircraft landing and taking off from Hilo Airport, the aircraft landing pattern takes aircraft over the bayfront area.

h. <u>Historic Resources</u>. The Hilo Breakwater was determined to be eligible for inclusion to the National Register of Historic Places by the Keeper of the Register in 1980. The Keeper of the Register indicated that the breakwater was significant to Hawaii Island commerce and transportation for the vital role that it played in the development of the port of Hilo, the historic main port of entry for the island of Hawaii, and that the breakwater has retained its essential physical integrity despite alterations to its original design, function and visual appearance. There are no Historic Resources in Reeds Bay.

i. <u>Marine Resources</u>. The two important marine areas within the bay are the areas with the greatest coral cover, Blonde Reef (16% coral cover) and Coconut Island (10% coral cover). Both the live and dead coral mass on Blonde Reef and at Coconut Island provide habitat for a variety of reef fish important to recreational fishing in the bay. Commercial fishing in the bay has declined, but the sale of the catch occurs at Suisan Harbor and fish market at the mouth of the Wailoa River. Fishermen suggest that fish stocks are declining due to over-exploitation, sedimentation and chemical pollution. However, exact factors affecting fish abundance have not been determined, although, high water turbidity reduces spear fishing success and sedimentation can bury fish shelter and food resources reducing the amount of nearshore fish habitat. Nehu (tuna fishing bait fish) resources have declined and are insufficient to support a fishing fleet. Principal nehu catch areas are located within the commercial port.

j. <u>Endangered Species</u>. The endangered humpback whale seasonally migrates through waters outside of Hilo Harbor. The whales begin to appear in November and leave the islands by the end of June. The greatest number of whales in the islands appear during February and March. The National Marine Fisheries Service indicates that no whales have been sighted inside Hilo Harbor. Data indicate that the whales concentrate at Upolu Point in northern Hawaii, and suggest that the Hilo Harbor area is not a calving, nursing and breeding area in the Hawaiian Islands. The endangered hawksbill turtle and the threatened green sea turtles have been observed in Hilo Harbor, but no nesting grounds exist in the harbor and no seasonal aggregations in the harbor have been reported. The green sea turtles are also reported by the US National Marine Fisheries to forage along the entire coastline from Hilo to Kalapana. It is doubtful if the turtles enter Reeds Bay due to the depauperate algae crop.

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The endangered Hawaiian coot was reported nesting in Mouholi Pond within Waiakea Pond. The pond has not been declared a wildlife refuge or critical habitat for the coot by the US Fish and Wildlife Service.

5. ENVIRONMENTAL EFFECTS.

5.1 Social. The improvements will not alter Hilo's population growth or influence its existing economic trend. No people, farms or businesses will be displaced.

5.2 Recreation. The construction of a new breakwater by implementation of either plan will provide an increase in the number of fishing sites in the Bay. In spite of the hazards associated with fishing from breakwaters, they are very popular fishing spots. Either plan will contribute to recreational boating by providing a sheltered harbor, but Plan A will provide over twice as many berths, but designed for smaller boats. Neither plan will have an effect on surfing, canoeing, or use of the many parks along the Hilo coast, except Reeds Bay. Plan A will have an adverse effect on the Reeds Bay beach, a very popular swimming site, and may effect Cold Pond, another popular swimming area at the inlet end of Reeds Bay. Neither plan will have an effect on the erosion along Hilo Bayfront Beach, but may effect erosion at Bakers Beach by changing the littoral drift slightly.

5.3 Natural Hazards.

a. Volcanic Hazards. Neither of the plans increase volcanic hazard risks.

b. Tsunami and Riverine Flood Hazards. Neither of the plans affect riverine flooding along the Alenaio Stream floodplain, nor tsumani run-up elevations. With increased boats in the bay, potential damages could increase.

5.4 Water Quality.

a. Both plans involve dredging and a temporary increase in water turbidity as a result of dredging. The impact is a cumulative impact which adds to the stress already created by the influx of sediment from the tributaries entering Hilo Bay. Usually the color of the water returns to normal within a day after

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each dredging operation, but transmissiometer and visual underwater observations indicate that fine sediments remain in suspension longer obscuring underwater visibility. The duration of dredging is used as a gross indicator of the extent of turbidity change anticipated. Neither of the plans affect the amount of sediment carried into the harbors, nor the current patterns in the bay.

b. Reeds bay has a thin layer of Hilo Harbor silts over a series of thin recent basalt flows. A cutter type dredge will probably be required. Transporting the dredged material by barge to the disposal site may result in highly turbid plumes between Reeds Bay and the disposal site. These plumes are not expected to damage the open ocean resources, but may cause stress on Blonde Reef both inside and outside the Hilo breakwater.

c. Sedimentation and turbidity stress related to dredging are dependent upon the characteristics of the material being dredged, the type of dredge used, and the direction and strength of water currents in the dredge area. The material dredged from Reeds Bay is expected to consist of silty-clays from the existing harbor channel and basin, and basalt from the underlaying lava . Blasting may be required. A suction dredge with barge and a mechanical dredge, clam shell or dragline, have the potential of increasing suspended sediment load, turbidity conditions, and siltation stress because water turbulence and water draining from the bucket and barge can wash dredged material into the bay. Hydraulic suction dredges combined with land disposal of dredged spoils create the least amount of water turbidity since material and water are drawn from the bottom and pumped to a retention pond where sediment is allowed to settle out of the water. Leaks from the pipelines and physical disturbance of the bottom are primarily responsible for turbid plumes associated with hydraulic dredging. The material previously dredged from Hilo Harbor during the 1977 maintenance dredging consisted entirely of silty-clay; 50% of the material had a grain size smaller then 0.010 millimeters. While most of the silty-clay material dredged may be plastic and cohesive, some loose fine material can be washed into the water where the material can remain in suspension for a considerable length of time. For example, a particle with a grain size of 0.10 can take about 33 minutes to settle 1-foot in the absence of strong currents. Dredging on rock can create fine silt particles, but most of the material will probably be coarse to medium size material with large grain sizes that can settle out quickly. For example, particles with grain size in the range of 5 to 1 mm can settle 1-foot in 0.3 to 3 seconds. Much of the fine material suspended by dredging on hard substrates is usually material which has settled out from the water column. Drogue studies (Reference M&E Pacific, 1980) indicate that water currents will carry turbid water from the commercial harbor out to the harbor mouth. The period of stress will vary depending on the length of time required to complete the dredging, and can be aggravated by rainfall induced turbidity. Periodic severe rainstorms impart similar sediment stresses in Hilo Bay because large amounts of sediments can be discharged from rivers and streams entering the Bay.

5.5 Sediment Quality. Neither of the plans will improve or further degrade sediment quality. The removal of possibly contaminated sediments may temporarily improve conditions in the bottom for infaunal organisms, but the continued movement of possible contaminants from inland and upland sources into Reeds Bay and the movement of potentially contaminated sediments into Hilo Bay and then into uncontaminated areas will maintain existing conditions in the bay sediments over the long term.

5.6 Estuaries. Neither of the plans involves work in the Wailuku or Wailoa Rivers. Reeds Bay estuary will not be modified significantly and due to the depauperate biota, a significant impact is not expected.

5.7 Ocean Disposal.

a. The probable impacts of ocean dumping are discussed in the Corps of Engineers, "Final Environmental Impact Statement Harbor Maintenance Dredging in the State of Hawaii," 1975, and the US Enviromental Protection Agency, "Final Environmental Impact Statement for Dredged Material Disposal Site Designation," 1980. In summary, the dump site has a silty-clay over lava substrate and is dominated by a polychaete infauna. Generally the level of biological activity is lower than in shallower coastal waters, however, this site is the most productive of any Hawaii dredge spoil site. The site is not a significant commercial fishing ground. The water depth and coastal currents provide significant dilution and dispersion of the dredged material. Agitation of the dredged material in the water column may create a temporary nutrient increase and a temporary depression in dissolved oxygen concentrations. Short-term biostimulation may occur, together with mounding and faunal shifts on the bottom. Suspended sediment load and water turbidity will temporarily increase. Some plankton may be entrapped in the sediment falling through the water column. The material deposited on the ocean bottom will smother some organisms, but repopulation is anticipated. Toxic effects and pollutant accumulation are possible, and bioassay and bioaccumulation tests performed prior to disposal will be used to assess the effects of the material on test animals. In accordance with US Environmental Protection Agency regulations, bioassay and bioaccumulation tests on the dredged material will be performed and the results submitted to EPA for their review and approval of the ocean dumping activity. The tests are designed to predict toxic effects of the dredged material on organisms representative of the dump site and any bioaccumulation which might occur. If necessary, EPA may proscribe treatment dilution or other precautions if the tests indicate the disposal material would result in significant toxic effects. However, the use of representative organisms does not accurately predict conditions and consequences which may occur in the actual deep ocean environment where organisms and environmental conditions are poorly studied and not well documented or researched.

b. State Department of Health analysis of sediment samples from Hilo Bay suggest that dredged material from the silty environment contain high concentrations of arsenic, PCB and chlordane. The results of bioassay and bioaccumulation analysis may find the material unsuitable for ocean dumping in accordance with EPA criteria. However, the presence of the pollutants may also make it unsuitable for land disposal. If so, the material may have to be either mixed with non-toxic material to dilute its toxicity, packaged prior to disposal, incinerated, biologically or chemically treated, or discharged into the ocean at a low rate to allow adequate dilution. In the aquatic environment, the pollutants, especially heavy metals, are in a stable physiochemical environment not subject to wide variations in pH or reduction-oxidation (redox) potential. Thus, the pollutants tend to be bound to the sediments and not readily available for biological uptake. When sediments are stirred up either by wave energy or dredging, the concentrations of pollutants initially increase, but rapidly decrease as the materials are oxidized.

5.8 Upland Disposal. The majority of the material dredged may be suitable for use as fill in the new breakwater. If any material is determined to be

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unsuitable, upland disposal may be considered. In upland disposal sites, the dredged material can undergo wide changes in pH and redox potential, and pollutants are readily released from the material. The presence of the pollutants can toxify the soil, preventing the growth of plants or limit the availability of other nutrients needed for plant growth. The pollutants can also be leached from the soil into the groundwater where they can possibly be conveyed into coastal waters by spring water or into subsurface drinking water sources. Plants may be able to bioconcentrate some of the pollutants, possibly removing the pollutants from the soil and limiting their availability in the environment. Initially soil salinity of the dredged spoil will prevent the growth of plants, except for those with a high salt tolerance. The salt will be leached from the material by rainfall, eventually permitting the growth of some vegetation. Because of the potential adverse environmental effects, a suitable land disposal site should not be adjacent to potable groundwater sources and should not be in agricultural use if the material to be disposed of is potentially toxic. Erosion control methods will have to be employed to keep the material within the disposal site. If the dredged material is found to have significant amounts of toxic material that could form leachates, disposal may require use of an approved hazardous waste disposal site. No such sites are in Hawaii. Leachate tests will have to be performed on the contaminated dredged material to determine the potential of toxic materials leaching from the material. In Hawaii, leachates can percolate through the porous volcanic material and enter the groundwater, possibly contaminating drinking water sources or municipal water supplies. Encryptment, impervious linings and locating the disposal site close to the shore where the groundwater is unsuitable for drinking may be alternatives used in land disposal. Some of the material dredged may be suitable for use as fill in the new breakwater.

5.9 Air Quality. Neither plan has the potential for affecting air quality. The dredged material may be a source of dust if used for fill until the area is covered with stones. The only habitated areas that will be affected are the homes at Baker's Beach and the hotels along Banyan Drive.

5.10 Noise Quality. Neither of the plans will result in a long-term increase in noise. The operation of equipment and possible blasting in the construction of the breakwaters and dredging and filling will be temporary noise sources. The duration of construction is a gross measure to the extent of the noise pollution. (See Water turbidity, Table 2.) The only habitated area which will be affected is the homes along Baker's Beach and the hotels along Banyan Drive.

5.11 Historic Resources. There are no sites listed or elegible for inclusion in the State or National Register of Historic Places identified in the Reeds Bay project area.

5.12 Marine Resources.

a. Dredging in Reeds Bay should not be extensive since much of the bay is already -12 feet Although benthic organisms will be destroyed in areas dredged, the fauna is depauperate and impact will be minimal. Recolonization by similar organisms is expected from other bay populations in a relatively short time.

b. During dredging, an artificial feeding situation will develop as predatory fish move in to exploit food resources displaced, exposed, or stirred up by the dredging activities. Because of the depauperate fauna and reduced dredging requirement, this phenomenon may not occur. If it does occur, fishermen will be attracted to the site and should experience increased catches.

c. The outflow of freshwater from Reeds Bay will carry silt raised by dredging into the main portion of Hilo Harbor, stressing organisms in areas removed from the dredging site. Due to the generally depauperate fauna in the inner harbor, this is not expected to be a serious impact.

5.13 Endangered Species.

a. Endangered humpback whale. Neither of the plans will affect the migratory route of the humpback whale, or any critical whale calving, nursing or breeding areas in Hawaii. Ocean disposal of dredged material would occur in offshore waters used by the whales. If the dumping was conducted during the migratory season, the dumping would not hinder whale movement through the area. The operation of the conveyance vessel would create underwater sounds which the whales may find unpleasant, but should not affect their migration.

In Glacier Bay, Alaska, the operation of tour boats averaging about 100 tons displacement appeared to interfere with whale feeding and possibly their use of the area. However, during their migration through Hawaiian waters, the whales are not known to feed and are not confined in an embayment.

b. Endangered hawksbill turtle and threatened green sea turtle. Neither of the plans would affect turtle nesting areas or areas of turtle aggregations in Hawaii. The plans would not eliminate foraging area along the coast outside of Hilo Harbor, or within the harbor, and may add foraging resources on the breakwater.

c. Endangered Hawaiian Coot. Neither of the plans involves modification of Waiakea Pond where the endangered Hawaiian Coot was reported nesting.

5.14 Blasting. Blasting will be required to facilitate dredging the rock underlying the thin sediment layer in the entrance channel and turning basin. If blasting becomes necessary, the Contractor shall submit a blasting plan which must be approved by the Corps of Engineers Contracting Officer. This plan shall contain the details of the blasting operations. General blasting related impacts are discussed below.

a. Blasting Noise. Detonation of the blasting agent will generate noise. The sound level will depend on the amount and kind of explosive used, the water depth over the charges and the distance of the observer from the blast. If a detonating cord is used to initiate detonation of the blasting agent, an audible air-shock wave will be created. The Contractor will be required to comply with all applicable State or local noise control regulations.

b. Ground Vibration. Ground vibration or seismic motion typically accompanies all detonations. The vibrations may or may not be perceptible depending on several factors, such as the geology of the site; the weight of explosives per delay; and the distance to structures and observers. The seismograph is used universally to measure vibratory motion. According to Corps safety and health requirements, when a blast is planned that would have a scaled distance less than 50, a 3-component seismograph will be required to monitor vibration levels. Scaled distance is a function of the distance from

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the nearest structure to the blast site and the maximum weight of explosives per delay as follows:

$$S = \frac{D}{W^{1/2}}$$

Where: S = Scaled distance ft/lb$^{1/2}$
D = Distance from nearest structure to blast site, feet.
W = Maximum weight of explosives per delay in pounds.

This formula will be used to determine the maximum explosive weight allowed per delay. If vibration levels are kept below 2 IPS (inches per second), no damage to structures is anticipated. If below 0.2 IPS negative reactions from nearby residents will be minimized.

c. Dust and Flyrock. No dust or flying particles are expected since the blasts will be under water and particulate matter will be contained by the water column if the charges are small.

d. Smoke and Odors. No smoke or odors from blasting are anticipated.

e. Marine Environment. The biota of Hilo Bay in the area of the entrance channel and turning basin is depauperate, with very little topographic relief and a silty/sand bottom. No significant damage to fish or other marine organisms used by man is expected.

f. Safety. The Contractor will be required to conduct his blasting operations in accordance with the blasting plan approved by the Corps Contracting Officer, Engineer Manual 385-1-1, Safety and Health Requirements Manual, and State Occupational Safety and Health Standards.

6. PUBLIC INVOLVEMENT

6.1 PUBLIC INVOLVEMENT PROGRAM. The public involvement program has consisted of meetings and workshops with the public at large, meetings and workshops with members of the Federal, State, and County agencies, and the distribution of various reports and documents resulting from studies conducted under the

Hilo Area Comprehensive Study to the public and agencies concerned with the progress of the study. In total, 10 public meetings were held including the initial public meeting in 1976, and eight technical studies have been released to the public. Tsunami hazards were the most frequent concern expressed by the public and the agencies. Surge (ship motion) in Hilo Harbor was the most frequent problem mentioned for deep-draft navigation, and beach restoration of the Bayfront beach was the most frequent recreational need.

6.2 REQUIRED COORDINATION. The following coordination must be completed with the following agencies:

a. Coastal Zone Management Act. Prior to Plan implementation, a Federal Consistency determination would be prepared by the Corps and concurrence would be requested from the State of Hawaii, Department of Planning and Economic Development, Coastal Zone Management Office.

b. Endangered Species. Coordination with the National Marine Fisheries Service will continue concerning the possible ocean disposal of the dredged material under the Marine Protection, Research and Sanctuaries Act, and the possible effect of blasting on the threatened Green turtle and the endangered Hawksbill turtle under the Endangered Species Act.

c. Marine Protection, Research and Sanctuaries Act, (Ocean Dumping Act). Bioassay and bioaccumulation test procedures need to be developed and approved by US Environmental Protection Agency, and the tests performed prior to ocean disposal of dredged material. The results of the test must be coordinated with the US Environmental Protection Agency, which will decide whether or not to permit the ocean dumping of the dredged material. A public notice of intent to dispose of the dredged material in the ocean will be released following the completion of the tests.

d. State and County Approvals. The State of Hawaii, Department of Transportation, is responsible for obtaining all necessary local permits and approvals and satisfying the requirements of Chapter 343, Hawaii Revised Statutes and EIS Regulations. The Federal EIS and CZM consistency request discussed the construction impacts and compatibility of the action to local coastal zone management policies, but did not address actions to be planned by the State.

6.3 STATEMENT RECIPIENTS. The following agencies and public-at-large will be sent copies of the draft environmental statement and survey report.

Federal Government

- US Advisory Council on Historic Preservation
  - Washington DC Office
  - Western Project Review Office
- US Environmental Protection Agency
  - Office of Environmental Review
  - Region IX
  - Pacific Islands Office
- US Army Corps of Engineers
  - Coastal Engineering Research Center
- US Department of Agriculture
  - Institute of Pacific Islands Forestry
  - Soil Conservation Service
  - Hawaii District Office
- US Department of Energy
- US Department of Commerce
  - Secretary of Environmental Affairs
  - National Marine Fisheries Service
    - Southwest Region Office
    - Pacific Program Office
  - Office of Coastal Zone Management
  - National Weather Service, Pacific Region
- US Department of the Interior
  - Office of Environmental Review
  - US Geological Survey, Hawaii Volcano Observatory
  - Secretary Field Representative, Pacific Southwest Region
  - US Fish and Wildlife Service
    - Regional Office
    - Pacific Islands Office
    - Endangered Species Coordinator
  - National Park Service
    - Office of Archaeological and Historic Preservation
    - Interagency Archaeological Service
    - Arizona Archaeological Center

Federal Government (contd)

Pacific Southwest Region Office
Hawaii State Office
US Department of Housing and Urban Development
US Department of Health, Education and Welfare
US Department of Transportation
Federal Highway Administration - no comment
14th Coast Guard District
Cape Small, Hilo
Federal Maritime Commission

State Government

Governor George R. Ariyoshi
Hawaii Congressional Delegation
Department of Planning and Economic Development - Clearinghouse
Department of Health
Office of Environmental Quality Control
International Tsunami Information Center
Department of Land and Natural Resources
State Historic Preservation Officer
Division of State Parks
Division of Fish and Game
Forestry and Wildlife Division
Land Management Division
Water and Land Development Division
Conservation and Resources Enforcement Division
Hawaii District and Agent
Board of Land and Natural Resources
Marine Affairs Coordinator
Department of Transportation
Highways Division
Harbors Division
Department of Accounting and General Services
Attorney General
State Department of Agriculture

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State government (contd)

Board of Agriculture
Public Utilities Commission
Hawaii State Library
Hawaii Island Branches
Department of Hawaiian Home Lands
Keaukaha School

County Government

Mayor Herbert T. Matayoshi
Hawaii County Council
Hawaii Legislative Delegation
Department of Parks and Recreation
Department of Planning
Planning Commission
Department of Public Works
Department of Research and Development
Department of Water Supply
County Fire Department
Department of Civil Defense

Organizations

Big Island Resource Conservation and Development Council
Big Island Casting Club
Association of Hawaiian Civic Clubs
Big Island Fish and Game Association
Conservation Council for Hawaii
Hawaii Island Chapter
Hale Consultants, Inc.
Hawaii Audobon Society
Hawaii Community College Library
Hawaii Electric Light Co.
Hawaii Island Board of Realtors
Hawaii Island Chamber of Commerce

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Organizations (contd)

- Hawaii Tribune Herald
- Hawaiian Civic Club
- Hawaii Leeward Planning Conference
- Hilo Transportation and Terminal Co., Inc.
- Hilo Trolling Club
- Hawaiian Paradise Park Corp.
- Hilo Sailing Club
- Life of the Land
- Kalapana Community Association
- Hilo Downtown Improvement Association
- Kailua Trolling Club
- Kawaihae Trolling Club
- Japanese Chamber of Commerce and Industry of Hawaii
- Kona Mauka Troller, Inc.
- Kona Yacht Club
- Mark's Boat Works
- North Hilo Community Council
- Moku Loa Sierra Club Group
- Matson Navigation Co.
- Puna Community Council
- Suisan Co.
- Save Our Surf
- University of Hawaii
  - Water Resources Research Center
  - Library
  - Environmental Center
  - Hawaii Institute of Marine Biology
  - Seagrant/Marine Advisory Program, Kona and Hilo Offices
- Young Brothers Inc.
- Wester Division Project Review, Lake Plaza South

Individuals

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- Mr. Dan Pakele
- Mr. Dave Soderland
- Mr. Edward Bumatay
- Mr. Herbert Mann
- Ms. Lei Keliipio
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APPENDIX A

404(b) (1) EVALUATION

A. DISCHARGE OF DREDGED OR FILL MATERIAL, REED'S BAY NAVIGATION IMPROVEMENTS, CLEAN WATER ACT, SECTION 404(b)(1), FACTUAL DETERMINATION.

1. Special Aquatic Areas.

Sanctuaries and Refuges: None.

Wetlands: None.

Mudflat: None.

Coral Reefs: None

Riffle and Pool Complex: None.

2. Human Use Characterization.

Municipal Water Supply: Not applicable.

Recreational and Commercial Fisheries: Hilo Bay supports a large recreational shoreline fishery, and fishing sites are located all along the bay shoreline, including within the discharge area. Recreational boaters possibly troll in the discharge areas. Common reef and nearshore coastal (neritic) fish are caught in the bay (see Attachment 1 for fish species list). The productivity of the fishery has not been measured, however, the fishery resource supports an estimated 2,100 local recreational shoreline fishermen, based on a 1972 survey (Hoffman and Yamauchi in Cheney, 1977). The State Division of Fish and Game indicated that 456 two-year permits for night fishing in the bay were issued between May 1975 and May 1976. Commercial fishing in Hilo Bay is no longer a significant industry. Effect: While the discharges will eliminate water area in the bay, the breakwater and fill structures will also provide new recreational fishing sites in the bay. The effect of the discharge of the rock used in constructing the breakwater will probably provide fish and intertidal habitat partially offsetting loss of fish habitat.

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Water-Related Recreation: Surfing, wading, swimming, canoeing and boating are significant recreational activities in Hilo Bay. Blonde reef is used by boaters and the Baker's Beach and Reeds Bay Beach areas provides open space, and wading and swimming opportunities. One surfing site in the bay is located at the tip of the Hilo Breakwater. Effect:

Base Condition	Plan A	Plan B
Boating	Breakwater fill removes less than 1 acre of open water from boating use, and creates new recreational boat harbor.	Breakwater removes less than 1 acre of open water from boating use, and creates a new navigation feature in the bay, and a new recreational boat harbor.
Wading, swimming and open space at Baker's Beach.	No effect	No effect
Reeds Bay Beach	Eliminates the beach	Minimal effect
Surfing at breakwater tip.	No effect	No effect
Cold Pond	No effect	No effect

Aesthetics: Hilo Bay's vista is dominated by the breakwater. Effect: The discharge will create visual elements in Hilo Bay.

National Monuments: None.

National Seashores: None.

National Wilderness Areas: None.

Research Sites: None.

National Historic Sites: None.

3. Physical Substrate Determination.

Size Gradation and Coarseness: The Reeds Bay discharge site substrate consists of mud overlying basalt lava layers. Effect: The discharge is associated with the construction of structures which will cover the substrate and raise the bottom elevations from below mean lower low water (MLLW) to about +8 feet above MLLW.

Compaction: Not applicable. The discharge involves the construction of breakwaters and the fill area to be protected and confined by a rock revetment.

Bottom Elevation/Contour: See table below:

Base Condition	Plan A	Plan B
Water depths at the discharge site.	-8 to -12'MLLW	-6 to -12' MLLW
Condition after the discharge. Breakwater crest elevation.	+8.5' MLLW.	+8.0' MLLW.

Material Movement: Baker's Beach and Bayfront Beach are presently eroding. Effect: No effect on Bayfront Beach. Either Plan may reduce littoral drift on Bakers Beach.

Deposition: Not applicable.

4. Water Quality, Circulation, Fluctuation and Salinity Determination.

Current Velocity, Direction and Pattern: Presently a predominant surface outflow occurs in the harbor along the breakwater due to the discharge of groundwater and riverine water into the bay. Drogue studies indicate that current velocities vary from 0.03 to 0.19 knots. The ocean water lies beneath the surface, freshwater layer, and its movement is tidal dependent with no set current direction. Effect: No effect from either plan.

Downstream Flow: Not applicable.

Normal Water Fluctuations: No estuarine tidal lags are evident in Hilo Bay and the discharge is not expected to interfere with normal tidal fluctuations.

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Salinity Gradient/Stratification: A salinity gradient is measurable in Hilo Harbor to a depth of 20 feet at the mouth of the harbor and 10 feet over Blonde Reef. The gradient is related to the amount of groundwater and riverine water discharged into the bay and the percent of freshwater in the surface layer can vary between 25% in the dry season to 75% following a storm event. Salinity measurements in the bay vary from 32-34 parts per thousand in the bottom layer and 11-30 parts per thousand in the surface layer. The formation of the salinity gradient is partially attributable to the breakwater which reduces wave energy as a water-column mixing force in the bay. Mixing is dependent upon wind and tidal forces, and ship traffic in the bay. Effect: Increased boat traffic in Reeds Bay may increase mixing, resulting in slightly altered salinity in Hilo Harbor.

Potability: Not applicable.

Water Physical Characteristics: Water chemical and physical characteristics in Hilo Bay are dependent upon riverine and groundwater discharges into the bay. Wastewater discharges into the bay were removed. Effect: No effect by either plan.

Pathogens/Biological Content: Fecal coliform mean concentrations (number per 100 ml) ranged from 10 to 239 and fecal strep mean concentrations ranged from 62 to 1480. The source of the fecal bacteria was the riverine and storm drainage discharges into Hilo Bay. Effect: Some increase may occur due to increased boating activities.

Eutrophication: Not applicable.

5. Suspended Particulate and Turbidity Determination.

Turbidity: The waters in Hilo Bay are highly turbid due to the discharge of suspended material from Wailoa River and other drainage ways into the bay. Turbidity usually increases with the volume of water discharged into the bay. Ship traffic and periodic maintenance dredging (once every 10 years) also contribute to normal turbidity levels in the bay. During the dry season, turbidity is considerably lower than the wet season. High chlorophyll-a and zooplankton concentrations are principal turbidity causing material during the dry season compared with inorganic sediment during the wet season.

	Storm	Wet Season	Dry Season
Turbidity (NTU, mean values)			
Surface	7.82-22.3	2.92-7.52	0.56-1.67
Bottom	4.9-7.65	3.65-9.15	0.69-2.20
Total Suspended Molds (mg/l, mean values)			
Surface	9.30-75.4	6.43-17.3	no data
Bottom	16.1-44.5	7.40-28.6	available

Source: M&E Pacific, 1980.

Effect: The discharge of rock to construct the breakwater in Plans 1 or 2 is not expected to result in a significant increase in turbidity.

6. Contaminant Determination.

Initial Evaluation:	Plan A	Plan B
a. The material proposed for discharge:	Basalt rock and dredged material from Reeds Bay	Basalt rock and dredged material from Reeds Bay
b. Source site:	Quarry and dredging from Reeds Bay	Quarry and dreding from Reeds Bay
c. Contaminants can flow into extraction site:	No	No
d. The material proposed for discharge was previously tested.	No	No
e. Can pesticides enter the extraction site.	No	No
f. Spills or disposal of contaminants have been documented in the past.	No	No
g. Natural deposits of minerals or other substances harmful to man are present at the extraction site.	No.	No.

The sediments in Hilo Harbor are contaminated with chlordane, PCB and arsenic based on analysis by the State Department of Health. The sediments in Reeds Bay

Findings:

a. The material proposed for discharge consists of uncontaminated basalt stone and contaminated dredged material. The dredged material is suspected of being contaminated with arsenic, PCB and chlordane.

b. The material classification for the basalt stone is Category 5, Discharge without potential for environmental contamination. The material classification for the dredged material is Category 2, Open water discharge with level of contamination similar to the discharge site.

c. Further testing of the dredged material is required under Category 2. Test protocol requires a sediment analysis and water column elutriate analysis.

List of Contaminants to be Further Evaluated: The discharge of dredged material for the landfill requires testing for arsenic, PCB and chlordane.

Results of testing will be provided.

Zone of Mixing: Not applicable. The dredged material will be used for construction purposes and will be confined to the fill site by a rock revetment, or will be discharged in the approved ocean disposal site.

7. Aquatic Ecosystem and Organisms Determination.

Fishery resources which support a recreational shoreline fishery are identified in Attachment 1. Corals are not present.

Rare/Threatened and Endangered Species: The threatened green sea turtle and the endangered hawksbill turtle have been seen near the breakwater and may enter the harbor while foraging for food. No nesting areas are found within the harbor or Reeds Bay.

Aquatic Ecosystem Dependency: Fishery resource dependency on Blonde Reef is unknown, however, fish surveys indicate that the most fish species and the greatest number of fish were found on Blonde Reef in comparison to other areas in Hilo Bay. Effect: No effect by either plan.

Determination: The discharge of armor units into the harbor under Plans A and B does not significantly degrade water quality or human uses of the water. Neither the basalt rock from a quarry nor dredged rock material is expected to contain contaminants, or cause prolonged water turbidity problems which will significantly degrade the aquatic ecosystem. In both Plans the dredged sediment material will probably be contaminated with arsenic, PCB and chlordane and should undergo elutirate and sediment analysis prior to discharge. The contaminants are found throughout Hilo Bay within the bay sediments.

Material Proposed for Discharge

	Plan A	Plan B
Basalt rock	Not specified in authorizing document.	23,000 Tons
Dredged basalt fill		25,000 Tons

ATTACHMENT 1

CHECKLIST OF FISH AND SHELLFISH TAKEN BY FISHERMEN WITHIN THE HILO BAY SURVEY AREA
(From Sunn, Low, Tom & Hara, Inc. 1977)

LOCAL/COMMON NAME	SCIENTIFIC NAME	LOCATION BY REGION
Aholehole	Kuhlia sandvicensis	5,6,7,9,11,12,14,16,17
Aku	Katsuwonus pelamis	3
Akule (Aji)/Hahalalu	Trachurops crumenophthalmus	1,6,9,11,14
Amaama (mullet)	Mugil cephalus	5,6,7,8,9,13,15
Awa (milkfish)	Chanos chanos	1,7
Aweoweo	PRIACANTHIDAE	16
Ehu (red snapper)	Etelis marshi	4
Hihimanu (ray)	DASYATIDAE	11,14
Hinalea (wrasse)	LABRIDAE	9,16
Humuhumu	BALISTIDAE	16,17
Kaku (barracuda)	Sphyraena barracuda	1
Kawakawa	Euthynnus yaito	14
Kumu	Parupeneus porphyreus	1,4,11,14,15,16
Kupipi	Abudefduf sordidus	9,11,16,17
Lae	Scomberoides sancti-petri	9
Maiko	Acanthurus nigroris	16,17
Manini	Acanthurus sandvicensis	11,14,16,17
Mano (tiger shark)	Galeocerdo cuvieri	1
Mano kihikihi (hammerhead shark)	Sphyrna lewini	1,2,11,14,16,17
Maomao	Abudefduf abdominalis	15,17
Menpachi	Myripristis spp.	16
Moano	Parupeneus multifasciatus	1,14,16,17
Moi/moi-lii	Polydactylus sexfilis	3,4,5,6,7,14

Table VI (cont.)

LOCAL/COMMON NAME	SCIENTIFIC NAME	LOCATION BY REGION
Nehu	Stolephorus purpureus	1,2,11,13,14
Nenue	Kyphosus cinerascens	14
Oio	Albula vulpes	1,5,6,9
Omaka	Caranx mate	1
Oopuhue (balloon fish)	Arothron Hispidus	4
Opakapaka	Pristipomoides microlepis	4
Opelu	Decapterus pinnulatus	9
Pakii (flatfish)	Bothus spp.	15
Palani	Acanthurus dussumieri	9,12,13,16,17
Piha	Spratelloides delicatulus	16
Pualu	Acanthurus xanthopterus	1
Puhi (moray eel)	MURAENIDAE	14
Puhi (tohe--conger eel)	Conger marginatus	14
Taape	Lutjanus kasmira	1,2
Toau	Lutjanus vaigiensis	11
Ulua/Papio	CARANGIDAE	1,3,4,5,6,7,9,11,14,15 16,17
Upapalu (cardinal fish)	Apogon snyderi	15
Weke/Oama	Mulloidichthys samoensis	1,11,12,13,15
Tilapia	Tilapia spp.	10
Oopu (goby)	GOBIDAE	5
Crab - Kuanono	Portunus sanguinolentus	3,4,6,7,15
Crab - Samoan	Scylla serrata	3,4
Opae (glass shrimp)	Palaemon debilis	7,8,10,15
Ula	Panulirus spp.	3,4,16,17
Tako (octopus)	OCTOPODA	4,16,17
Opini	Cellana spp.	4,16,17

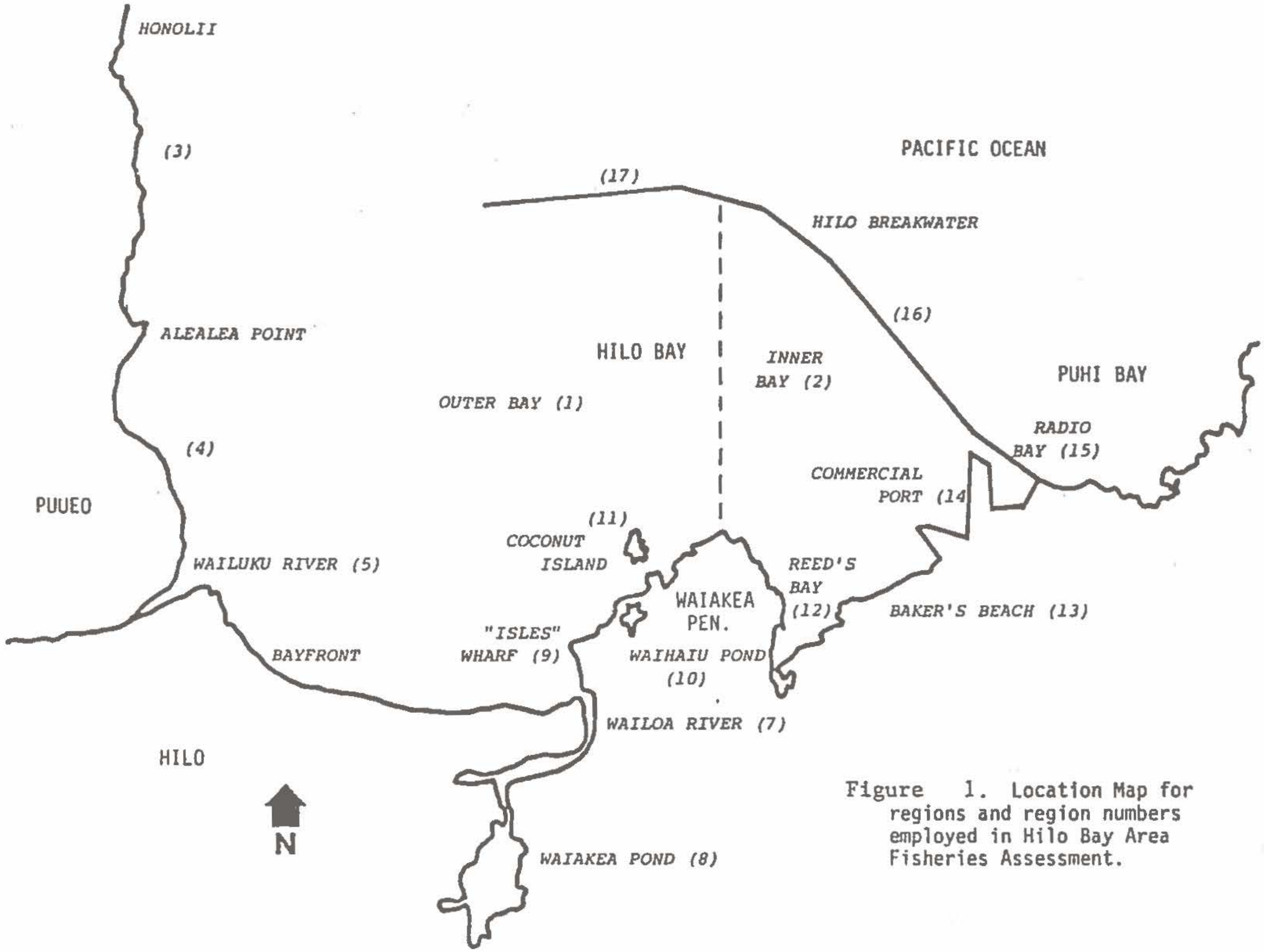

Figure 1. Location Map for regions and region numbers employed in Hilo Bay Area Fisheries Assessment.

From Sunn, Low, Tom & Hara, Inc. 1977

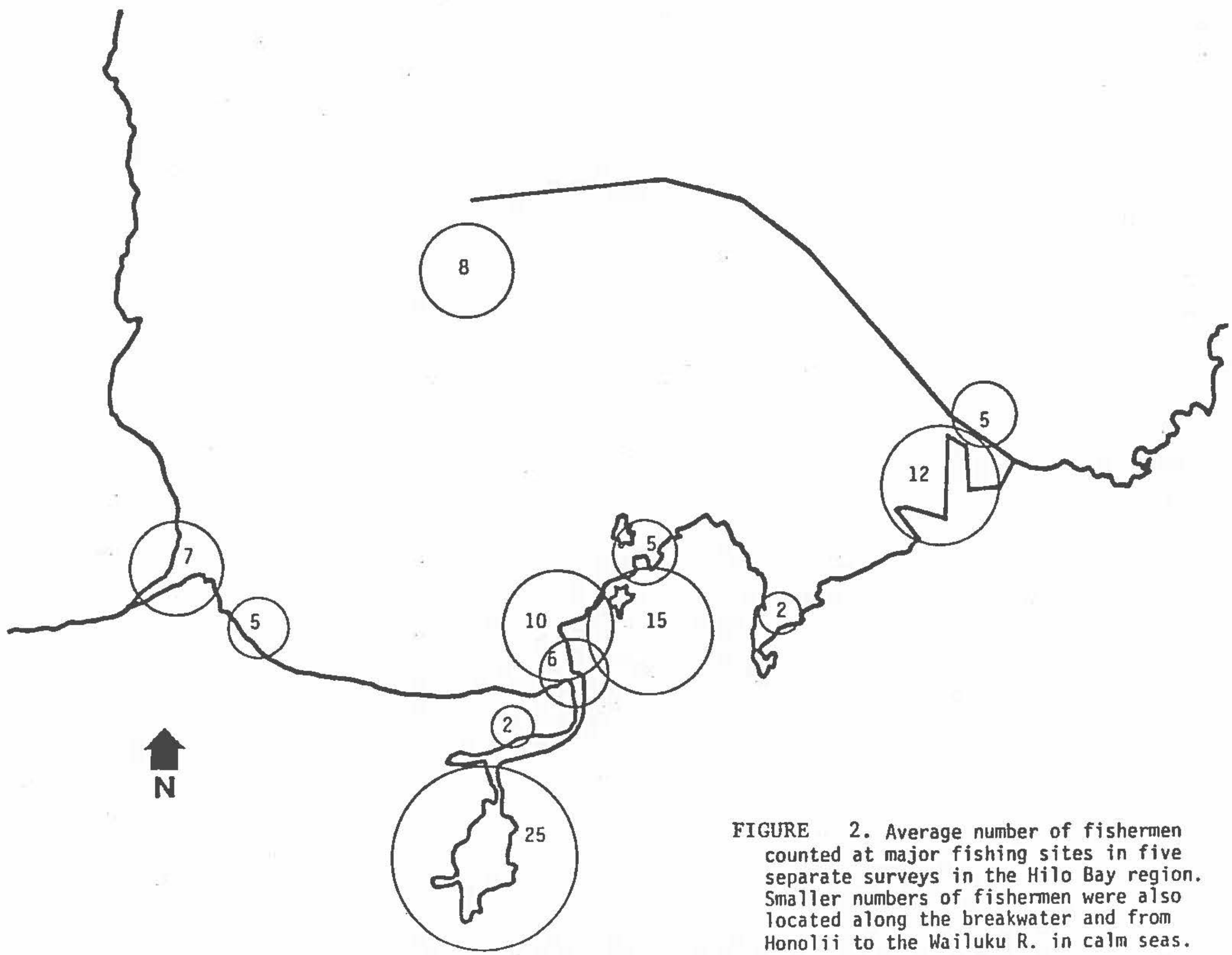

FIGURE 2. Average number of fishermen counted at major fishing sites in five separate surveys in the Hilo Bay region. Smaller numbers of fishermen were also located along the breakwater and from Honolii to the Wailuku R. in calm seas.

From Sunn, Low, Tom & Hara, Inc. 1977

APPENDIX B

RECREATION AND NATURAL RESOURCES

1. Recreational Resources.

a. National Scenic and Wild Rivers. None present. Local land use planning documents propose the development of Wailuku River as a natural wilderness area and the development of Wailoa River and Waiakea Pond as park, open space.

b. National Trails. None present.

c. Natural Landmarks. None present.

d. National Shoreline Parks or Beaches. None present. Several State and County parks are present along the shoreline. While public access and use of the Hilo Breakwater is discouraged due to hazardous conditions, fishermen use the breakwater as a fishing site.

TABLE B-1. RECREATIONAL RESOURCES

Recreation Site	Acres	Ownership	Park Use
Wailuku River Mouth	-		Surfing
Mooheau Park	18.9		Beach (eroding)
Bayfront Park	6.8		Beach (eroding), canoeing, fishing
Wailoa River Park	146.0	State	General, boating, shoaling, river mouth
Liliuokalani Gardens and adjacent areas	20.5		General
Coconut Island	3.1		General, surfing
Banyan Drive Shoreline	-		Scenic
Reeds Bay	15.5		Beach (man-made) swimming
Baker's Beach		State	Beach (man-made)
Radio Bay		State	Boating
Radio Bay Park		State	General
Hilo Breakwater		Federal	Fishing

e. Water contact Recreation. Principal water contact recreation activities in Hilo Bay include shoreline fishing, boating, wading and canoeing. Swimming is seldom observed possibly due to the highly turbid nearshore waters and concentrated mats of vegetative debris carried into the bay from the tributary systems. Six surfing sites were identified in Hilo Bay in the "Hilo Bay - a Chronological Study" in 1981. According to the Hawaii Chamber of Commerce, 1973, surfing demands have grown sufficiently to warrant investigations for increasing the number of surfing sites on the island. Fishing and boating are judged the most significant recreational activities. Canoeing is centered on use of the Bayfront beach and Wailoa River. Swimming is most prevalent in Reeds Bay.

(1) Fishing. Recreation fishing areas and resources in Hilo Bay are limited, popular, and need to be protected. Leisure time, recreational fishing is more important in Hilo Bay than commercial fishing as a source of seafood for local residents. Commercial fishing interests are principally interested in the offshore fishing grounds. The number of recreational fishermen in the Hilo Bay area is about 2,100 persons; 60% are shore fishermen, 5% are net fishermen, and the remainder utilize other fishing methods (Cheney, 1977). Favorite fishing sites, list of recreational fish species and general locations where the fish are caught are provided in Cheney, 1977. Fishermen believe that too many fishermen and poor enforcement of fishing regulations are partially responsible for over-exploitation. Fishermen are also competing for water use with canoe paddlers, surfers and boaters. Increasing the number of fishing sites and enforcing existing fishing regulations were believed to be beneficial to recreational fishing in Hilo Bay.

(2) Surfing. Five surfing sites are located in Hilo Bay (Kelly, 1981). One is located at Coconut Island, 2 at the Wailuku River mouth, one at Wainaku, and one at the tip of the breakwater. Kelly indicated that more surfing sites existed in the bay in the 1800's prior to construction of the breakwater.

(3) Beach Parks. The principal beach parks in Hilo Bay are Baker's Beach, Reeds Bay, Hilo Black Sand Beach, and Liliuokalani Gardens. Both Hilo Black Sand Beach and Baker's Beach are man-made. Also, portions of Reeds Bay

were created from material dredged from Hilo Harbor turning basin during the period from 1925-1930. Hilo Black Sand Beach was formed by the natural accretion of eroded basalt material from the 1881 lava flow in the Wailuku River drainage basin. Black sand was mined from the beach in the 1900's. Both beaches are eroding. The creation of Baker's Beach appeared to have altered the dynamic equilibrium of the shoreline area and erosion is believed to be a natural process which reestablishes equilibrium. Erosion at Hilo Black Sand Beach appears to be related to the Hilo Breakwater (Reference M & E Pacific, 1980). The breakwater protects a portion of the beach which has remained stable. However, the exposed portion has eroded and beach sand is transported in an easterly direction. The breakwater appears to have eliminated the westerly component of the littoral transport.

(4) Boating. Wailoa River provides berthing for recreational and fishing craft. A State launch ramp is located in the river. Radio Bay and Reeds Bay are also used for berthing principally for sail craft and vessels with high superstructures which prevent use of the Wailoa River area. Boats using the Wailoa river must have an over-the-water height of less than 8 feet to pass under the Kamehameha Highway bridge. The existing facilities provide berthing for only 106 vessels. Only 4 transient berths are available.

2. Natural Resources.

a. Land Resources. The Hilo Bay shoreline is classified as Keaukaha Extremely Rocky Muck with 6-20% slope. The bay shoreline specifically consists of rocky headlands at Wailuku River, rock revetment and black sand along the Mooheau Beach Park, black sand at the Bayfront Beach park, rock headlands around Waiakea Penninsula, dredged coral fill at Baker's Beach and Reeds Bay and the developed port area. The harbor bottom consists of silty clays carried into the bay from upland areas by the Wailuku and Wailoa Rivers. Blonde Reef is principally a coralline reef area.

b. Prime and Unique Agricultural Lands. None present.

c. Natural Hazards.

(1) Volcanic Hazards.

TABLE B-2 RECORDED OR ESTIMATED NUMBER OF VOLCANIC ERUPTIONS ON THE ISLAND OF HAWAII DURING HISTORIC TIMES (1800-Present)

The summit and major rift zones of Mauna Loa and Kilauea volcanoes on the island of Hawaii have been very active during historic times, and volcanic activity is expected to continue through the foreseeable future.

Volcano	Total Eruptions	Eruptions Outside the Caldera
Mauna Loa	30-40	About 15
Kilauea	40-50	About 25
Mauna Kea	0	-
Hualalai	2	-
Kohala	0	-

Adapted from US Geological Survey, 1974.

TABLE B-3. NUMBER OF ERUPTIONS ORIGINATING WITHIN HAZARD AREAS AND NUMBER OF TIMES LAVA FLOW COVERED LAND WITHIN HAZARD AREAS DURING HISTORIC TIMES (SINCE 1800) ON THE ISLAND OF HAWAII

Hazard Area	# of Eruptions	# of Lava Flows	% Land Covered by Lava
A	0	0	0
B	0	0	0
C	0	0	0
D	0	0	0
DE	1	2	6
E	1	35	15
F	80	More than 80	50

Source: US Geological Survey, 1974.

Hilo is located in a high risk volcanic area (designated risk area E in U.S. Geological Survey, 1974; see Figure B -1). While the greatest danger to Hilo from volcanic activity is associated with eruptions within the northeast rift zone of Mauna Loa, the risk of potential damages and losses from lava flow and other hazards (ejecta, gases, subsidence and surface rupture) generally decreases down the volcanic slopes toward Hilo. Most lava flows from Mauna Loa have stopped short of the Hilo suburbs. Subsidence and surface rupture risks are considered low in Hilo, although earthquake property damage has occurred. An earthquake in 1975 caused about $4 million in property damage throughout the island. Since major structural damage risks are high, earthquake resistant structural design regulations are enforced.

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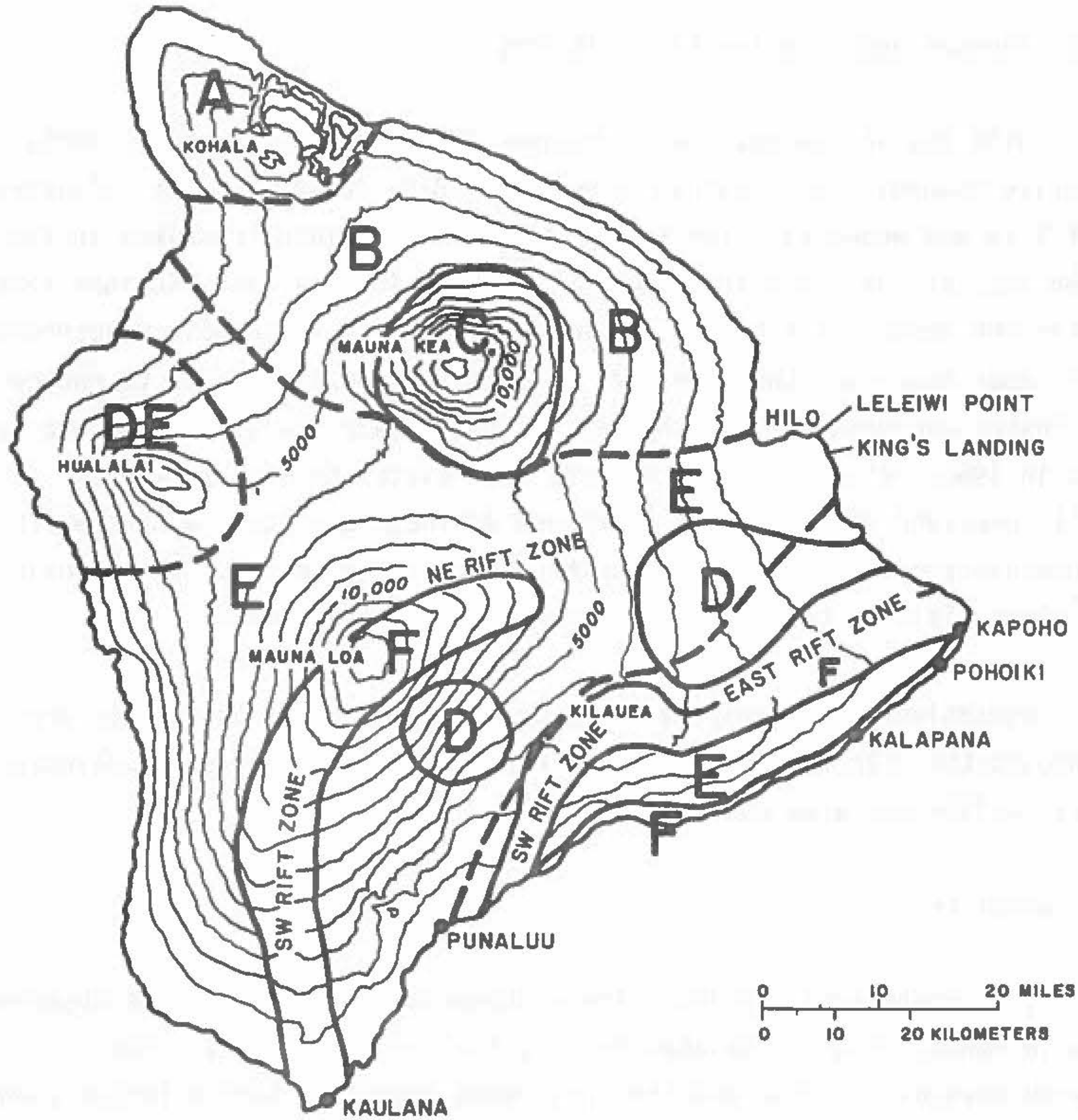

THE FIVE VOLCANOES THAT FORM THE ISLAND OF HAWAII: KOHALA, MAUNA KEA, HUALALAI, MAUNA LOA AND KILAUEA. CONTOUR INTERVAL 1,000 FEET. DASH LINES SEPARATE NAMED VOLCANOES. (USGS, 1974)

HAZARD DESIGNATION	EXPLANATION
F	AREA OF HIGHEST RISK WITH HISTORIC AND RECENT PREHISTORIC RECORD OF ACTIVE VOLCANISM, FAULTING AND SUBSIDENCE.
E	AREA SUSCEPTIBLE TO BURIAL BY LAVA FLOWS ORIGINATING FROM AREA F. DEGREE OF RISK GENERALLY DECREASES WITH DISTANCE FROM SUMMITS AND MAJOR RIFT ZONES.
DE	HUALALAI VOLCANO ONLY. LAVA BURIAL MORE FREQUENT THAN AREA D, BUT LESS THAN AREA F.
D	MODERATE RISK. NO HISTORIC OR RECENT PREHISTORIC LAVA FLOWS.
C	MAUNA KEA VOLCANO SUMMIT. SMALL RISK. ERUPTION FREQUENCY LOW, LAST ERUPTION 3000 - 5000 YEARS AGO.
B	NO ERUPTIONS DURING LAST 10,000 YEARS.
A	NO VOLCANIC ACTIVITY IN LAST 60,000 YEARS.

SOURCE: USGS, 1975

FIGURE B-1

(2) Tsunami and Riverine Flood Hazards

Hilo Bay is susceptible to tsunami and riverine flooding. Forty destructive tsunamis have reached Hilo since 1819, seven of which inflicted loss of life and property. The tsunamis of 1946 and 1960, resulted in the combined loss of 234 lives and damages in excess $52 million. Actions taken to lessen the impact of tsunamis included rezoning of vulnerable waterfront areas to open space and the adoptions of structural design codes to reduce future losses and damages. The highest tsunami runup elevation recorded was 35 feet in 1960. Riverine flood hazards are related to high intensity rainfall, overland sheetflow and undefined drainageways, the last of which is the consequence of the geological youthfulness of the region. The Alenaio Stream flood plain is the principal flood hazard area in Hilo.

d. Vegetation. No significant vegetation communities or species are found around the Hilo Bay shoreline, although the Wailuku River is planned as a natural wilderness area by local planners.

e. Wildlife.

(1) Endangered Species. The endangered Hawaiian coot was observed nesting in Mohouli Pond in Waiakea Pond by Shallenberger, 1977. The endangered hawksbill turtle and the threatened green sea turtle forage along the coastal areas and have been observed near the breakwater. The National Marine Fisheries Service (1981) indicated that Hilo Harbor is not a habitat on which the turtles depend for their continued existence, but that they may enter the harbor while foraging for food.

(2) The humpback whale seasonally migrates through Hawaiian waters and can be found around all the major islands from Hawaii to Kaula Rock during the seasonal migration. The whales begin to appear during November and leave the islands by June with the greatest number occurring during February and March.

The National Marine Fisheries Service indicated that 500-700 whales annually migrate through Hawaiian waters to mate, calve and nurse their young. The whales prefer relatively shallow water, usually waters less than 100 fathoms deep, and are particularly numerous on Penquin Banks, in the area between

Maui, Lanai, Molokai and Kahoolawe, around the northwest tip of Hawaii and between Niihau and Kauai. However, they are consistently seen in small numbers in other areas of the Hawaiian Islands during the season. Herman (1981) suggests that the whales first arrive in Hawaii around the island of Hawaii and travel northward toward the islands in Maui County and continuing toward Niihau and Kauai, where they leave on their return to the northern summer feeding grounds. The relative concentrations of whales in the Hawaiian Islands is illustrated in Figure B-2 based upon information provided in 1976 and 1977 census (Wolman and Jurasz 1976, and Rice and Wolman, 1977). The National Marine Fisheries Service provided the following whale census in the Leleiwi Point area of Hawaii. The whales have not been seen in Hilo Bay.

TABLE B-4. WHALE SIGHTINGS OFF LELEIWI POINT

Year	# Whale Sighted
1976	12
1977	7
1978	5
1979	9

(3) Wildlife Refuges. No wildlife refuges are established in the area.

(4) Marine Sanctuaties. No marine sanctuaries are established in the area.

(5) Migratory Waterbirds. The Hilo Bay area is not a major area of concentration for migratory shorebirds or waterbirds. However, migratory and domestic ducks have been observed in Waiakea Pond during the winter seasons. The most common waterbird in the Waiakea Pond is the domestic mallard.

(5) Wetlands. No wetlands are located along the Hilo Bay shoreline.

(6) Estuaries. Reeds Bay, Waiakea Pond, Wailoa River and the Wailuku River form small localized estuaries. These estuaries are not listed on the National Inventory of Estuaries.

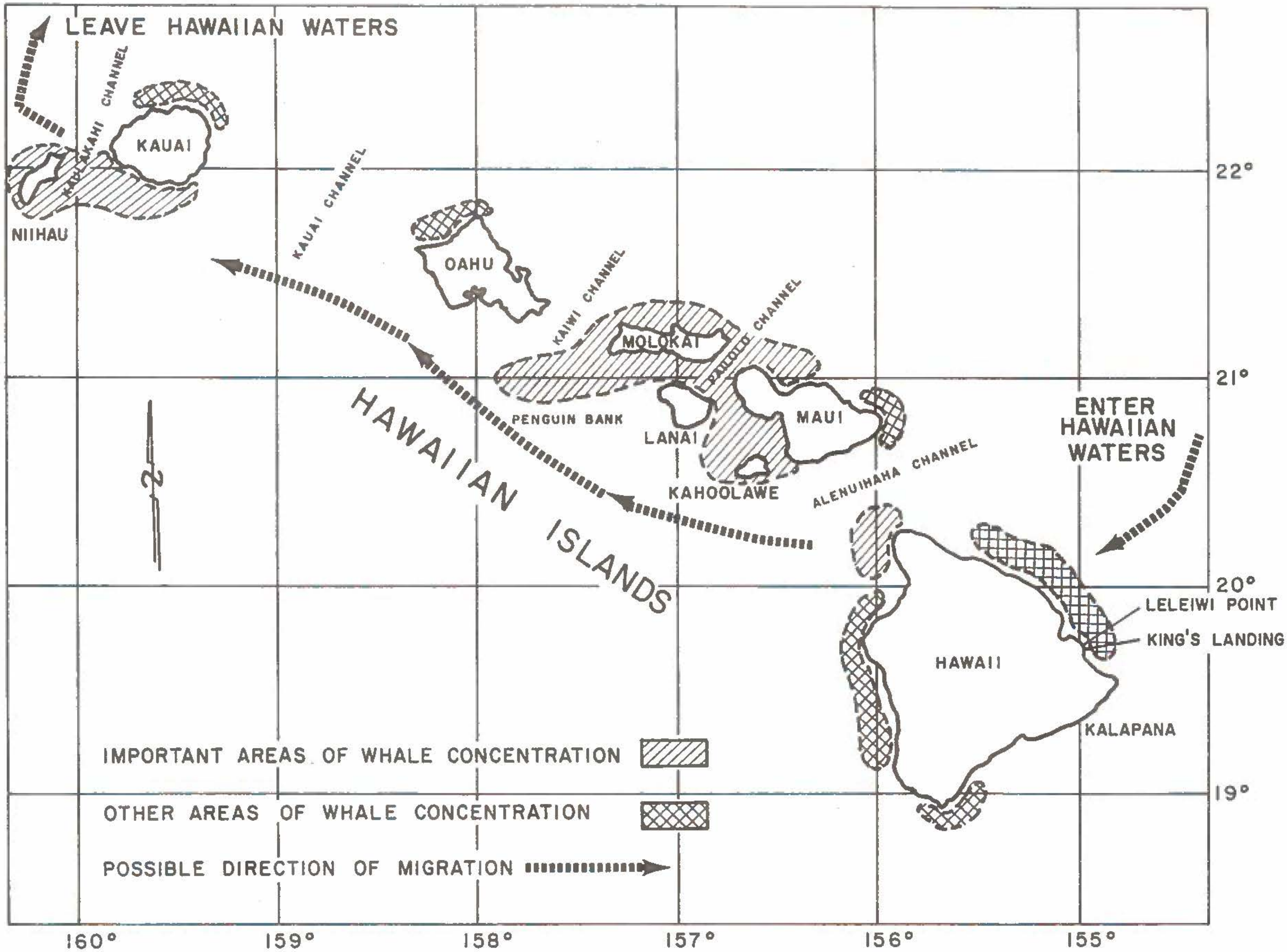

FIGURE B-2. DISTRIBUTION OF HUMPBACK WHALES IN HAWAII

ADAPTED FROM: WOLMAN AND JURASZ, 1976 AND RICE AND WOLMAN, 1977. HERMAN IN WHITTEN, 1981.

f. Marine Resources.

(1) Hilo Bay is biologically depauperate, possibly the consequence of freshwater, siltation and turbidity stresses. The breakwater reduces the wave energy and water transport into the harbor, possibly allowing increases siltation in coral areas and reduce the mixing of marine and freshwaters masses. Freshwater stress prevents the establishment and growth of benthic marine communities on the reefs, and poor light penetration in water limits photosynthetic activity. The silt areas lack a developed infauna (Reference M & E Pacific, 1981). No live organisms were found in benthic samples taken from the silt areas probably as a result of recent maintenance dredging in the harbor. Six samples containing live organisms were obtained from rocky coralline areas in the bay. Scour and freshwater stress may be factors limiting benthic development in the Wailuku River mouth area.

(2) Blonde Reef: Live coral cover based on a survey of 5 sites in Hilo Bay ranged from 1-16% attaining the highest cover on Blond Reef (16%). The areas around Coconut Island had a live coral cover ranging from about 1-10% (M&E Pacific, 1980a). The surveyed detected a decline in coral cover between 1977 and 1980 possibly attributed to large floods in March 1980. Coralline algae, Porolithon, was more abundant than coral increasing its substrate coverage between 1977 and 1980. Porolithon is responsible for the consolidation of loose reef material and encrusting coral skeletons. Large dead coral heads on the reefs inside the breakwater suggest that the reef was once a viable ecosystem. Wave energy on the reef would have created a high energy environment that flushed silt from the reef and reduced salinity stress by rapidly dissipating freshwater concentrations before the freshwater could affect the reef area. The wave action would have also created a high dissolved oxygen environment, and surge and wave currents would have promoted excellent water circulation over the reef, creating favorable conditions for coral growth. Areas within the breakwater exposed to waves refracted around the end of the breakwater have flourishing coral communities. The dead coral mass does provide habitat for fish and invertebrates and are areas of richness within the bay. The number of fish observed on the hard substrate habitat ranged from 4-365 fishes representing 3-29 species. For comparative purposes, areas seaward and to the east of the breakwater had coral cover ranging from 40-70% and fish numbers ranging from 172-543 fish representing 36-39 species

(M&E Pacific, 1980b). Plankton densities in Hilo Bay, based upon 300 measurements, were not considered significantly different from other areas in the State, but were similar to ocean areas.

g. Fisheries.

(1) Fishermen believe fish stocks in Hilo Bay are declining (Reference Cheney, 1977) and attribute this reduction to a variety of factors including over-exploitation, removal of juveniles by bait fishermen, mechanical sugarcane harvesting and chemical pollutants. Whether or not a decline has acutally occurred is unknown and the exact factors affecting fish abundance have not been determined. The inshore fish catch presently accounts for less than 10% of the total fish landings in Hilo Bay, and are represented by fewer species than offshore fish. This contrasts to earlier trends at the turn of the century, when inshore reef fish accounted for 50% of the total pounds of fish landed in Hilo Bay and represented more species caught than offshore fish. Nehu catches have declined and are presently insufficient to support a fishing fleet. The decline in nehu resources is attributed by fishermen to overfishing, nutrient and sediment loading and an overall decline of the tuna fishery. The Hawaii Island Chamber of Commerce, 1973, would like to see nehu of other bait resources improved in hopes of revitalizing the commercial fishing industry in Hilo. The principal nehu catch areas are located within the commercial port. Former baiting areas were along the Bayfront shoreline to Hoolii.

(2) The development of the bay as a commercial port, dredging and filling shoreline areas, and disposal of industrial and domestic wastes have affected the aquatic habitat and may have affected fishery resources. However, the long-term trend in fishing stocks and composition is unclear. Fishermen opinions concerning cause and effect relationships on local fishery stocks suggest that certain natural or man-related factors influence fish abundance and species, and the fishing methods used. For example, siltation probably fills habitat required by moi, aweoweo amd menpachi. Low stream flow and dry winters appear correlated to increased catch rates, but high stream flows usually correlate with increased papio catches. Murky water tended to increase ulua and moi catch rates, but reduced reef fish and nehu catches.

High waves are thought to clear out the mud and improve fishing. The canec plant discharge into Waiakea Pond were thought to improve fishing. Good crabbing along the bayfront was associated with abundant Enteromorpha and Ulva growth. Chlorine from the sewage plant discharge was believed to be the cause of decline in piha (Spratelloides delicatulus) abundance. Shutting down and cleaning the sugar mills have resulted in a decrease in papio, ulua and moi catch and in an increase in menpachi, aweoweo, aku and other reef fish catch. Trawlers no longer foul their lines on rafts of bagasse. Turbid waters reduced spearfishing success and probably accounted for reduced reef fish catches.

h. Harvestable Shellfish Beds. None present.

i. Water Quality.

(1) Water quality in Hilo Bay has improved over the long-term with the removal and treatment of agricultural, industrial and domestic wastewater discharges. The pollutant sources have included wastewater from sugarcane and canec processing operations, raw sewage discharges, periodic shipboard waste disposal, cesspool overflow and leachates, surface runoff from agricultural lands, a thermal discharge, fish wastes, and petroleum wastes. At present, the major, point source discharges in Hilo Bay are the municipal sewage treatment plant discharge outside of the breakwater in Puhi Bay, and the Hilo Electric Company's Shipman power plant thermal discharge (28 mgd) into Wailoa River. The only sugar mill discharge in the area is located 8 miles north of Hilo Harbor entrance at Pepeekeo. The principal nonpoint pollution sources in Hilo Bay are the surface runoff from agricultural lands and leachates from cesspools. Groundwater seepage and riverine discharge into Hilo Bay has a significant influence on bay water quality.

(2) Hilo Bay is a two-layered water body (M & E Pacific, 1980a) due to the discharge of 300 mgd of freshwater from Wailuku River and 700 mgd of groundwater into the harbor. The freshwater forms a distinct surface layer over the more saline bottom water. The surface layer persists throughout the year and is thicker in the wet season than in the dry season reflecting hydrologic conditions in the watershed. Salinity gradients are higher near the shore where groundwater discharges into the harbor and persist next to the breakwater, suggesting that the breakwater forms a barrier that inhibits mixing of marine and freshwaters.

(3) The predominant surface current direction is seaward out of the harbor. A continuous outflow occurs along the breakwater possibly as a result of groundwater outflow from Radio Bay. The surface current is dependent upon the influx of freshwater and the predominant wind direction. The influence of freshwater is measurable to a depth of 10 feet on Blonde Reef inside the breakwater and outside of the harbor mouth. In some areas the freshwater influence extends down to 20 feet. The depth of the freshwater influence generally reflects the low degree of mixing between the surface and bottom waters in the bay. The primary mixing force is provided by the wind with some mixing at the interface due to the shear force between the freshwater layer and the saline bottom water. Turbulence from ship traffic periodically mixes the two water layers. During certain periods (20% of the time) the prevailing wind direction is onshore retarding the outward flow of water on the surface. A two-cell circulation pattern was measured in 1973 (Reference Neighbor Island Consultants, 1973), but this condition may be the exception rather than the norm. Subsurface currents are influenced by the predominant westerly offshore coastal current off Blonde Reef (M & E Pacific, 1980a). Subsurface waters flow into Hilo Bay at a depth of 20-40 feet along the western side of the harbor mouth. Water continuously flows out of the harbor along the eastern side of the harbor mouth.

(4) Water quality baseline data are incomplete to compare annual variations with the State Water Quality Standards. The problem is due to water quality monitoring patterned after standards which were later revised in September 1979. The existing data are not reported in the same units of measurements contained in the new standards, and were not collected at a frequency sufficient to determine compliance with the new standards. In some instances the constituents analyzed are not the same as those required by the standards. The new standards classify Hilo Bay (inside the breakwater) as an embayment with marine water standards for a wet and dry season. Other types of water qaulity standards are further provided for artificial basins, reef communities and soft bottom areas within Hilo Bay. Data collected between March and June 1980 in comparison with the State Water Qaulity Standards indicate that turbidity, nitrate plus nitrite and total phosphorus exceed the geometric mean standard, and values for suspended solids, total kjeldahl nitrogen and chlorophyll-a exceeded standard maximum values (M & E Pacific, 1980). In general, Hilo Bay is vertically stratified due to freahwater

discharges from surface and groundwater sources. Nutrients concentrations do not limit phytoplankton growth and do reflect seasonal fluctuations related to surface runoff and groundwater influx. Water temperatures are warmer in the surface waters than in subsurface waters, but solar heating can warm subsurface waters when the surface outflow is retarded. Suspended solids and turbidity fluctuate with seasonal water runoff and do not appear related to phytoplankton density. Subsurface seawater pH values are normal for seawater conditions and are higher than the freshwater surface layer. Generally, pH values are high when photosynthetic activity increases. Chlorophyll-a concentrations also fluctuate seasonally, being lower in the wet season when light water-penetration is reduced and when water turbidity is higher due to increased suspended solids. Dissolved oxygen levels are near saturation on the surface and attain super-saturated conditions in areas of high photosynthetic activity. Dissolved oxygen levels were lowest near the silty bottoms of the inner harbor and in Wailoa River probably due to reduced mixing with surface waters, to organic loading from terrestrial sources, and to organic material in the harbor that settles out of the water column. Fecal strep and fecal coliform bacteria concentrations have decreased over the past years with the removal of the sewage discharges, and are presently influenced by riverine and groundwater discharges. Fecal strep bacterial tend to survive longer in Hilo Bay than other areas in the State due to the freshwater layer in the harbor.

(5) Sedimentation. Water qualtiy data indicate that sedimentation is a significant factor influencing water quality in Hilo Bay. The low wave energy environment created by the breakwater allows silt to settle out onto the coral reef environments smothering and destroying the reef ecosystem. The rate of sedimentation may be slow based on maintenance dredging records for Hilo Bay Harbor; approximately 54,000 cubic yards of material were removed from the harbor in 1977 reflecting the amount of material accumulated in the harbor since 1962. The estimated maintenance dredging cycle for Hilo Harbor is once every ten years based on past records. Silt is derived primarily from upland erosion within the Wailuku River drainage basin. Based on Table G-14, the principal sources of silt are the agricultural areas and the areas around the summit of Mauna Loa. However, about 35,000 tons of silt per year are deposited into Hilo Bay from Wailuku River (Corps of Engineers, 1976). Based on average annual rainfall in the region, significant soil losses are related

to severe storm or intense rainfall events which affect severe erosion areas rather than smaller daily rainfall events. The rates of sedimentation in the harbor may be lower than in the past due to volcanism depositing new lava over erodible soils and to the termination of the sugar mill processing wastewater discharge into the harbor. The lava flow of 1881 covered some of the erodible soil in the Wailuku River drainage basin, and Wainaku Mill discharged 20,000 tons of suspended solids a year into the bay until it closed in 1976.

TABLE B-5. LAND-USES AND EROSION HAZARD OF THE WAILUKU RIVER DRAINAGE BASIN

Land-Use	Acres	% Total Area	Estimated Erosion Damage (Tons/Acres/Year)
Urban	1,800	1.0	4
Sugarcane and Diversified Crops	3,900	2.5	7-11
Forest	77,500	46.5	0.2
Pasture	33,800	20.2	2-3
High Mountains Conservation	50,000	29.8	1-15

Source of Data: Hilo Comprehensive Study, Plan of Study, December 1976, Honolulu District, U.S. Army Corps of Engineers

(6) Sediment Quality. Pollutant discharge into Hilo Bay have left arsenic, PCB (Polychlorinated biphenyls), and pesticide contaminants in the bay sediments. A State Department of Health survey in 1978 indicated that arsenic, PCB and chlordance concentrations were found in significantly high amounts in Hilo Bay (State of Hawaii, 1978) in comparison with other sites surveyed in the state. The contaminants in dredged material may make the material unsuitable either for land or ocean disposal, and may require special handling or treatment of the material prior to disposal. Sand sediments from a shoal in the mouth of Wailoa river were found suitable for upland disposal following Environmental Protection Agency EP testing which indicated that pollutants did not leach from the sediment.

(a) Arsenic.

Based on the State survey, sediment samples from the Hilo Bay area contained total arsenic residues in concentrations ranging from about 22 ppm to 6370 ppm. A Canec plant, which manufactured canec boards from bagasse, discharged wastewater containing arsenic trioxide, a termicide, into Waiakea Pond. Sediments form the pond contain total arsenic residues in concentrations of about 6370 ppm. Sediments from the mouth of Wailoa River contained 131 ppm total arsenic, and sediments from Hilo Harbor contained total arsenic concentrations ranging from about 33 to 104 ppm. Total arsenic concentrations from sediments obtained from the outer part of the harbor ranged from about 22 to 33 ppm. The analysis indicated that arsenic migrated from Waiakea Pond into the bay environment. Arsenic concentrations in other Hawaiian estuarine sediments ranged from less than 4 ppm at Manele/Hulopoe, Lanai to about 20 ppm in Kaneohe Bay, and may reflect natural levels in Hawaiian soils. Analysis of fish and crab tissue indicate that arsenic is not bioconcentrating in the species tested.

(b) PCB.

Out of ten sites sampled in the State of Hawaii only two, Hilo Bay, Hawaii and Ala Wai Canal, Oahu, had measurable concentrations of PCB. Concentrations of PCB in Ala Wai Canal sediment ranged from 200 to 740 ppb with a mean of 372.6 ppb. The mean PCB concentration in Hilo Bay sediments was 200 ppm. The mean PCB concentration for other sample sites was less than 200 ppb. Under the test procedure the detectable limit was 200 ppb. No concentration of PCB was found in 27 biota samples analyzed.

(c) Chlordane.

Hilo Bay sediments also contained measurable quantities of chlordane. The sum of the mean values of three deriatives of chlordane was 84.2 ppb and was one of four sites in Hawaii found to have chlordane present in the sediments. Sediment from six other sites contained no chlordane residues above the detectable limit of 10 ppb. The levels of chlordane residue in mullet flesh from Waiakea Pond ranged from 80-160 ppb. No mullet from Hilo Bay was analyzed. The mullet viscera contained a chlordane residue 3 to 4 times higher than the flesh. The mean concentration of chlordane residue in Hilo sediment were considerable lower than the range of mean concentrations of chlordane residue (about 296 to 567 ppb) found in the Ala Wai and Kapalama canals.

United States Department of the Interior

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IN REPLY REFER TO:
ES
Room 6307

APR 8 1983

Colonel Alfred J. Thiede
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858

Re: Draft Coordination Act
Report, Reeds Bay Small
Craft Harbor Study
Hilo, Hawaii

Dear Colonel Thiede:

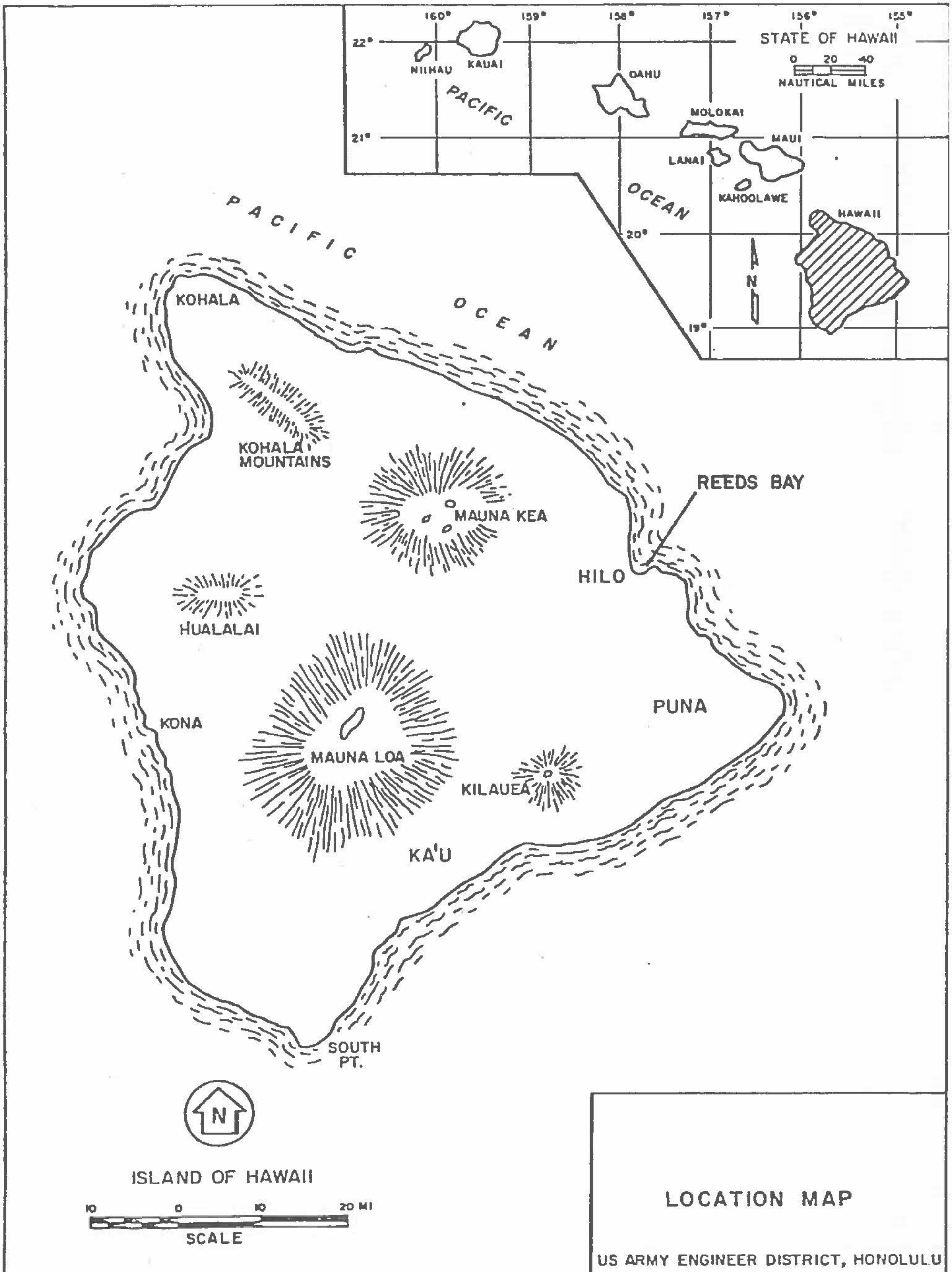
This is the U.S. Fish and Wildlife Service's Draft Coordination Act Report regarding plans of the Honolulu District to construct small boat harbor facilities at Reeds Bay in Hilo, Hawaii. Reeds Bay lies within the Hilo Comprehensive Water Resources Study planning area. This draft report has been prepared under the authority of and in accordance with the provisions of Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and other authorities mandating Department of Interior concern for environmental values. It is also consistent with the intent of the National Environmental Policy Act.

These comments are preliminary in nature and are subject to revision. Additional Service comments and recommendations will be provided in a Final Coordination Act Report. The Service's final report will be published in a revised format.

This report has been prepared by John Ford and Yvonne Ching using the results of previous planning studies conducted in the Hilo area, current scientific literature, results of joint-agency field surveys conducted by John Ford and William Lennan in June 1982, and numerous planning reports and conceptual drawings provided by the Corps.

DESCRIPTION OF THE PLANNING AREAS

The Hilo Comprehensive Water Resources Study area is located on the eastern side of the island of Hawaii (Figure 1), and includes approximately 1300 square miles of land (Reference 14).



LOCATION MAP

US ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 1

Previous studies which present detailed descriptions of the geology, hydrology, oceanography, water quality, and fish and wildlife resources in these areas include References 2, 4, 8, 10-12, and 15-20. In the interest of avoiding redundancy, the information presented here concerning the proposed project in Hilo Bay is intended to supplement existing data developed by the Corps for these studies.

Reeds Bay

The location of Reeds Bay is illustrated in Figure 2. Reeds Bay has been described in detail in the references listed above. Previous consideration for small boat harbor construction at Reeds Bay appears in Reference 8.

a. Fish and Wildlife Resources

Results of the field survey of June 1982 suggest that Reeds Bay is a very depauperate area within few fish and wildlife resources. Recreational fishing in the area appears to be limited to occasional pole and line fishing. The nearshore area is popular for bathing and swimming. Water clarity in the bay is generally poor. There is strong vertical salinity and temperature stratification due to influent springwate[from the "ice pond" area. Probable discharge of sewage from numerous recreational sailcraft which moo[in the bay complicate water quality here. A list of resources observed in June 1982 appears in Table 1.

There are no listed species, or species eligible for listed, as threatened or endangered within the area affected by the proposed action.

DESCRIPTION OF THE PROPOSED PROJECT

The Honolulu District has evaluated two alternative small boat harbor designs involving construction of a revetted mole either from the eastern or western shore of the bay. The Honolulu Districts' preferred plan (Plan 1) is both the National Economic Development (NED) plan, but also the least environmentally damaging alternative (Figure 3).

Plan 1 involves construction of a 1,400' long, inverted "J"-shaped breakwater from the eastern edge of the Bay. The breakwater would be constructed of approximately 45,000 cubic yards of clean quarry stone. Some excavated material from harbor dredging may also be used to form the core of the breakwater. The breakwater slope is expected to be 1 vertical to 1.5 horizontal. The seaward portion of Reeds Bay would be dredged to -13' MLLW for Plan 1. A turning basin and berthing area for 100 boats are to be dredged to a depth of -12' MLLW. Design length for boats using the facilities is 25-35'.

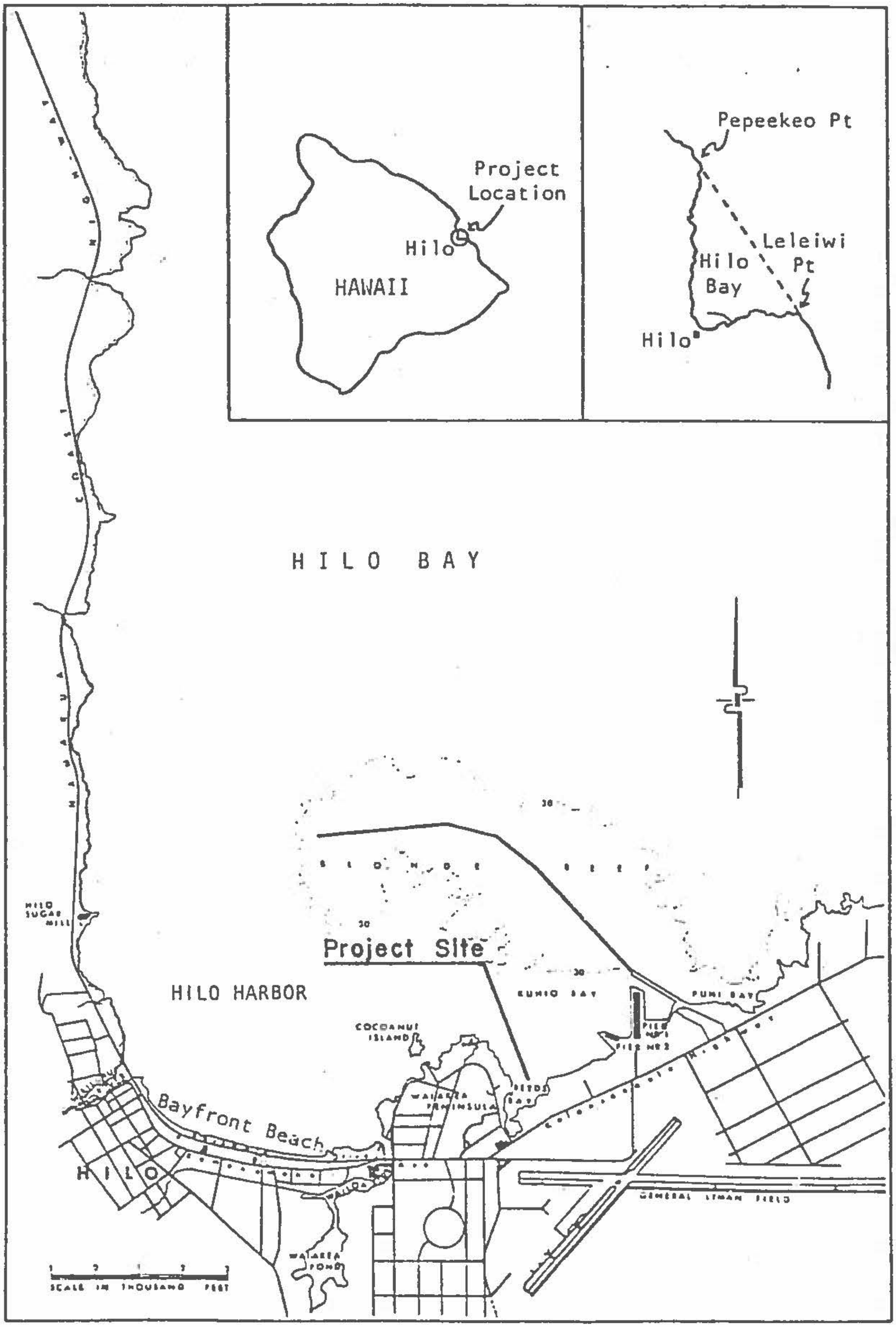


FIGURE 2. HILO BAY

Table 1. Checklist of fishes and invertebrates observed in Reed's Bay, Hilo, Hawaii in June 1982.

FISHES

ACANTHURIDAE

Acanthurus triostegus sandvicensis Randall
A. mata Randall

LABRIDAE

Stethojulis balteata (Quoy & Gaimard)
Thalassoma fuscum (Lacepede)

MULLIDAE

Parupeneus porphyreus Jenkins

POMACENTRIDAE

Abudefduf abdominalis (Quoy & Gaimard)

INVERTEBRATES

PORIFERA (3 spp.)

ANNELIDA

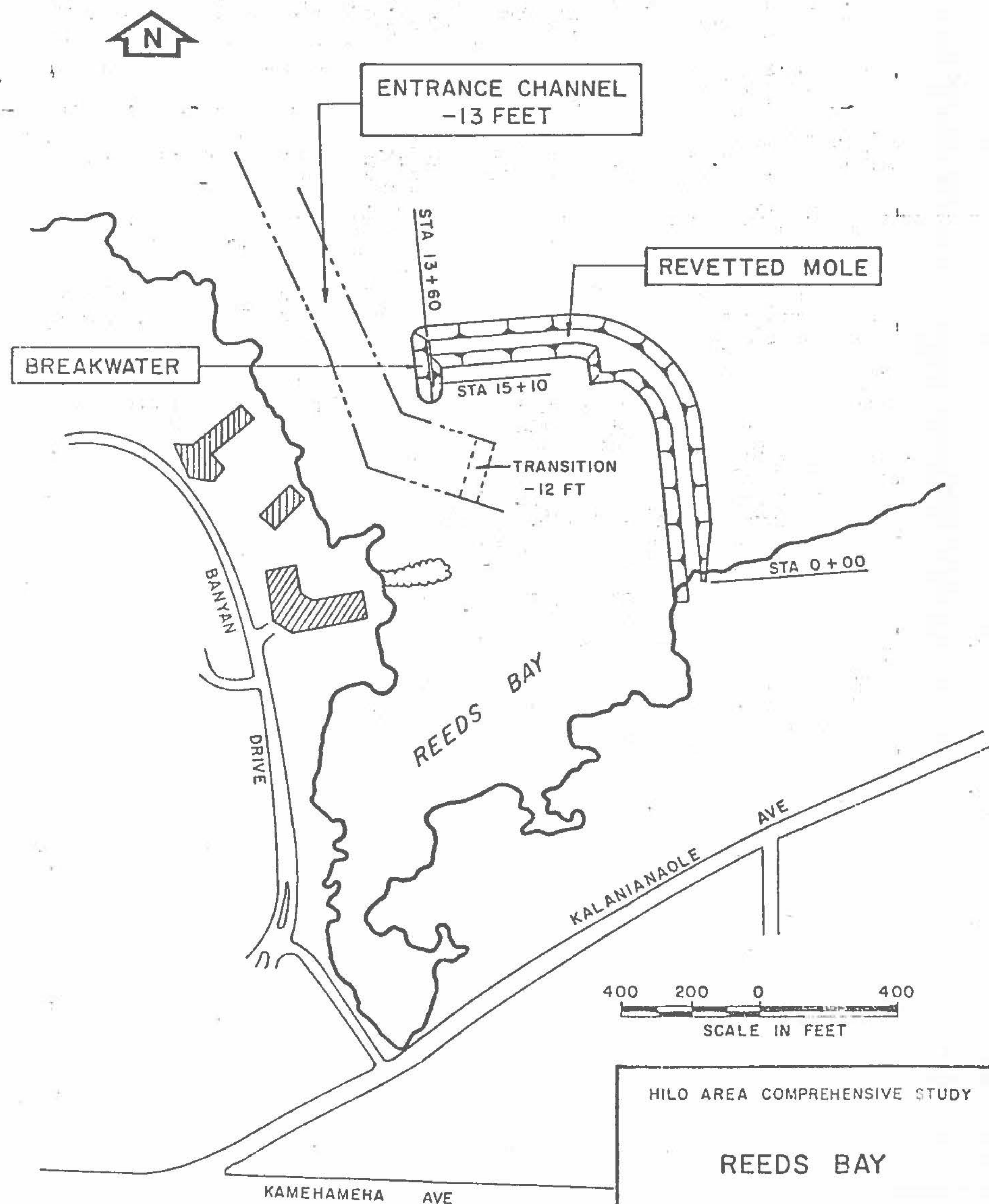
Lanice conchilega
Sabellastarte sp.

MOLLUSCA

Nerita picea (Recluz)
Crasostrea sp.

CRUSTACEA

Alpheus sp.
Grapsus grapsus tenuicrustatus Herbst
Xanthid crab



HILO AREA COMPREHENSIVE STUDY

REEDS BAY

U.S. ARMY ENGINEER DISTRICT, HONOLULU

FIGURE 3

Construction would involve drilling, blasting and excavation of bottom sediments. The Honolulu District is evaluating several alternative methods of excavating bottom sediments including clamshell dredge, dragline, suction dredge and cutterhead-suction dredging. Suction dredging may involve either piping the spoil slurry to a contained on-land disposal area, or temporary stockpiling of slurry in barges and eventual ocean disposal. Other dredging methods would likely entail barging the dredged material to an offshore ocean disposal site in Hilo Bay which has been approved for use by the Environmental Protection Agency (EPA).

Ocean disposal of dredged spoil cannot be conducted until the requirements of bioassay and bioaccumulation testing with Reeds Bay sediments are met. There is concern that toxic substances including arsenic, PCB's and chlordane may occur in high concentrations in bay sediments as an artifact of previous industrial activities. Should the material to be dredged be found unsuitable for ocean disposal, the Honolulu District will be required to identify an appropriate location on land to contain dredged materials and contaminated runoff water. If necessary, the material may have to be diluted with other non-toxic materials, packaged prior to disposal, incinerated, biologically or chemically treated, or discharged at sea at a very slow rate to allow adequate dilution. There are no EPA-approved hazardous waste disposal sites in Hawaii at the present time.

Plan 2 was originally developed in the early 1960's and was, in fact, approved by Congress. This alternative calls for construction of a breakwater extending 900' into Hilo Bay from the western bank of Reeds Bay. This alternative would have the capacity to shelter 270 vessels of 25' in length. Construction would also require dredging an entrance channel to -13' MLLW. This plan, as originally formulated, was considered unacceptable due to public and local sponsor concern about adverse impacts to recreational uses in the area. The fact that the majority of the resort hotels in Hilo are located along the western edge of Reeds Bay makes this alternative even less attractive.

SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Potential impacts common to the construction of each of the two alternative plans include temporary degradation of water quality parameters (specifically, increased turbidity, dissolved and suspended nutrient concentrations, and biological oxygen demand; and decreased dissolved oxygen concentrations and pH). Fine sediments would be carried into Hilo Bay toward the northwest by freshwater discharge into Reeds Bay and by Hilo Bay currents. Sediments falling or spilling from a dredged material barge may also locally degrade water quality. This may lead to loss of some benthic resources along Blonde Reef and the breakwater.

These impacts may be minimized by implementation of careful construction methods (refer to Recommendations). Construction of either plan may lead to temporary restrictions upon access for shore fishermen, boaters and swimmers, and may also lead to reduced fishing success. Disruption of the Reed's Bay - Baker's Beach area by construction of a small boat harbor would probably have little effect upon fish and wildlife resources. Breakwaters associated with the project would increase the availability of rocky, intertidal habitat. Reduced circulation of waters within the dredged basin in association with incidental pollutants typical of small boat marinas, may lead to long-term degradation of local water quality. Some reduction in the number of nehu and akule caught in waters to the East of the area may occur as a result of harbor construction and operation.

No impacts to threatened or endangered species are anticipated.

RECOMMENDATIONS

The Service recommends that the Corps consider adopting the following general measures to avoid or minimize adverse impacts upon fish and wildlife resources. Additional Service comments will be provided in the Final Coordination Act Report as additional project-specific information is provided by the Corps.

1. Facilities should be designed to avoid significant alterations of nearshore current patterns. Where practicable, harbor facilities should be incorporate to take advantage of natural flushing and circulation characteristics of existing current patterns.

2. Floating boat slips and pile-supported structures are encouraged in lieu of facilities requiring fill within boat basins.

3. Silt retention curtains of appropriate depth should be deployed during calm sea conditions to isolate active dredging operations from Hilo Bay and Ice Pond, near the head of Reeds Bay.

4. Construction mobilization should avoid impeding access to or disturbing public recreational activities at Ice Pond.

5. Conscientious water quality monitoring programs should be established to check excessive construction-related degradation to nearshore waters and marine life. Monitoring the concentrations of certain dinoflagellates may be appropriate to evaluate the potential effect of construction on the occurrence of ciguatera in Hilo Bay.

6. Recreational fishing should be accommodated at the new harbor

facilities, and appropriate public conveniences should be provided.

Sincerely,

William R. Kramer
William R. Kramer
Acting Project Leader,
Office of Environmental Services

Enclosure: Bibliography

cc: Hawaii DAR
NMFS-WPPO
RD, FWS, Portland, OR (AE)

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SUPPORTING DOCUMENTATION

ENGINEERING INVESTIGATIONS AND DESIGN

ENGINEERING INVESTIGATIONS AND DESIGN

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SECTION I. DESIGN ANALYSIS

1. GENERAL CRITERIA

a. ANALYSIS. The analysis of the alternative plans was based on the Waters Resources Council's Principles and Standards, applicable Corps regulations and guidelines on planning and design.

b. TECHNICAL CRITERIA. The following technical criteria were adopted for developing the alternative plans:

(1) The design of the protective works will allow for minor overtopping by a design wave which could be expected from a theoretical 50-year hurricane.

(2) The entrance channel is to be of adequate depth and width to safely accommodate two-way traffic by the design vessel and the turning basin is to provide a safe maneuvering area. The prevailing wind and wave approach directions are to be evaluated to determine safe channel alignments for navigation. To insure navigational safety, the severity of turns (dog legs) of the entrance channel should be minimized and widening (flaring) of the channel at the turns is to be provided. The protected basin is to have a maximum wave amplitude of 2 feet to insure minimal damage to vessels.

(3) Navigation improvements shall be designed to accommodate a design vessel, whose length is 40 feet, beam is 15 feet, and draft is 7.0 feet, during all weather and sea conditions.

(4) The protective harbor basin shall provide a safe maneuvering area for the design vessel.

(5) Provision for adequate land area for shoreside facilities and adequate access.

c. GENERAL NAVIGATION FEATURES. Federal design features include an entrance channel, revetted mole and breakwater. All berthing and shoreside features necessary for a complete harbor facility would be provided by the local agency.

d. LEVEL OF DESIGN ANALYSIS. The appendix contains engineering data and analysis to support the survey report formulation and the plan selection process. The alignment and location of the selected entrance channel and protective structures is based on theoretical wave analysis and appears to be the most feasible of several possibilities.

2. SITE LOCATION

a. HILO BAY. The study area was limited to the triangular shaped Hilo Bay at approximately 19.7° north latitude and 155.1° west longitude (Figure 2 of main report) on the northeast coast of the island of Hawaii. The south and east shores are relatively flat and at low elevations, while the west shore is rocky, nearly vertical cliffs. The entrance to the bay between the cliffs and a coral reef, known as Blonde Reef, is about 1 mile wide with a maximum depth of 60 feet.1/ Blonde Reef extends about 2 miles northwesterly from the southeast side of the bay, with depths varying from 6 to 18 feet. The reef and the existing 10,080-foot long rubble mound breakwater affords storm wave protection to the inner bays. The inner bay includes Kuhio, Radio and Reeds Bays (Figure 2 of main report). Reeds Bay is a small inlet on the eastern side of Waiakea Peninsula next to the hotel district. Kuhio Bay serves as the deep draft harbor turning basin which is 1,400 feet wide, 2,300 feet long and 35 to 40 feet deep. The port area is located in the southeast end of the bay at the root of the 10,080-foot long breakwater. Two small rivers enter Hilo Bay: The Wailuku River adjoining the bluffs on the west, and the Wailoa River on the south. Published maps of the study area and vicinity are available as follows:

1/ All elevations referenced to mean lower low water datum (MLLW), unless stated otherwise.

Description	Prepared by	Chart No.
Hawaiian Islands	National Oceanic and Atmospheric Administration National Ocean Survey (N.O.A.A.)	19004
Island of Hawaii	N.O.A.A.	19320
Hilo Bay	N.O.A.A	19324

b. EXISTING INVENTORY

Physical Features: Reeds Bay is a relatively shallow bay with rock outcroppings along the outer edges. An artificial coral beach composed of dredged material from the excavation of Hilo Harbor in the 1920's lines the inner bay. The area provides a picturesque view for both pedestrians and passersby in automobiles traveling on Banyan Drive. The site is situated within tsunami inundation limits.

Use: Reeds Bay presents many opportunities for water-related activities. These include swimming, snorkeling, throw-net fishing, angling, and sailing. The deeper water is currently used to moor sailboats. The beach area is often used to launch trailer mounted sailboats and acts as a gathering place for Hilo residents.

3. CLIMATOLOGY

a. LOCAL CLIMATOLOGY. The average annual temperature at Hilo is 73°F. The highest average monthly temperature is 76°F in August and September and the lowest average monthly temperature is 71°F for January to March. Owing to the moderating influence of the bay and ocean, extreme temperatures are of short duration and range from a record low of 53°F to a high of 94°F. Within the city of Hilo itself, average rainfall varies from about 130 inches a year near the shore to as much as 200 inches in mountain sections. The wettest part of the island, with a mean annual rainfall exceeding 300 inches, lies about 6 miles upslope from the city limits. Rain falls on about 280 days a year in the Hilo area. Temperature and precipitation data compiled by the Department of the Naval Oceanography Command Detachment, Barbers Point, Hawaii for the period 1946 to 1979 are shown on Table D-1. The wind velocity and direction table shows that winds approach Hilo Bay primarily from the southwest (SW) and west southwest (WSW) directions, rather than the typical northeasterly trade direction for the islands. Winds are predominantly from the SW and WSW during the night and early morning hours, with winds generally shifting to the typical trade direction by late morning. A wind diagram for the years 1965-1974 from the gage located at General Lyman Field is shown on Plate D-1.

b. TROPICAL STORMS AND HURRICANES. Although extremely rare in the Hawaiian Islands, tropical storms and hurricanes have, from time to time, affected the islands. Tropical storms are defined as having sustained wind speeds between 34 and 63 knots, while hurricanes are defined as storms with sustained wind speeds equal to or greater than 64 knots. Based on information from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) National Weather Service, from 1950 to 1978 at least fourteen tropical storms or hurricanes have intruded within 500 miles of the state. So far, most of the threatening storms have weakened before reaching the Island of Hawaii and their effects have been minimal in most cases. Tropical storms and hurricanes which impact on sea and weather conditions in Hawaii generally occur during the winter months.

4. WATER LEVEL AND CURRENTS

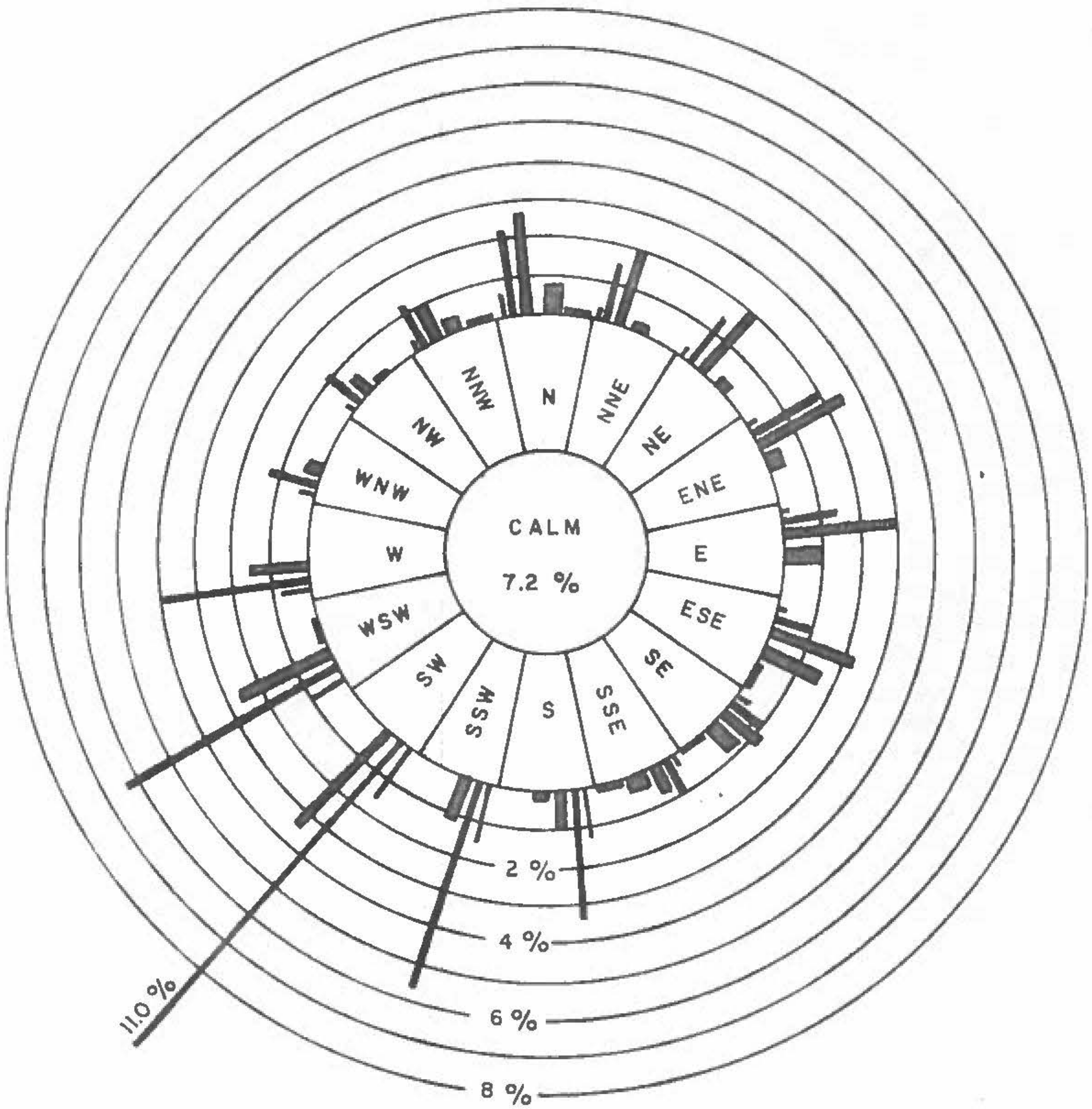
a. TIDES. The tidal data shown below were obtained from the U.S. Coast and Geodetic Survey and are referenced to Mean Lower Low Water (MLLW). All elevations in this appendix are referenced to MLLW datum.

	Feet
Highest Tide Observed	3.8
Mean Higher High Water	2.4
Mean High Water	1.9
Mean Tide Level	1.1
Mean Low Water	0.3
Mean Lower Low Water	0.0
Lowest Tide Observed	-1.6

TABLE D-1. HILO, HAWAII CLIMATOLOGY

	TEMPERATURE DEGS F							PRECIPITATION IN INCHES						
MON	AVG MAX	AVG MIN	AVG	EX MX	YEAR	EX MN	YEAR	AVG	MAX	YEAR	MIN	YEAR	24 HR MAX	YEAR
JAN	79	63	71	90	1977	54	1969	09.07	29.11	1949	00.36	1953	09.94	1949
FEB	79	63	71	92	1968	53	1962	12.90	43.66	1969	01.70	1963	15.70	1969
MAR	78	63	71	93	1972	54	1971	13.69	31.91	1948	00.88	1972	09.18	1953
APR	80	65	72	89	1978	56	1949	12.88	31.94	1963	02.93	1962	11.07	1971
MAY	81	65	74	94	1966	58	1947	10.07	25.01	1964	01.18	1945	10.26	1965
JUN	83	67	75	90	1969	60	1946	06.61	15.50	1943	02.46	1977	04.21	1978
JUL	83	68	75	89	1977	62	1970	09.54	14.89	1958	03.83	1975	05.42	1951
AUG	84	68	76	93	1950	63	1955	10.88	26.42	1957	02.66	1971	09.65	1970
SEP	84	68	76	92	1970	61	1970	07.44	13.63	1947	01.59	1974	06.02	1960
OCT	83	67	75	91	1976	62	1970	10.96	26.10	1951	02.40	1962	08.88	1951
NOV	81	66	74	88	1978	58	1948	13.77	27.03	1959	03.74	1943	15.59	1959
DEC	79	64	72	91	1977	55	1977	15.76	50.82	1954	00.77	1963	10.50	1946
					MAY		FEB			DEC		JAN		FEB
ANN	81	65	73	94	1966	53	1962	133.57	50.82	1954	00.36	1953	15.70	1969

GENERAL LYMAN FIELD
HILO, HAWAII



NOTE: THE PERCENTAGES AND THE DIRECTIONS ARE AVERAGES DURING THE 10 YEAR PERIOD, 1965 TO 1974 INCLUSIVE.

LEGEND:

———	0-3 KNOTS
▬▬▬	4-6 KNOTS
▬▬▬	7-10 KNOTS
▬▬▬	11-16 KNOTS
▬▬▬	OVER 16 KNOTS
—8%—	TOTAL % OF YEAR

SOURCE – HONOLULU DLNR, DOWALD

HILO AREA COMPREHENSIVE STUDY

WIND DIAGRAM

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE D-1

b. ASTRONOMICAL TIDE.

The astronomical tide is assumed to be comparable to the mean higher high water.

c. ATMOSPHERIC PRESSURE DROP.

The water level rise due to atmospheric pressure is calculated by,

$$S_p = 1.14\ (P_n - P_o)\ (1 - e^{-R/r}) \qquad \text{EQ. 3-85, SPM}$$ [2/]

Assuming parameters of hurricane Fico, 1978

P_n = 29.92 inches

P_o = 28.20 inches

R = 25 nautical miles

r = 100 nautical miles

S_p = 0.4 feet

d. STORM SURGE.

The water level rise due to storm surge is calculated by:

Storm surge = S_i, where S_i is the incremental rise in water level due to wind stress perpendicular to the bottom contour

$$S_i = \frac{540K\ U_R^2\ X}{\bar{d}} \qquad \text{(TR-4, 1-64)}$$ [3/]

2/ U.S. Army Coastal Research Center, Shore Protection Manual, 3rd Edition, 1977.

3/ U.S. Army Coastal Research Center, Technical Report No. 4, 3rd Edition, 1966.

Storm surge in the study area was estimated to be in the neighborhood of 0.5 feet for the July 1978 hurricane Fico.

e. DESIGN STILLWATER LEVEL. The design stillwater level (d_{swl}) during hurricane conditions consists of (1) astronomical tide, (2) the rise due to atmospheric pressure drop, and (3) the rise due to storm surge.

(1)	Astronomical Tide	+2.6 ft.
(2)	Atmospheric Pressure Drop	+0.4 ft.
(3)	Storm Surge	+0.5 ft.
	Design SWL =	+3.5 ft.

f. CURRENTS. The "Geological, Biological and Water Quality Investigations of Hilo Bay," prepared by M and E Pacific, Inc., for the Corps of Engineers in September 1980, provides a general understanding of the circulation pattern in Hilo Harbor. The following findings are presented:

(1) The freshwater discharge into Hilo Harbor has a significant influence in the circulation pattern by the creation of a vertical stratification of the water column.

(2) Wind stresses have significant influences on the surface layer.

(3) A net seaward flow occurs in the surface layer of the water column, while the bottom layer responds primarily to the tide.

(4) Subsurface flows at the harbor mouth are primarily influenced by tide. During periods of flood tide, subsurface flow is generally inshore (southerly) across the entire mouth of Hilo Bay.

During periods of ebbtide, the subsurface flow is generally seaward (northerly) across the entire mouth of the Bay.

Surface flows in the Bay are influenced primarily by wind stresses and by the general gradient of the surface layer.

(5) Surface flows at the entrance to Kuhio Bay (deep draft harbor turning basin) are influenced by wind stresses. The surface flow is generally in the direction of the wind and a counterflow exist at about the 5-foot depth.

Current speeds averaged less than 0.1 knot during floodtide and ebbtide conditions.

(6) The subsurface layer current speed in inner bay near the deep draft harbor pier and Baker's Beach averaged 0.05 knots during ebb and 0.02 knots during floodtide.

5. WAVE CONDITIONS.

a. WAVE CLIMATE.

A large percentage of waves arriving at Hilo Bay are generated in the northeastern and eastern sector of the Pacific Ocean, ranging from the Aleutian Islands in the north and as far south as South America.
Three primary wave types affect the study area, including (a) east-northeast trade waves, (b) northern swells, and (c) tsunamis.

LOCAL WIND WAVES. There are no wave gage stations in the area. Information on wave conditions is based on statistical data on offshore waves presented in the "Summary of Synoptic Meteorological Observations" (SSMO), Hawaii and Selected North Pacific Island Coastal Marine Areas, Volume 1, Area 1, Hawaiian Windward, prepared by the National Climatic Center for the U.S. Weather Service Command, June 1971. The wave information is for the position 20.9° north latitude and 156.0° west longitude.

The SSMO data was obtained through direct synoptic observation by shipboard personnel near the island of Hawaii and represent data recorded during the 8-year period from 1963 to 1970. The statistics represent average conditions during the period of record. The data also shows that the majority of waves affecting Hawaii are easterly tradewind-generated waves.

East-northeast trade waves may be present throughout most of the year, but are most frequent between May and September, the summer season, when they usually dominate the local wave spectrum. They result from the strong trade winds blowing out of the northeast quadrant over long fetches of open ocean. Typically, these deepwater waves have periods ranging from 6 to 12 seconds and heights of 2 to 10 feet. Generally, northeast trade waves are present from 80 to 90 percent of the time during the summer season, and from 60 to 70 percent of the time during the remainder of the year (Table D-2).

TABLE D-2

ANNUAL PERCENT OF OCCURRENCE OF WAVE HEIGHTS VERSUS DIRECTION

Wave Ht (Feet)	N	NE	E	SE	TOTAL
1	0.7	0.8	1.4	0.4	3.3
1-2	1.8	4.1	10.0	2.1	18.0
3-4	2.6	7.0	19.1	3.2	31.9
5-6	1.5	4.5	13.9	1.5	21.4
7	0.7	2.1	6.2	0.6	9.6
8-9	0.3	0.9	3.0	0.1	4.3
10-11	0.1	0.2	0.9	0.1	1.3
12	0.1	0.1	0.4	0.1	0.7
13-16	-	-	0.2	-	0.2
17-19	-	-	0.1	-	0.1
TOTAL	7.8	19.7	55.2	8.1	90.8

NORTHERN SWELL. Northern swell is generated in the north Pacific Ocean during winter storms. Waves may typically have periods of 10 to 15 seconds, and heights of 5 to 15 feet. Some of the largest waves reaching the Hawaiian Islands are of this type. Northern swell usually occur during the winter season from October to April.

TSUNAMI. Tsunami are impulse-generated water waves caused by catastrophic geological occurrences within an ocean basin. The orientation of the triangular-shaped bay at Hilo makes this port city susceptible to tsunami attacks from the eastern half-circle of the seismic belt extending from the Aleutian Islands down to the west coast of South America. In several tsunami occurrences (Table D-3) at Hilo, the waves were transformed into bores which devasted or damaged large areas of the city and harbor.

TABLE D-3. LIST OF SIGNIFICANT TSUNAMIS SINCE 1946[4/]

Date	Origin of Tsunami	Distance and Direction from Hawaii	Time of Arrival and Travel Time	Largest Wave Reported (Feet)
1 Apr 46	Aleutian	2000 nautical miles due north	Hilo 0645 4 hrs 55 min	30
4 Nov 52	Kamchatka	2600 nautical miles northeast	Hilo 1335 6 hrs 37 min	12
9 Mar 57	Aleutian	2000 nautical miles northwest	Hilo 0911 4 hrs 49 min	14
22 May 60	Chile	6600 nautical miles southeast	Hilo 1024 14 hrs 47 min	35
28 Mar 64	Alaska	2350 nautical miles north-northeast	Hilo 2300 5 hrs 24 min	10
29 Nov 75	Local	--	Hilo 0512 24 min	8.5

The most recent tsunami, which occurred on 29 November 1975, was unique because it was generated locally by a large scale land subsidence which occurred during an earthquake centered off the southeast coast of the island of Hawaii. This earthquake measured 7.2 on the Richter scale. The tsunami caused runups of about 10 feet along much of the Hilo District. In Hilo, the water level dropped with the recession of the first tsunami. The USS Cape Small, a Coast Guard cutter moored in Radio Bay, settled to the muddy bottom and began to list to one side. A series of waves surged in and out of the bay at approximately 15-minute intervals, smashing some small boats and washing others into docks; four boats were sunk and three damaged.[5/]

Adverse impacts resulting from location in the tsunami flood zone include the risks of destruction of property 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 requirements of the National Flood

4/ Loomis, H. G. 1976 Tsunami Wave Runup Heights in Hawaii, HIG-76-5, Hawaii Institute of Geophysics, University of Hawaii, Honolulu.

5/ Cox, D.C. and J. Morgan, 1977 Local Tsunamis and Possible Local Tsunami in Hawaii, HIG-77-14, Hawaii Institute of Geophysics, University of Hawaii, Honolulu.

Insurance Program will minimize tsunami damages. Adverse impacts resulting from increased use of the tsunami flood zone can be minimized by adequate tsunami warning. A State-wide tsunami warning system is presently operational. The harbor can be evacuated in most cases in the event of a tsunami warning. Boats would not reenter the harbor until the tsunami warning has been cancelled.

b. REFRACTION ANALYSIS.

Previous wave refraction studies for deepwater waves approaching from the North, N.22.5°E., and N. 45°E. directions were reviewed. Deepwater storm waves were analytically transformed considering refraction and shoaling to shallow water wave heights at the entrance to Hilo Bay. Refraction analyses studied for the various wave approach directions indicated that the critical direction for storm waves at Hilo Harbor is north northeast. The computed wave heights for a storm approaching from N.22.5°E were higher than any other direction. Based on a deepwater wave height of 27 feet[6/] and a wave period of 17 seconds, the maximum theoretical storm wave height incident to the entrance of Hilo Bay was computed according to SPM equation 2-77:

$$\frac{H}{H_O} = K_R K_S$$

$$H = H_O K_R K_S$$

where H = wave height in any depth

H_O = wave height in deep water = 27 feet

K_R = refraction coefficient = 0.81

K_S = shoaling coefficient = 1.30

H = 28.4 feet

6/ U.S. Army Engineer District, Honolulu, Corps of Engineers, Technical Report No. 1, 1977.

c. BREAKING WAVE CONDITION.

Assuming a wave period of 17 seconds to be characteristic of the largest storm wave, seaward bottom to have a slope m - 0.00 and H_b = 28.4 feet.

Breaker depth (d_b) from SPM figure 7-2 is:

$$\frac{H_b}{gT^2} = \frac{28.4}{32.2(17)^2} = 0.0031$$

$$d_b(max) = H_b = 1.5\ (28.4) = 43 \text{ feet}$$

$$d_b(min) = H_b = 1.28\ (28.4) = 36 \text{ feet}$$

Breaker travel distance (x_p) from SPM EQ 7-3

$$x_p = p\ H_b = [4.0-9.25m]H_b = 114 \text{ feet}$$

Based on the foregoing calculations, the design storm wave of 28.4 feet will be fully broken seaward of the 30-foot contour which is seaward of the existing Hilo Breakwater. Thus, the design wave for the small boat harbor structures within the bay will be based on the largest wave generated by either wave forecasting for shallow water within the Hilo Breakwater limits or diffraction-refraction analysis performed in accordance with procedures, techniques and diagrams described in the SPM.

d. FORCASTING FOR SHALLOW WATER WAVES.

The wave heights and periods for various wind directions, fetch lengths and average constant depths are tabulated from Coastal Engineer Technical Note I-6, March 1981.

Wind Direction	Fetch (Feet)	Average 7/ Constant Depth (Feet)	U (MPH)	H_f (Feet)	T_f Second
North	3300	20	75	2.8	2
Northeast	2100	25	75	1.5	2
Northwest	5000	35	75	2.2	2

7/ Includes design SWL (3.5 feet).

e. DIFFRACTION-REFRACTION ANALYSIS.

The previous theoretical wave diffraction-refraction studies were also analyzed, the incident wave perpendicular to the head of the existing Hilo breakwater is computed to be the maximum nonbreaking wave of 16.8 feet based on controlling depth of 21.5 (18 feet plus Design SWL) feet, m = 0.00. The results of the diffraction-refraction analysis are tabulated in the Table D-4.

6. SHORELINE CHANGES

No erosion or accretion is expected in the area as a result of the construction of the harbor. The shoreline and ocean floor in the vicinity of the site is basaltic rock, and there is no evidence of appreciable littoral drift in the area.

7. DESIGN VESSEL

The entrance channel, turning basin, and main access channel are designed to accommodate vessels up to a length of 40 feet, a beam of 15 feet, and a draft of 7.0 feet. These criteria represent the draft of a loaded tuna boat, a medium size charter fishing boat or a medium size sailboat, which are the largest vessels anticipated to use the harbor. Vessel characteristics are listed in the following tabulation:

VESSEL CHARACTERISTICS

Vessel	Length (Feet)	Beam (Feet)	Draft (Feet)
Sailboat	40	13	7.0
Charter fishing boat	35	15	5.5
Trailer fishing boat	27	7	2.5

TABLE D-4. DIFFRACTION - REFRACTION ANALYSIS

Approaching Deepwater Wave Direction	Wave Period Period (seconds)	Azimuth of Approaching Wave[8/] (degrees)	Incident Wave Height, H_i (feet)	Diffraction Coefficient K'	Refraction Coefficient K_R	Shoaling Coefficient K_S	Wave Height $H = H_i K' K_R K_S$ (feet)
North	17	139	16.8	0.40	0.31	1.47	3.1
N22.5°E	17	141	16.8	0.40	0.41	1.47	4.1
N45°E	17	134	16.8	0.40	0.41	1.47	4.1
North	14	141	16.8	0.25	0.38	1.34	2.1
N22.5°E	14	152	16.8	0.25	0.39	1.34	2.2
N45°E	14	139	16.8	0.45	0.38	1.34	3.8
North	10	147	16.8	0.35	0.23	1.15	1.6
N22.5°E	10	139	16.8	0.25	0.32	1.15	1.5
N45°E	10	151	16.8	0.14	0.35	1.15	0.9

8/ Azimuth is measured with south as zero.

8. HARBOR DESIGN

a. SELECTED DESIGN CONDITIONS

(1) DESIGN STILL WATER LEVEL (d_{swl})

$$d_{swl} = 2.6 \text{ feet} + 0.5 \text{ feet} + 0.4 \text{ feet} = 3.5 \text{ feet}$$

(2) DESIGN WAVE HEIGHTS.

Breakwater/Revetted Mole

Design wave height is based on the largest diffracted-refracted wave as shown in Table D-4.

Using H = 4.1 feet

The depth required to initiate breaking of the design wave for a slope (m) of 0.00 in front of the breakwater is determined by:

$$H_b = 0.78 d_b \qquad \text{(Fig. 7-4, SPM)}$$

or

$$d_b = \frac{H_b}{0.78} = \frac{4.1}{0.78} = 5.3 \text{ feet}$$

Since the depth at the breakwater (d_s = 11.5 feet) is greater than the computed breaking depth (d_b = 5.3 feet), the breakwater will be subjected to non-breaking waves.

b. CHANNEL AND TURNING BASIN DESIGN

Minimum Width. Required channel width is based on concurrent, 2-way passage of the design vessel. Total channel width is the sum of (1) the maneuvering lane, (2) the vessel clearance lane, and (3) the bank clearance lane. Width factors are calculated assuming good vessel operators, presence of strong and gusty wind conditions. Lane widths and total channel width based on charter crafts are:

Lane	Beam Factor X (Feet)	Width (Feet)
Bank clearance	1.5 X 15	22.5
Vessel maneuvering lane	2.0 X 15	30.0
Vessel clearance	1.0 X 15	15.0
Vessel maneuvering lane	2.0 X 15	30.0
Bank clearance	1.5 X 15	22.5
Total Design Channel Width	8.0 X 15	120.0

Channel width is increased to 180 feet at the turn into the harbor basin.

Minimum Depth. Required depth for safe navigation of the design vessel (based on sail boat) is computed as the sum of the following items at the calculated and estimated values shown:

	Channel Depth (Feet)	Basin Depth (Feet)
Loaded draft of the design vessel	7.0	7.0
Vessel squat and trim	1.0	-
Pitch and roll due to wave action	2.0	1.0
Bottom clearance	3.0	3.0
Total Channel Depth	13.0	11.0

c. PROTECTIVE STRUCTURES DESIGN

Stability Requirements. Shore Protection Manual (SPM) design formulas were used to determine the breakwater revetted mole requirements. The following factors were used in the armor layer design computations:

Unit weight of stone:	W_r = 161 pcf
Design wave height:	H = 4.1 feet
Stability coefficient:	K_D = 3.2
Specific gravity of armor unit relative to seawater:	S_r = 2.5
Cotangent of structure slope:	$\cot \theta$ = 1.5
Layer coefficient:	k = 1.15 for n = 2
Layer thickness:	n = 2
Armor stone size:	$= \dfrac{W_r H_b^3}{K_D(S_r-1)^3 \cot \theta}$
	= 700 lbs.

An acceptable range of armor stone is ± 25% of the calcuated weight.

$$\text{Armor layer thickness} = nk \left(\frac{W}{W_r}\right)^{1/3}$$

$$= 3.8'$$

Say 4.0

The underlayer stone size in accordance with SPM criterion is based on one-tenth the weight of the armor stone. However, since the material excavated from the channel is basaltic rock, this material will be used as a combined underlayer - core for the revetment works. Table D-5 summarizes the stone requirements for a stable protective structure.

TABLE D-5. STONE REQUIREMENTS

	Stone Weight (pounds)	Layer Thickness (feet)
Armor	500 - 900	4.0
Underlayer-Core	1 - 100	

The crest width was calculated using the same formula for determining armor layer thickness. For a 3-stone crest width, n = 3 and k = 1.15.

$$\text{Crest width} = nk \left(\frac{W}{W_r}\right)^{1/3}$$

$$= 5.6', \text{ Say } 6.0'$$

Stone size requirements for the harbor interior revetment based on a 2-foot wave height within the harbor and SPM procedures would require armorstone size from 60 to 100 lbs. Riprap size stones varying from 5 to 200 lbs would satisfy the requirements and would be available from the harbor dredging work.

The runup was based on existing information[9/], a runup (Ru) to design wave height (H) ratio of 1.3 is estimated for waves approaching perpendicular to a rubblemound structure. Therefore:

$$\frac{Ru}{H} = 1.1 \qquad Ru = 1.1(4.1') = 4.5'$$

and the required crest elevation equals

$$Ru + d_{swl} = 4.5' + 3.5' = 8.0'$$

9. BASIN RESPONSE TO INCIDENT WAVE CRESTS

A theoretical analysis was conducted to determine the wave periods that would increase resonant surging. The fundamental resonance period (T) is the time it takes a wave to travel from one end of the basin to the other end and back. Any multiple of this wave period may induce resonant surging. The fundamental resonance is computed as follows:

$$T = \frac{2b}{gd}$$

b = basin length, 1200 ft.
g = acceleration due to gravity, 32.2 ft/sec^2
d = basin depth, 10 ft.
T = 134 seconds

9/ WES Research Report No. 2-11, "Design of Rubblemound Breakwaters Subject to Non-Breaking Waves," 1968.

APPENDIX D

SECTION II. COST ESTIMATES

Table of Contents

Title	Page
BASIS FOR ESTIMATE	D-20
PROJECT FIRST COST	D-21

1. BASIS FOR ESTIMATE

a. Estimated quantities were based on existing topographic and hydrographic maps and surveys and typical plans and section;

b. Materials to be dredged and excavated are expected to be basalt rock requiring drilling and shooting;

c. Suitable dredged material to be disposed as fill for the revetted mole;

d. Armor stones will be obtained from commercial sources in Hilo;

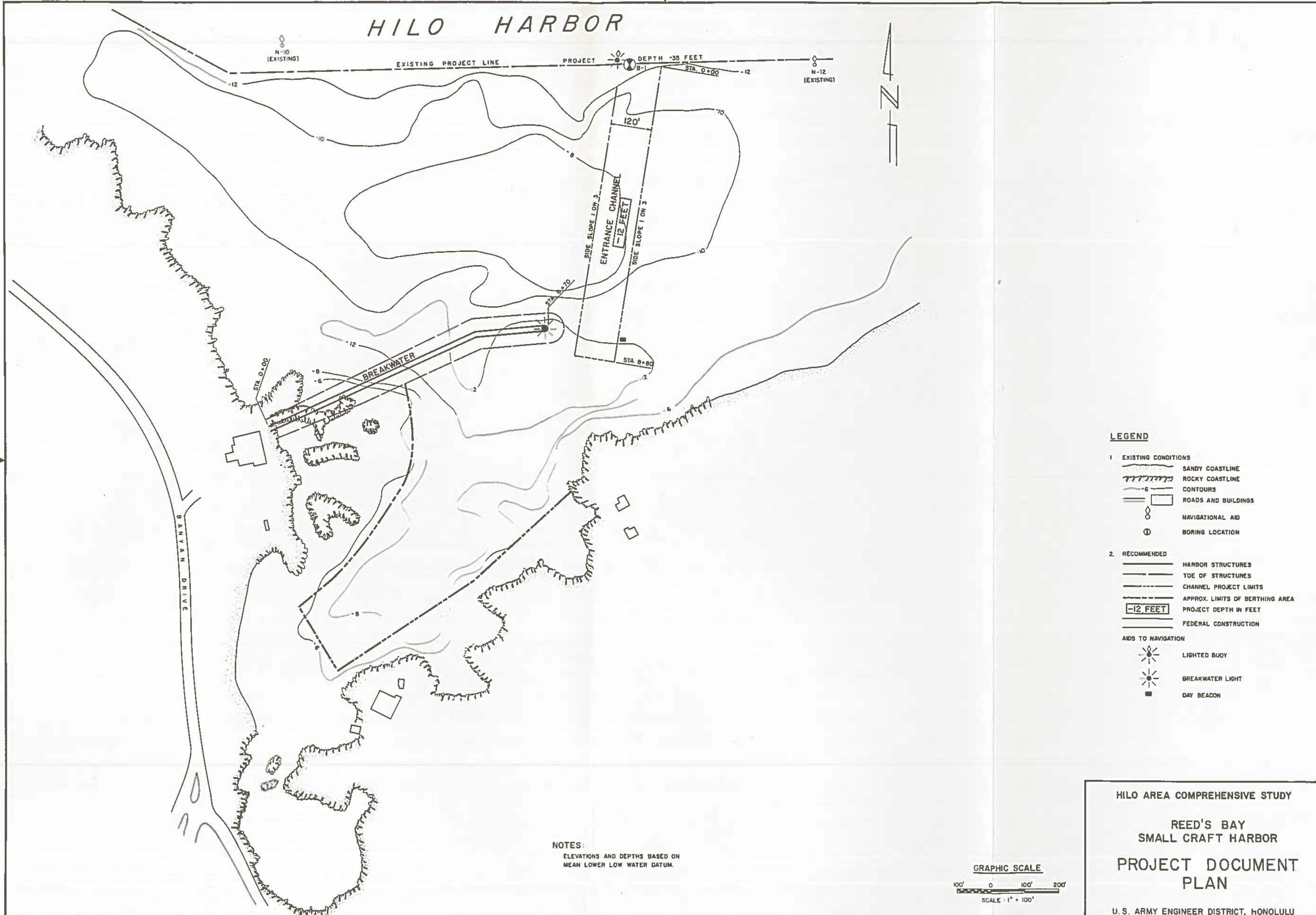
e. Estimated construction period is twelve (12) months;

f. Construction costs are based on June 1982 price levels.

2. ESTIMATED PROJECT FIRST COST

	Quantity	Unit	Unit Cost	Item Cost	Total
FEDERAL COST					
Mob & Demob	1	Job		$110,000	
Dredging	20,000	C.Y.	$ 38.	760,000	
Armor Stones	13,500	Tons	42.	567,000	
Quarry Run Stones	10,000	Tons	21.	210,000	
Dredged Fill	25,000	Tons	3.	75,000	
Subtotal					$1,722,000
Contingency 25%±					428,000
Subtotal Direct Cost					2,150,000
Engineering and Design				$260,000	
Supervision and Administration				180,000	
Total Corps of Engineers First Cost					$2,590,000
US Coast Guard Aids to Nav.				20,000	
Total Federal First Cost					2,610,000
NON-FEDERAL COST					
Fill Material	24,000	C.Y.	$ 21	$504,000	
Contingency				126,000	
Indirect				70,000	
Total Non-Federal First Cost					$ 700,000
Total Estimated First Cost					$3,310,000

AVERAGE ANNUAL OPERATION AND MAINTENANCE COST 10,000



NOTES:
ELEVATIONS AND DEPTHS BASED ON MEAN LOWER LOW WATER DATUM.

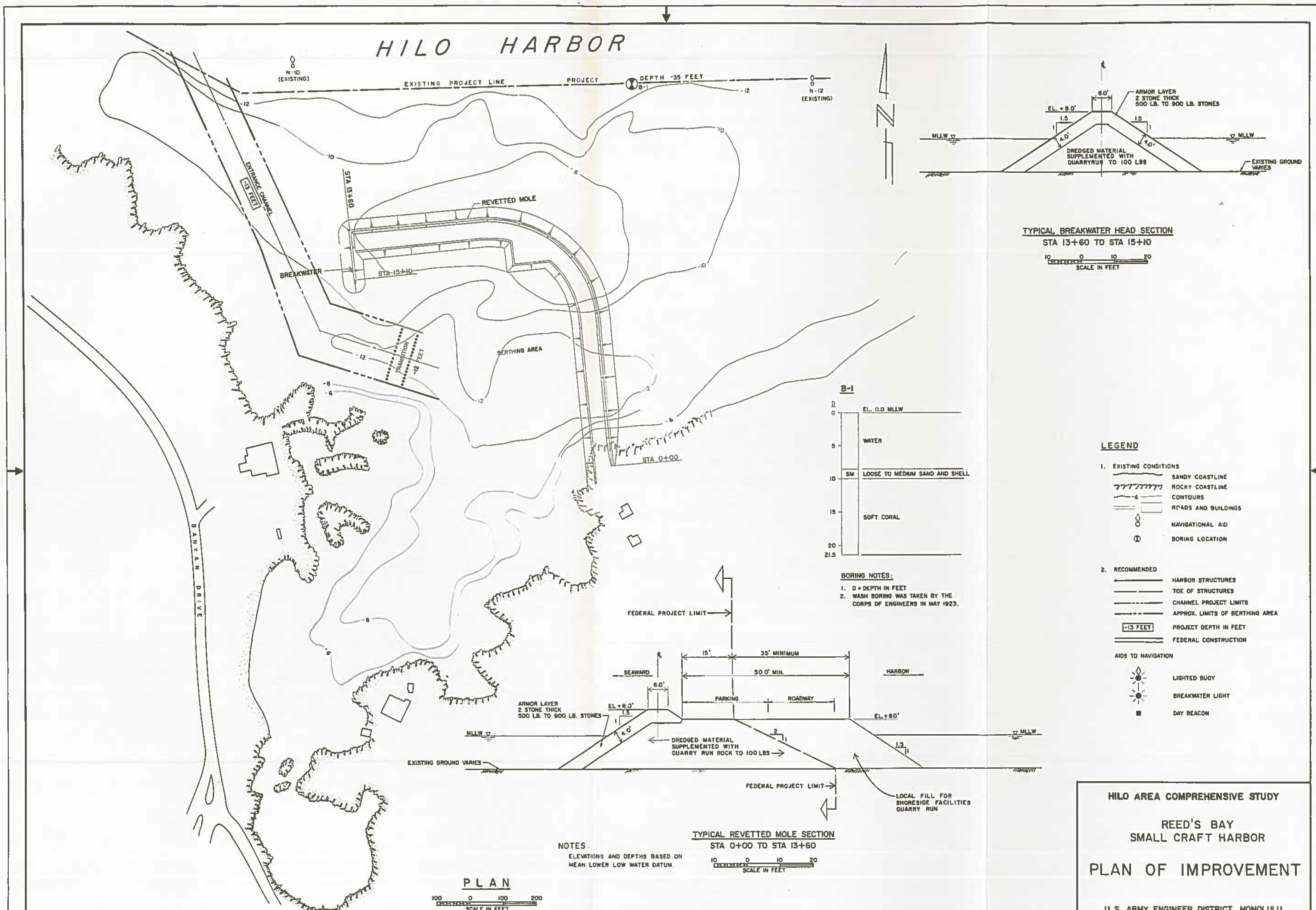
HILO AREA COMPREHENSIVE STUDY

REED'S BAY
SMALL CRAFT HARBOR

PROJECT DOCUMENT PLAN

U.S. ARMY ENGINEER DISTRICT, HONOLULU

PLATE D-2


HILO HARBOR
N-10 (EXISTING)
EXISTING PROJECT LINE
PROJECT
DEPTH -35 FEET
B-1
N-12 (EXISTING)
ENTRANCE CHANNEL
-13 FEET
STA 13+60
REVETTED MOLE
BREAKWATER
STA 15+10
TRANSITION
BERTHING AREA
STA 0+00
BANYAN DRIVE
TYPICAL BREAKWATER HEAD SECTION
STA 13+60 TO STA 15+10
ARMOR LAYER
2 STONE THICK
500 LB. TO 900 LB. STONES
EL. + 8.0'
6.0'
MLLW
DREDGED MATERIAL
SUPPLEMENTED WITH
QUARRYRUN TO 100 LBS
EXISTING GROUND VARIES
SCALE IN FEET
B-1
D
EL. 0.0 MLLW
WATER
SM
LOOSE TO MEDIUM SAND AND SHELL
SOFT CORAL
BORING NOTES:
1. D = DEPTH IN FEET
2. WASH BORING WAS TAKEN BY THE CORPS OF ENGINEERS IN MAY 1923.
LEGEND
1. EXISTING CONDITIONS
SANDY COASTLINE
ROCKY COASTLINE
CONTOURS
ROADS AND BUILDINGS
NAVIGATIONAL AID
BORING LOCATION
2. RECOMMENDED
HARBOR STRUCTURES
TOE OF STRUCTURES
CHANNEL PROJECT LIMITS
APPROX. LIMITS OF BERTHING AREA
-13 FEET
PROJECT DEPTH IN FEET
FEDERAL CONSTRUCTION
AIDS TO NAVIGATION
LIGHTED BUOY
BREAKWATER LIGHT
DAY BEACON
FEDERAL PROJECT LIMIT
SEAWARD
HARBOR
15'
35' MINIMUM
50.0' MIN.
PARKING
ROADWAY
EL.+8.0'
ARMOR LAYER
2 STONE THICK
500 LB. TO 900 LB. STONES
DREDGED MATERIAL
SUPPLEMENTED WITH
QUARRY RUN ROCK TO 100 LBS
EXISTING GROUND VARIES
LOCAL FILL FOR
SHORESIDE FACILITIES
QUARRY RUN
TYPICAL REVETTED MOLE SECTION
STA 0+00 TO STA 13+60
NOTES
ELEVATIONS AND DEPTHS BASED ON
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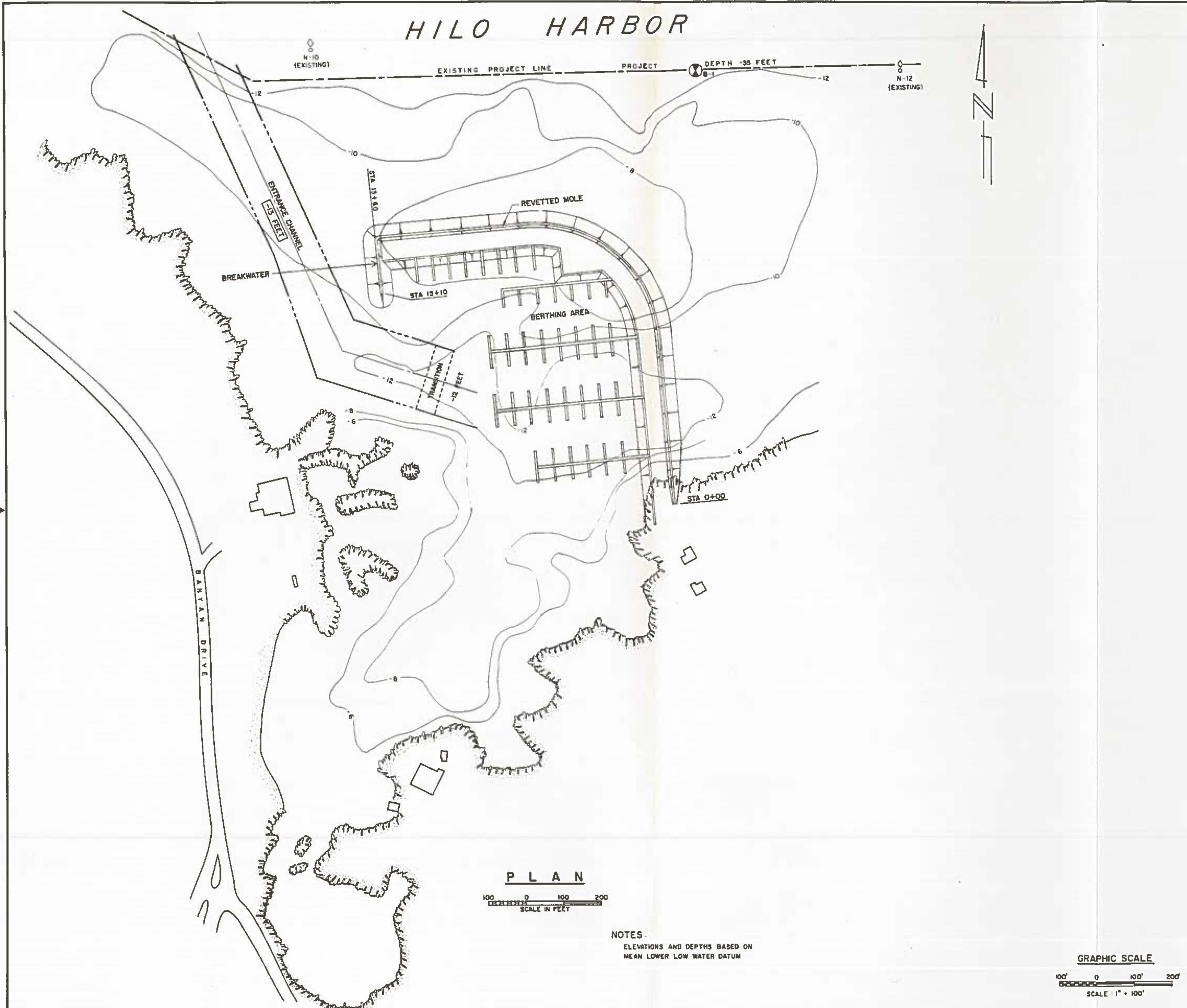
PLAN
SCALE IN FEET
HILO AREA COMPREHENSIVE STUDY
REED'S BAY
SMALL CRAFT HARBOR
PLAN OF IMPROVEMENT
U. S. ARMY ENGINEER DISTRICT, HONOLULU



LEGEND

1. EXISTING CONDITIONS
   - SANDY COASTLINE
   - ROCKY COASTLINE
   - CONTOURS
   - ROADS AND BUILDINGS
   - NAVIGATIONAL AID
   - BORING LOCATION
2. RECOMMENDED
   - HARBOR STRUCTURES
   - TOE OF STRUCTURES
   - CHANNEL PROJECT LIMITS
   - APPROX. LIMITS OF BERTHING AREA
   - -15 FEET PROJECT DEPTH IN FEET
   - FEDERAL CONSTRUCTION

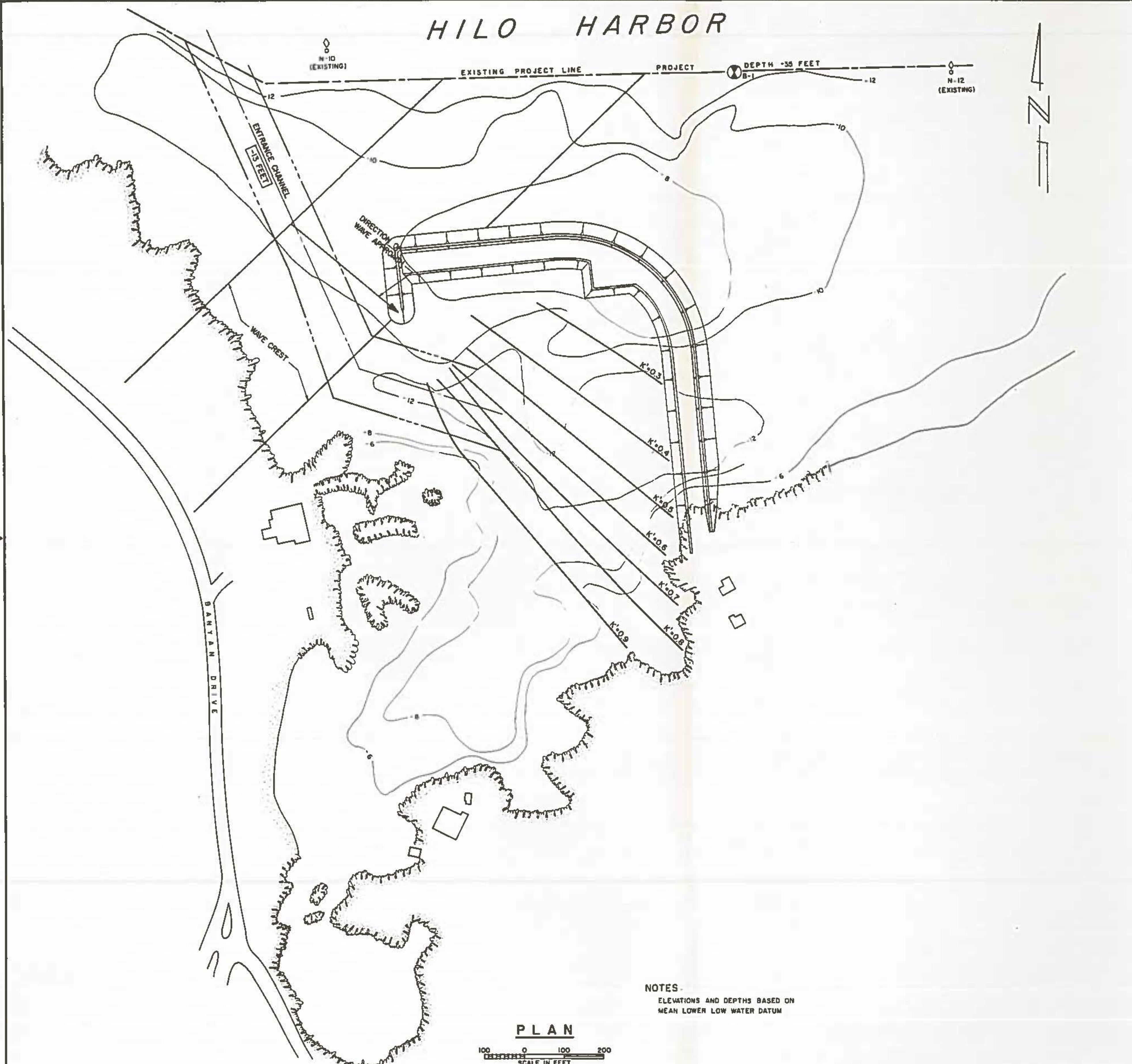
   AIDS TO NAVIGATION
   - LIGHTED BUOY
   - BREAKWATER LIGHT
   - DAY BEACON

HILO AREA COMPREHENSIVE STUDY

REED'S BAY
SMALL CRAFT HARBOR

POSSIBLE BERTHING PLAN

U. S. ARMY ENGINEER DISTRICT, HONOLULU



NOTES.
ELEVATIONS AND DEPTHS BASED ON MEAN LOWER LOW WATER DATUM

LEGEND

1. EXISTING CONDITIONS
- SANDY COASTLINE
- ROCKY COASTLINE
- CONTOURS
- ROADS AND BUILDINGS
- NAVIGATIONAL AID
- BORING LOCATION

2. RECOMMENDED
- HARBOR STRUCTURES
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- APPROX. LIMITS OF BERTHING AREA
- -13 FEET PROJECT DEPTH IN FEET
- FEDERAL CONSTRUCTION

AIDS TO NAVIGATION
- LIGHTED BUOY
- BREAKWATER LIGHT
- DAY BEACON

HILO AREA COMPREHENSIVE STUDY

REED'S BAY
SMALL CRAFT HARBOR

WAVE DIFFRACTION
DIAGRAM

U. S. ARMY ENGINEER DISTRICT, HONOLULU

SUPPORTING DOCUMENTATION

ECONOMICS

REEDS BAY SMALL BOAT HARBOR

RESOURCES AND ECONOMY

GENERAL

Hawaii is a prosperous state with a growing economy. The gross State Product in 1979 amounted to $10 billion, or almost 6 times the 1960 total. The three largest contributors to the State economy are tourism ($3.0 billion), defense expenditures ($1.3 billion), sugar production ($594 million), and pineapple production ($223 million). The most rapid growth in the past decade has been in the tourist industry. Visitor expenditures have increased over 400 percent in the ten years from 1969 to 1979. Visitor spending in 1980 resulted in tax revenues of $323 million and generated 117,000 jobs.

Hawaii County experienced a population increase of 50 percent from 1960 to 1980, nearly equalling the State's overall increase of 52 percent for the same period. The resident population of the Hilo area (Puna, North Hilo and South Hilo districts) increased by 43 percent from 39,076 in 1960 to 55,708 in 1980. Sixty percent of the population on the island is centered in the Hilo area.

The basic elements of the economy of Hawaii County are tourism, agriculture and fishing, manufacturing, and scientific research with tourism being the number one industry. Visitor expenditures for Hawaii County grew from $50 million in 1969 to $172 million in 1979. While Hilo is not noted as a destination area, its role as a gateway to and from the state suggests a continued active role in the visitor industry. As the urban, commercial, and government center for the county, Hilo has a stronger orientation toward transportation, communications and utilities, trade, services, and government. It is expected that Hilo will continue to be the major urban center on the island. The following table summarizes the demographic, general social, and economic characteristics of the County.

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TABLE 1
RESIDENT POPULATION OF HAWAII COUNTY AND DISTRICTS:
1960 TO 1980

	1960	1970	1980
The State	632,772	769,913	965,000
Hawaii	61,332	63,468	92,053
Puna	5,030	5,154	11,751
South Hilo	31,553	33,915	42,278
North Hilo	2,493	1,881	1,679
Hamakua	5,221	4,648	5,128
North Kohala	3,386	3,326	3,249
South Kohala	1,538	2,310	4,607
North Kona	4,451	4,832	13,748
South Kona	4,292	4,004	5,914
Ka'u	3,368	3,398	3,699
Median Years of School Completed1/	8.6	11.4	NA

1/ 25 years old and over.

Source: U.S. Bureau of the Census, U.S. Census of Population: 1970, PC(1)-A13, Table 10, and advance counts from the 1980 Census of Population.

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TABLE 2
INCOME, LABOR FORCE, AND EMPLOYMENT

	1960	1970	1980
Personal Income ($ Millions)	100	241	650 2/
Per Capita Income ($)	1,630	3,785	7,760 2/
Civilian Labor Force	22,270 1/	28,300	35,450
Civilian Employment	21,520 1/	27,050	33,050
Unemployment (%)	3.4	4.4	6.7
Subcount by Industry			
Total Job (Non-agriculture)	16,040	28,870	28,400
Construction	820 1/	1,500	1,650
Manufacturing	3,300 1/	2,960	2,750
Transportation, Communication, and Utilities	970 1/	1,380	1,900
Trade	3,100 1/	5,010	7,000
Finance, Insurance and Real Estate	250 1/	900	1,100
Services	1,640 1/	3,730	7,450
Government	3,050 1/	4,370	6,550
Agriculture	2,910 1/	3,610	3,250

1/ Hawaii State Dept of Labor and Industrial Relations
2/ 1979 Estimate

Source: State of Hawaii Data Book 1981; County of Hawaii Data Book 1980 and 1979, Department of Research and Development.

TABLE 3
TOURISM HAWAII COUNTY

	1960	1970	1980
Visitor Arrivals	72,300	445,401	761,000
Visitor Expenditures ($ Millions)	5.6	53.4	172 1/
Hotel Room Inventory	558	3,092	6,260
Occupancy Rate (%)	NA	68.3	52.7

1/ 1979 Estimate

Source: County of Hawaii Data Book 1981, Department of Research and Development. The State of Hawaii Data Book, 1962, Department of Planning and Economic Development.

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SMALL BOAT HARBORS

As population, income, and leisure time increase, a greater demand is being put on the existing recreational facilities in Hawaii County. Twenty years ago, in 1962, there were only 4 principal harbors for small craft on the island. Total berthing capacity was 212 craft. In 1980, the number of harbors increased to seven and total berthing capacity increased to 329 or 55 percent. Boat registration since 1970 has increased 106 percent in the county.

Table 4 lists the small boat harbors in Hawaii County and their berthing capacities. Three of the harbors used primarily for recreational boating activities are located in the Hilo area. They are Wailoa River, Radio Bay, and Reeds Bay. The Wailoa River site is located in central Hilo and is part of the Wailoa State Park. The facility has approximately 54 berthing spaces, 2-lane ramp, loading dock, parking for 20 cars with trailer, restrooms, picnic areas, boat wash area, and freashwater faucets. Expansion of the Wailoa River site has significant limitations due to the low clearance under the Wailoa Bridge downstream at the river mouth. Sailboats and other vessels with higher profiles exceeding 11 feet are barred from using the facility. However, the concrete launching ramp is used extensively. In 1970, an estimated 4,000 launchings were made by local boaters. Reports have indicated that boating demands in the Hilo area have increased considerably since construction of the ramp in 1958 and it is now inadequate to meet the needs of local users.

Radio Bay small boat harbor is located just east of the Hilo deep draft harbor facilities. The bay has approximately 11 berths with mooring by anchor in the middle of tne bay for 10 more craft. The bay is used primarily for moorage of transient boats. It is also used to moor commercial fishing boats which come in from Kona to fish in the Hilo area. The Department of Transportation is considering plans to fill in a portion of the bay to expand the container storage yard at the commercial port.

Reeds Bay is a small inlet on the eastern side of Waiakea Peninsula next to the hotel district. It has long been considered a potential site for development of a small craft facility. Existing facilities in the bay include anchor moorings for approximately 16 sailboats, restrooms, and picnic area.

TABLE 4

PRINCIPAL HARBORS FOR SMALL CRAFT
HAWAII COUNTY

Harbor	Number of Berthing or Mooring Facilities 1962	1981
West Hawaii County		
Honokohou	0	164
Kawaihae	27	58
Kailua-Kona	49	9 1/
Keauhou	61 2/	16
East Hawaii County (Hilo area) 3/		
Wailoa River	75 4/	54 4/
Reeds Bay	0	16
Radio Bay	0	12

1/ The number of moorings have been reduced because the bay is a high risk area for mooring. Honokahau now provides refuge and permanent all weather wet storage for the area.

2/ Includes mooring capacity by anchor in middle of bay. (Area considered high risk today.)

3/ Field investigations and surveys indicated there were 110 moored craft in the Hilo area in 1980. The State Harbors Division reported available berthing capacity of 82 for the same period.

4/ The reason there are 21 less spaces in 1981 is that boats were moored abreast in the 1960's. This berthing arrangement is no longer permitted in the basin.

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ECONOMICS

GENERAL

The projects for a small recreational boat harbor in Reeds Bay, Hilo, was authorized under Section 107 of the 1965 River and Harbor Act, as amended. The purpose of this section is to reevaluate the existing and future monetary benefits estimated in the authorizing document in light of current conditions and criteria.

METHOD OF ANALYSIS

In 1980 a study was conducted to evaluate the economic feasibility of a shallow draft harbor to serve the Hilo recreation boating and commercial fishing needs. The report is titled Benefit Analysis of Hilo Light Draft Harbor. The report analyzed the feasibility of a 250-, 300-, and 350-slip small boat harbor. It also estimated increased use of proposed facilities by trailer-mounted craft. The analyses were based on projections of future recreational and commercial boating activity in the Hilo area which included Puna, South Hilo, and North Hilo districts. The projections assumed ideal conditions of unrestricted access to berthinq and launching facilities. The data, projections, and benefit analysis for recreational boating demand in the report were used to determine the existing and future use and feasibility of Reeds Bay small boat harbor. The data has been revised to reflect current economic and demograpiic conditions. Annual benefits have been recomputed using the current discount rate of 7-7/8 percent and updated to January 1982 price levels. Project life is assumed to be 50 years and 1985 was selected as the base year when the project would be completed and benefits begin accruing to users.

BENEFITS

Reeds Bay small boat Harbor will provide wet storage for 100 recreational boats. Excess demand for wet storage in the Hilo area was over 90 recreational craft in 1980. This figure is projected to increase to approximately 123 craft in 1985. Thus, 100 percent of the benefits that will accrue to users of Reeds 8ay small boat Harbor will occur in the first year of operation.

Tables 1 and 2 project boating demand and commercial and recreational boat distribution with and without additional boating facilities in the Hilo area. Table 3 analyzes the recreational boating benefits to users of Reeds Bay. Based on these tables and the findings in the report, Reeeds Bay small boat harbor will only partially meet the growing demand for recreational boating facilities in the Hilo Area. Net average annual benefits to the Reeds Bay project are estimated at over $340,000.

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TABLE 1
EXISTINGS AND PROJECTED FLEET

Year	Hawaii Population (1,000's)	July 1, Hilo Trib. Area Population (1,000's)	Hilo Trib. Area Registered Crafts	Hilo Trib. Area Total Crafts	Hilo Trib. Area Moored Craft Capacity	Excess Demand for Moored Space Moored Space	Dry-Stored Craft	Hilo Trib. Area Craft/1000 Population[7]/
1970	64.4	41.0	292[9]	---	43	---	249	7.1
1971	68.1	42.9	293	---	43	---	250	6.8
1972	69.0	43.6	340	---	67	---	273	7.8
1973	71.3	45.2	382	---	99	---	283	8.5
1974	73.2	46.9	383	---	100	---	283	8.2
1975	75.3	48.4	428	---	100	---	328	8.8
1976	77.8	49.4	456	---	100	---	356	9.2
1977	79.2	50.7	524	---	100	---	424	10.3
1978	80.9	51.3	565	---	106	---	459	11.1
1979	83.7	53.2	---	631[10]	106	(146)[6]	525	11.9
1980	92.1[1]	55.7	---	723[4]	106[8]	(163)	572	12.9
1985	95.2[2]	59.0[3]	---	885	---	(317)[5]	568	15.0
1990	105.1	63.0	---	1071	---	(383)	688	17.0
1995	115.0	67.9	---	1221	---	(437)	784	18.0
2000	123.3	71.5	---	1359	---	(487)	872	19.0

Notes: ( ) Projected or extrapolated
1. Census
2. Projections for 1980-2000 based on II-F projections by County established by State Department of Planning and Economic Development, 1979 preliminary.
3. Puna, South Hilo, and North Hilo Districts. Population distribution of II-F projections per Hawaii Water Resources Regional Study, Social Base - Study Element Report, p. 36.
4. Modified projection to reflect 1980 census data.
5. Demand for additional moored berths (211) plus existing (106) = 317.
6. Determined from boater responses to Hawaii State-Wide Boating Survey (1980).
7. Projected graphically; historical data per Report of Undocumented Vessel Registration, State of Hawaii, Dept of Transportation 1970-1979 indicates a decreasing rate of increase that will likely level off at 19 craft per 1,000 population in year 2000.
8. Harbor capacity is locked at this level without new small boat harbor.
9. Corps of Engineers State-Wide Boating Survey results show that 33% of the registered crafts are within the the Hilo Tributary Area - assumed constant from 1970-1978.
10. Includes documented (20) crafts.

Source: "BENEFIT ANALYSIS OF HILO LIGHT DRAFT HARBOR," Pacific Ocean Division, Corps of Engineers, August 1980.

TABLE 2

FLEET DISTRIBUTION

	PARAMETERS			COMMERCIAL FISHING					RECREATION							TRANSIENT
									WET-STORED					TRAILERED		
Year	No. Boats	Wet Stored	Dry Stored	Full-Time Wet	Full-Time Dry	Part-Time Wet	Part-Time Dry	Total	Out-Brd	Sail	Sail with Power	Cruisers & Inbds.	Total	No.	Full-Time Equiv.	
Without Improvments																
1979	631	106	525	26	26	26	189	267	10	4	21	19	54	310	212	4
1980	723	106	617	26	30	26	224	306	10	4	21	19	54	363	249	4
1985	885	106	779	26	47	26	276	375	10	4	21	19	54	456	312	4
1990	1071	106	1065	26	62	26	339	453	10	4	21	19	54	564	386	4
1995	1221	106	1215	26	75	26	390	517	10	4	21	19	54	650	445	4
2000	1359	106	1253	26	86	26	437	575	10	4	21	19	54	730	500	4
With Improvments																
1979	631	106	525	26	26	26	189	267	10	4	21	19	54	310	212	4
1980	723	106	617	26	30	26	224	306	10	4	21	19	54	363	249	4
1985	885	317	568	50	23	90	212	373	33	13	69	62	177	333	228	8
1990	1071	383	688	60	28	109	256	453	40	16	83	75	214	404	277	8
1995	1221	437	784	69	32	124	292	517	45	18	95	86	244	460	315	8
2000	1359	487	872	77	35	138	325	575	50	20	106	96	272	512	351	8

Note: 1. Unconstrained after 1985 except for equivalent transient craft which are shown limited by the space allotted to them.

Source: "BENEFIT ANALYSIS OF HILO LIGHT DRAFT HARBOR," Pacific Ocean Division, Corps of Engineers, Aug 1980.

TABLE 3
RECREATIONAL BENEFITS REEDS BAY SMALL BOAT HARBOR

Year	WET STORED					TRAILERED			
	Outboard	Sail	Sail w/ Power	Cruisers/ Inboards	Total	No.	Full-Time Equiv.	Transient	Total
Prospective Fleet w/o Reed's Bay									
1980	10	4	21	19	54	363	249	4	
1985	10	4	21	19	54	456	312	4	
1990	10	4	21	19	54	564	386	4	
2000	10	4	21	19	54	730	500	4	
2035	10	4	21	19	54	730	500	4	
Prospective Fleet w/ Reed's Bay									
1980	10	4	21	19	54	363	249	4	
1985	29	11	60	19	154	356	244	8	
1990	29	11	60	19	154	464	318	8	
2000	29	11	60	19	154	630	432	8	
2035	29	11	60	19	154	630	432	8	
Returns/Craft ($)									
Average Depreciated Value[1]	4,679	8,327	45,045	38,370			5,103	41,708	
% Annual Return	15	12	9	9			13	9	
Net Annual Return (w/Reeds Bay)	702	999	4,054	3,453			765	3,754	
Net Annual Return (w/o Reeds Bay)	562	799	3,446	2,935			612	3,191	
	(80%)	(80%)	(85%)	(85%)			(80%)	(85%)	
Annual Returns (w/Reeds Bay) ($)									
1985	20,358	10,989	243,240	186,462	461,049		186,660	30,032	
1990	20,358	10,989	243,240	186,462	461,049		243,270	30,032	
2000	20,358	10,989	243,240	186,462	461,049		330,480	30,032	
2035	20,358	10,989	243,240	186,462	461,049		330,480	30,032	
Annual Returns (w/o Reeds Bay) ($)									
1985	5,620	3,196	72,366	55,765	136,947		190,944	27,780[3]	
1990	5,620	3,196	72,366	55,765	136,947		236,232	27,780	
2000	5,620	3,196	72,366	55,765	136,947		306,000	27,780	
2035	5,620	3,196	72,366	55,765	136,947		306,000	27,780	
Total Net Gain ($)									
1985	14,738	7,793	170,874	130,697	324,103		(4,284)	2,252	322,070
1990	14,738	7,793	170,874	130,697	324,103		7,038	2,252	333,392
2000	14,738	7,793	170,874	130,697	324,103		24,480	2,252	350,834
2035	14,738	7,793	170,874	130,697	324,103		24,480	2,252	350,834
Equivalent Average Annual Benefit (7-7/8%) ($)									340,460

TABLE 3
RECREATIONAL BENEIFTS REEDS BAY SMALL BOAT HARBOR (Cont)

1. Updated to reflect current 1982 price levels.
2. Estimated at 80% of Annual Returns on recreational boating investment for outboards and sailboats and 85% for the larger sailboats with power, cruisers, and inboards.
3. Computed based on the full annual return on investment being realized by four boat operators and 85% of the annual return on investment of four other boat operators who would take advantage of available transient space, but are not able to.

Source: "BENEFIT ANALYSIS OF HILO LIGHT DRAFT HARBOR," Pacific Ocean Division, Corps of Engineers, Aug 1980, and TABLE 2.

SUPPORTING DOCUMENTATION

GEOLOGY

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<u>Geology</u>

(1) <u>General</u>. - The majority of geological data is based on findings gathered during the investigations for the construction of the breakwater expansion on Blonde Reef and periodic dredging of the navigation channel of Hilo Harbor.

(2) <u>Regional Geology</u>. - The island of Hawaii, the largest of the Hawaiian Archipelago, covers an area of over 4,000 square miles. The island was formed during the last 800,000 years by the gradual emergence and subsequent coalescence of five volcanoes; Mauna Loa and Kilauea, which are still active, Hualalai, which last erupted in 1801, Mauna Kea, which has been inactive in recent geologic time, and Kohala, which has been extinct for eons.

The volcanic mountains are generally oval and dome-shaped. Mauna Loa rises from a base 15,000 feet below sea level to 13,680 feet above sea level. It is the largest active volcano and is considered the biggest single mountain on earth. These five mountains have been formed almost entirely by the accumulation of thousands of thin flows of lava, each separate flow averaging less than ten feet in thickness. The broad, smooth, dome shapes have given rise to the name of "shield" volcanoes. Nowhere are the lower slopes of the mountains steeper than twelve degrees with the average slope around six degrees. Gentle, flat slopes extend outward beneath the water to the sea floor.

The city of Hilo and the breakwater are located where the lower slopes of Mauna Loa and Mauna Kea merge. The surface of the ground in South Hilo, Waiaka District, has a gentle, flat slope northward toward the ocean of one-foot in 400 feet, or less than one degree.

Hilo Bay is a broad identation in the northeastern coastline of the island created by the Hamakua volcanic series of Mauna Kea and the Ka'u volcanic series of Mauna Loa. Recent scoriaceous, black lava flows from Mauna Loa have formed the entire central and southern half of the Bay. Older flows from Mauna Kea have made vertical, high, wave-cut cliffs along the north side of the bay. The existing breakwater structure is built on a coral-limestone reef over lava. Marine sediments consisting of fine and medium grained sand and silt from volcanic sources interspersed with fragments of coral limestone and cover the narrow beach and form the ocean floor in shallow water.

East of Wailuku River the surface rocks consist of the Ka'u volcanic series of Mauna Loa, an extremely permeable basalt that is too recent in origin to have had formed a deep soil and saprolite top layer. Patches of Pahala ash on some older Mauna Loa lavas near the Wailuku River are insignificant in contrast to the wide extent of bare Ka'u lava over the remainder of the area.

(3) Site Geology. - Geologic studies have not been made specifically for Reeds Bay and only generalities from nearby wash probings and the topography of Hilo Harbor and vicinity were used in preparing the site geology.

Reeds Bay is a natural embayment in the south central side of Hilo Bay, bounded on the west by Makaoku Peninsula and on the east by the Waiakea Flatlands. The two physical features, a peninsula and the flatlands, were made by different lava flows. Mauna Loa was the source of lava for both features. The shoreline around Reeds Bay is jagged and irregular. The basalt exposed at water level is black (wet) to dark gray (dry) with large cavities (tubes) and discontinuous layers. A thin mantle (less than two feet estimated) of reddish-brown clay with pieces of broken basalt covers the surface back from the shoreline. The beach or shoreline is marked by a thin layer (less than one-foot thick) of black basalt silty sand deposited as backwater material from Hilo Bay. The composition and thickness of the black sand varies with the time of the year and amount of disturbance to the materials on the floor in Hilo Bay. At the head of Reeds Bay is Kauakea Pond, a deep (50 feet estimated) cavity or tube formed at the intersection of the Mokaoku Peninsula and the Waiakea Flatlands. Large springs of fresh water flow into Reeds Bay, and the water in Kauakea Pond during the rainy season loses much of its saltiness.

Seismicity

Hawaii has the highest density of earthquakes (occurrence rate of magnitude two and greater earthquakes per unit area) in the United States. During the past 18 years, about 48,000 earthquakes in Hawaii have been located and their magnitude determined. Of these, more than 3,000 events were of magnitude 3.0 to 7.2; magnitude 3.0 is generally the threshold of felt earthquakes.

The strongest earthquakes in historic time in the islands occurred on April 2, 1868 and was centered along the south coast of the island of Hawaii. The earthquake had a Richter magnitude of about 7.5 and caused a Tsunami and earth movement which did serious damage across the entire island, even stopping clocks as far away as Honolulu. Practically all earthquakes on the island of Hawaii and Maui are associated with intermittent volcanic activity. However, potential earthquakes in the islands can also be caused by deep seated tectonic forces and not from the indirect action of volcanic activity. A Richter magnitude 7 earthquake on January 23, 1938 had an epicenter 25 miles north of Pauwela Point on the north shore of Haleakala, Maui. Recent explorations of geophysical methods show that faults and rift zones cut through the major islands and that these faults are branches of a gigantic fracture system known as the Molokai Fracture Zone.

The only major earthquake since 1938 occurred on April 26, 1973. The tremor registered 6.2 on the Richter scale and was centered offshore about twelve miles northeast of Hilo, Hawaii and about 35 miles deep.

The Army Technical Manual 5-809-10 (Feb 1982) assigns a zone four (4) seismic risk rating for the southern half of the island of Hawaii and Hilo area for design considerations.

The magnitude of Hawaiian earthquakes was not routinely determined locally until 1958. Prior to that, magnitudes of large earthquakes were measured by seismograph stations on continental United States, usually by those at the California Institute of Technology, University of California at Berkeley, and Columbia University.

Subsurface Investigations

No recent subsurface investigations were performed for the Reeds Bay Small Boat Harbor project. Borings drilled in the past amount to a series of 15 borings drilled approximately 1,000 feet outside of the bay in 1923, Corps of Engineers*.

In addition, 49 water jetting (wash borings) were "drilled" and sampled in 1980 for the Hilo Area Comprehensive Study. Four of these probings, Station No's. 7-1, 8-1, 8-2, and 9-1 were in the subject project area. The location of these probings is figure 1.

Jet probing was accomplished using a 2" pump and up to 100' of 2" hose attached to a 10' length of 1" pipe. A diver (SCUBA) jetted the pipe vertically into the bottom until some type of refusal was encountered. The refusal was classified as either "hard" indicating firm bottom material was reached, "cruchy" indicating gravel or shells were encountered limiting further penetration, or "seizing" generally caused by a collapse of the sidewalls of the probe hole resulting a halt to penetration. In some instances this latter type of resistance is confused with a lack of sufficient hose to penetrate further often caused by the boat drifting off position. In either instance, the seizing type of refusal suggests that the sediment is possibly thicker than the amount shown.

At stations selected for sampling, a surface sample was obtained before jetting began by the diver in a one quart plastic bag. In some instances a "wash" sample was taken from around the perimeter of the probe hole after the probe was extracted to obtain a composite sample of the subsurface sediments. In general wash samples were not taken where mud was encountered throughout the probing range. Since the subsurface mud is washed up and away from the probe hole in suspension, it does not settle out around the hole; thus wash samples are meaningless under these sediment conditions. In some rubble, the wash sample was taken by the diver by reaching to the bottom of the probe hole (see sample 5-6-W). Samples are designated by their station number with the suffix S or W to denote surface or wash sample and were used to aid in the classification of site materials. A summary of the four wash sample probing follows:

Station Number	Water Depth (Feet)	Probing Depth (Feet)	Type of Refusal	Comments	Sample Number
7-1	11	2	Hard	White Sand	None
8-1	12	1	Hard	Sand, gravel	8-1-S
8-2	9	6	Hard	Coral rubble over sand and gravel	None
9-1	10	3	Crunchy	Sand and gravel over rubble	None

The strata at the site is anticipated to be a thin sediment layer of bay silts and residue, underlain by a series of thin, recent basalt flows. Lenses and pockets of silts, sands, and gravels may occur throughout the harbor bottom surface.

Design and Construction Considerations

(1) Foundation Condition. - The basalt bay floor should provide adequate bearing for the breakwater. However, clinker material from basalt flows or sand and sediment layers on the ocean floor may exist and should be cleared away from the breakwater foundation or designed toe protection provided to prevent undermining by currents.

(2) Slopes. - Excavation into the bay floor for channels and basin should be designed no steeper than 1 vertical to 1 horizontal. Rough and irregular cut slopes may result due to variances in the foundation materials. Slopes for the breakwater should be no steeper than 1 vertical to 1.5 horizontal.

(3) Excavation. - Drilling and blasting will be required to remove the hard basalt layers of foundation material in the entrance channel or basin, depending on proposed depths. Excavated material may be used for the core of the breakwater, if found to be of suitable quality. The remainder will be spoiled in waste areas to be determined.

(4) Turbidity. - Excavation and breakwater construction activities may cause turbidity through the Reeds Bay and west Hilo Harbor areas. Control of turbidity may be required.

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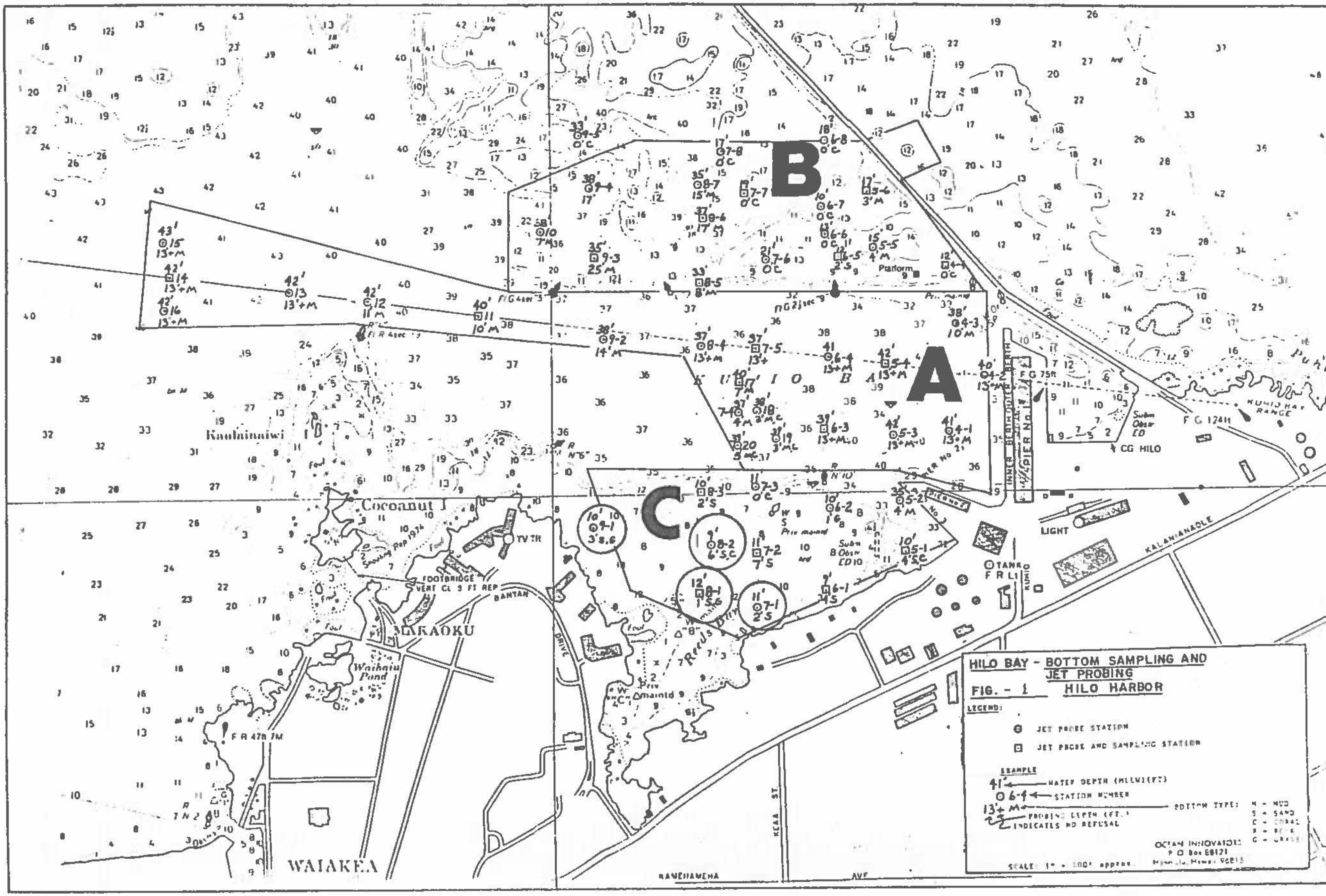
* Reference "Hilo Area Comprehensive Study, Draft Navigation Report", page E-8.

Sources of Materials

Two commercial quarries operate in the Hilo area, Glovers Quarry and the Y and S Quarry. Both are located in the industrial Waiakea District about one mile south of the Terminal Building at the General Lyman Airfield, or one mile from the project site. The two quarries work the same deposit which was described in detail in Design Memorandum No. 2: Construction of Tsunami Protection and Navigation Improvement Project, Hilo, Hawaii. The rock is a prehistoric member of the Ka'u volcanic series in the Mauna Loa groups of igneous rocks.

Both quarries supply aggregate site material for paving operations. Neither quarry operates to produce armor stone sizes (larger than 100 lb. pieces), and special arrangements have to be made in advance for small amounts of large stones to be stockpiled in both quarries from time to time.



A
B
C
Coconut I
Kaulainaiwi
MAKAOKU
Waihaiu Pond
WAIAKEA
BANYAN DRIVE
KALANIANAOLE
KAMEHAMEHA AVE
KEAA ST
FOOTBRIDGE VERT CL 3 FT REP
LIGHT
CG HILO
Platform
HILO BAY - BOTTOM SAMPLING AND JET PROBING
FIG. - 1 HILO HARBOR
LEGEND:
JET PROBE STATION
JET PROBE AND SAMPLING STATION
EXAMPLE
41' WATER DEPTH (MLLW)(FT)
6-4 STATION NUMBER
13'+ M BOTTOM TYPE: M = MUD S = SAND C = CORAL
PROBING DEPTH (FT.)
INDICATES NO REFUSAL
OCEAN INNOVATORS
P O Box 68121

HILO AREA COMPREHENSIVE STUDY COMPONENTS