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[IVER AND HARBOR, FLOOD CONTROL, AND BEACH EROSION CONTROL PROJECTS

IN THE

STATE OF HAWAII

REPORT

TO THE

[COMMITTEE ON PUBLIC WORKS
UNITED STATES SENATE

BY

SENATOR STEPHEN M. YOUNG, Chairman
SUBCOMMITTEE ON FLOOD CONTROL—RIVERS AND HARBORS

ON

A SPECIAL ON-SITE INSPECTION

MADE ON

NOVEMBER 18–23, 1968

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LETTER OF TRANSMITTAL

DECEMBER 31, 1968.

To the Committee on Public Works:

MY DEAR COLLEAGUES: I have felt for a long time that the interests of our sister States of Alaska and Hawaii, especially in the field of water resource development, are not adequately taken care of by the Congress. This, I am sure, is due in part to the great distances that separate these States from the mainland, making physical inspections difficult.

The committee has during the 90th Congress made inspections and held public hearings in the State of Alaska. The information thus obtained will be most helpful to the committee and the Congress in determining the future needs of that State.

However, the committee has never conducted an investigation of the water resource needs and problems of the State of Hawaii. Therefore, I requested the Honorable Stephen M. Young, chairman, Subcommittee on Flood Control—Rivers and Harbors, to make such an investigation in order that the committee would be more adequately informed on the river and harbor, flood control, and beach erosion control matters in the fiftieth State.

During the period of November 18 to November 23, 1968, Senator Young conducted an on-site inspection of the water resource projects and problems in the State of Hawaii that are under the jurisdiction of Honolulu district of the Corps of Engineers, U.S. Army. His findings and recommendations are contained in this report.

I appreciate Senator Young taking time from his busy schedule to make this inspection. I am sure his report will prove to be a very valuable source of information and reference for the Committee on Public Works.

Truly,

JENNINGS RANDOLPH,
Chairman, Committee on Public Works.



Colonel Walter Winegar, Senator Stephen M. Young, Mr. Herman Fong, Capt. Leonard Hasse, Jr., and Mr. Joseph Van Vladricken at the site of the Honokahau Harbor Project, Kona, Island of Hawaii

LETTER OF SUBMITTAL

DECEMBER 11, 1968.

HON. JENNINGS RANDOLPH,
Chairman, Committee on Public Works,
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: Recently, I completed an on-site investigation of various civil works projects in the State of Hawaii. Details of the investigation, conducted from November 18 through November 23, 1968, together with other appropriate information are set forth in the attached report.

My inspections were made both on the ground and by aerial reconnaissance. Projects viewed were located on the islands of Oahu, Molokai, Maui, and Hawaii, and included navigation, flood control, and beach erosion improvements.

During the course of my inspections I met with the Corps of Engineers, State and county officials, representatives of water resource development associations, and others. I was impressed with the great interest that is shown by all concerned in the present and future development of the water resources of the State of Hawaii.

As a result of this inspection, I find there is a need to reexamine certain previously approved projects, institute additional investigations in the interest of navigation, flood control, and beach erosion control, and to pursue other authorized projects with greater vigor.

I am quite concerned with the lack of progress on the Hilo Harbor tidal wave project. This project was approved by Congress after the disastrous tidal wave of May 1960 which caused damages estimated at $22 million and killed 61 people. Previously, the tidal wave which struck in 1946 practically devastated the Hilo area, causing property damage estimated at $26 million, with a loss of 96 lives. We must assure ourselves that in the event of a similar recurrence of such a storm, lives and property will be adequately protected.

I took note of the vast industrial development that is taking place in the area known as Barbers Point on the island of Oahu. To accommodate the commercial activity that will be generated by this industrial complex, a deep-draft harbor has been approved by the Congress at this location. It is my understanding that the necessary engineering and design work is nearing completion by the Corps of Engineers. Inasmuch as the planning work is about completed, and in view of the great need for this additional deep-draft harbor to serve the needs of both present and prospective commerce, I urge the early appropriation of funds for its construction.

The need for additional improvements in the interest of navigation, flood control, and beach erosion control was brought to my attention by interested parties. I find that there is a definite need for additional harbors and other navigation facilities throughout the islands. Floods continue to plague urban and rural areas and the devastation of the beaches which are so important to the economy of the islands continues unchecked. In order to determine the economic justification and engineering feasibility of projects to meet the water resource needs of the State of Hawaii, surveys must be prepared by the Corps of Engineers. My report covers those localities which I consider should be investigated at an early date.

While my stay in Hawaii was limited due to the pressure of other committee business, I do feel that much was accomplished in a short space of time. I was not able to see all of the projects that have been approved by the Congress for the State of Hawaii, but those that I did inspect represent a cross section of the approved water resources program under jurisdiction of the Army Corps of Engineers.

I wish to thank all those individuals who played a part in making my stay productive as well as enjoyable. I particularly want to thank Col. Walter Winegar, Deputy Division Engineer of the Pacific Ocean Division, Corps of Engineers, who was so helpful in making arrangements for my inspection trip. Colonel Winegar is an exceptionally fine engineer and a credit to the military service. I also want to express my appreciation to Colonel John Hughes, the District Engineer at Honolulu for his valuable assistance, and to Mr. Clarence Fujii, of the Honolulu district engineering division. Mr. Fujii is well versed in the civil works activities of the State of Hawaii, which contributed a great deal to my understanding of the water resource projects and problems of that State.

In closing, Mr. Chairman, let me say that I appreciated the opportunity to go to Hawaii to review first hand the authorized water resource program of that State. I hope the committee, the Senators from the State of Hawaii, and the Congress will act promptly on those measures I have recommended for the continued development of the navigation, flood control, and beach erosion control programs for our 50th State.

Sincerely yours,

STEPHEN M. YOUNG,
Chairman, Subcommittee on Flood Control—Rivers and Harbors.

FOREWORD

The Committee on Public Works of the U.S. Senate is responsible for initiating legislation leading to the authorization of projects for construction by the Army Corps of Engineers, in the interest of flood control, navigation, hydroelectric power development, beach erosion control, recreation, and other beneficial water resource purposes.

It is also the responsibility of the committee to take necessary actions to insure that a survey investigation program is maintained by the Corps of Engineers, thus providing a basis upon which the Congress may take action to provide for the improvement on a continuing basis of the Nation's rivers, harbors, coastal areas, and other waterways.

A periodic check of the progress being made in the authorized improvement of our rivers and harbors is necessary to insure the optimum development of this vital resource. Therefore, it is incumbent upon the Public Works Committee of the U.S. Senate to learn first hand about the nature and extent of problems confronting the States in water resource matters.

This report contains information on navigation, flood control, and other projects in the State of Hawaii, under jurisdiction of the Honolulu district of the U.S. Army Corps of Engineers. It also reports on the problems facing that State in its quest for the maximum development of the water resources of the islands in the interest of single- as well as multiple-purpose development.

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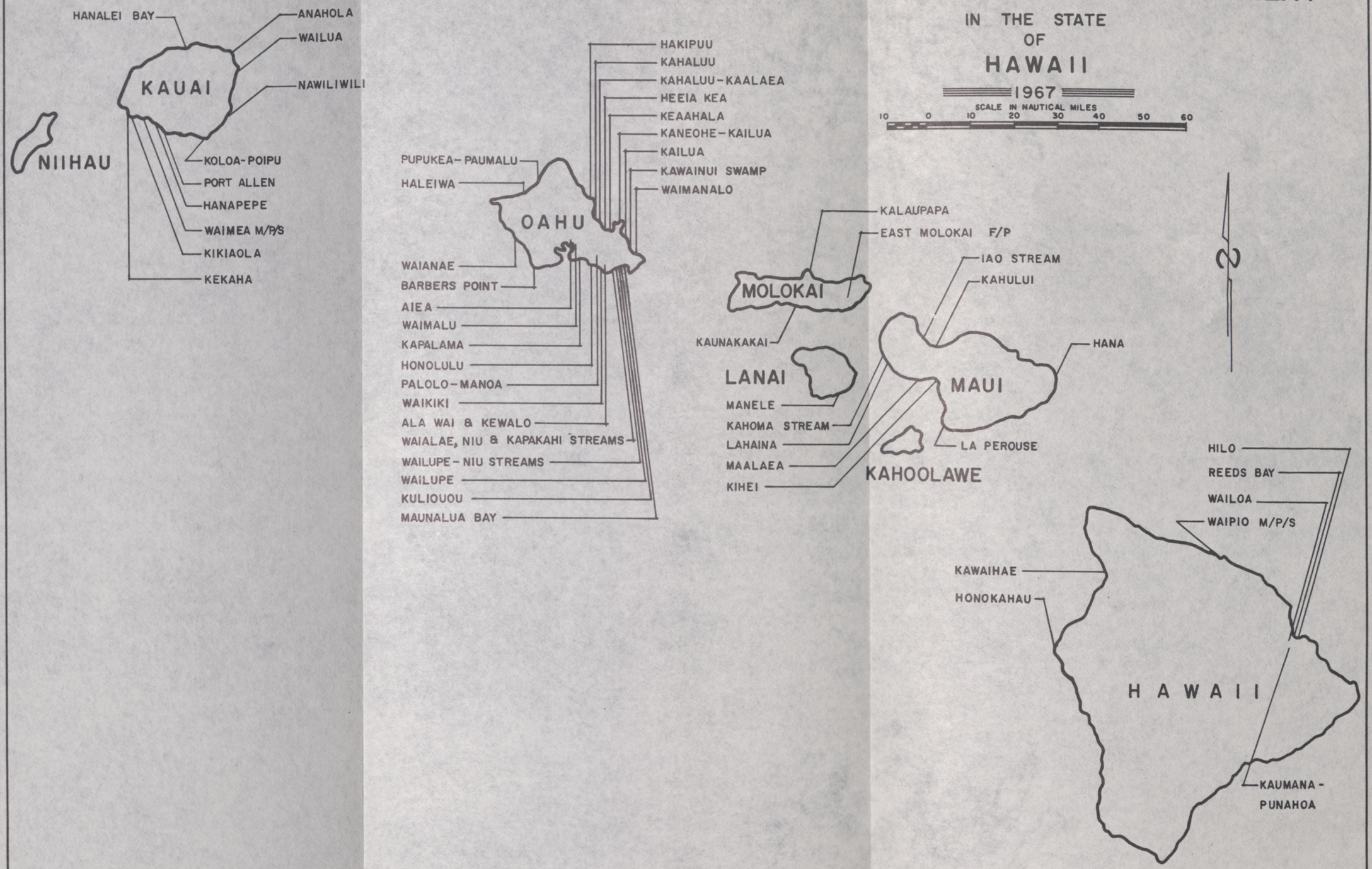
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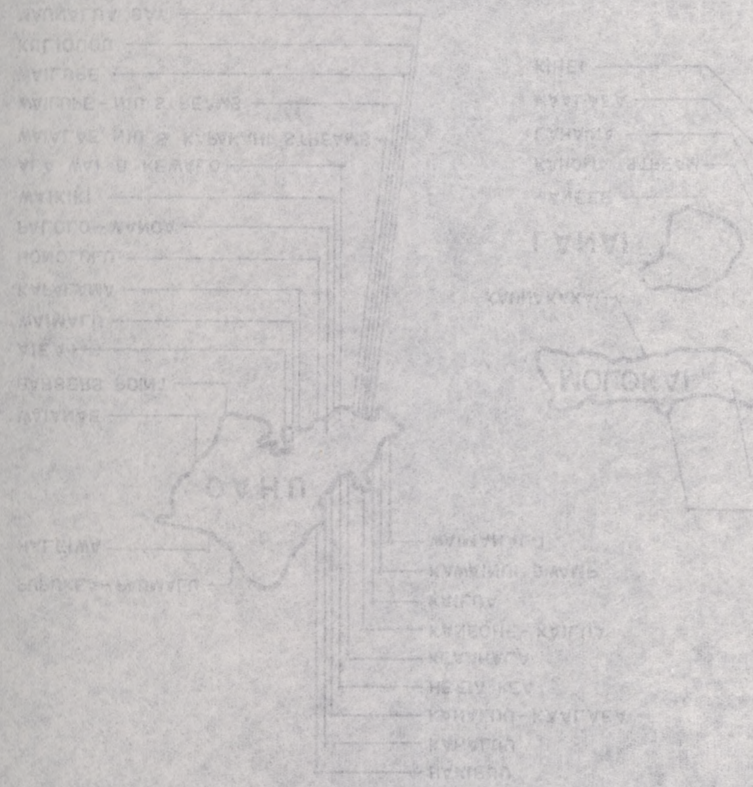
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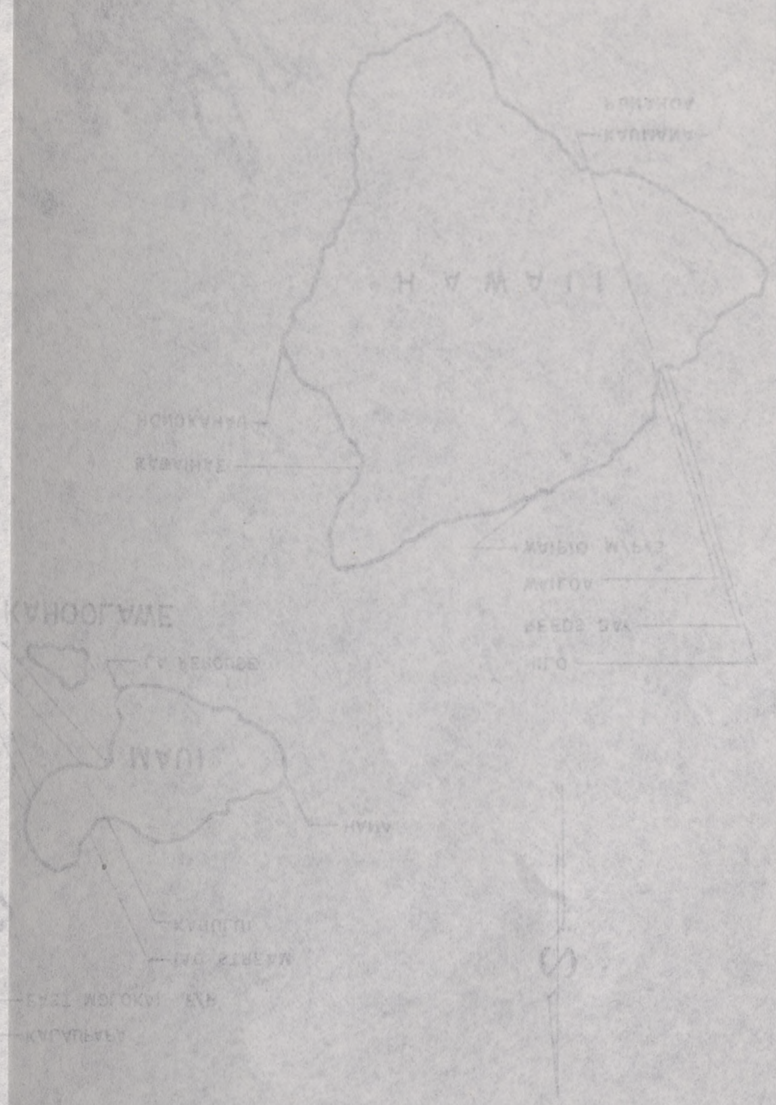
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RIVER AND HARBOR, FLOOD CONTROL, AND BEACH EROSION CONTROL PROJECTS IN THE STATE OF HAWAII

DESCRIPTION AND HISTORY OF THE HAWAIIAN ISLANDS

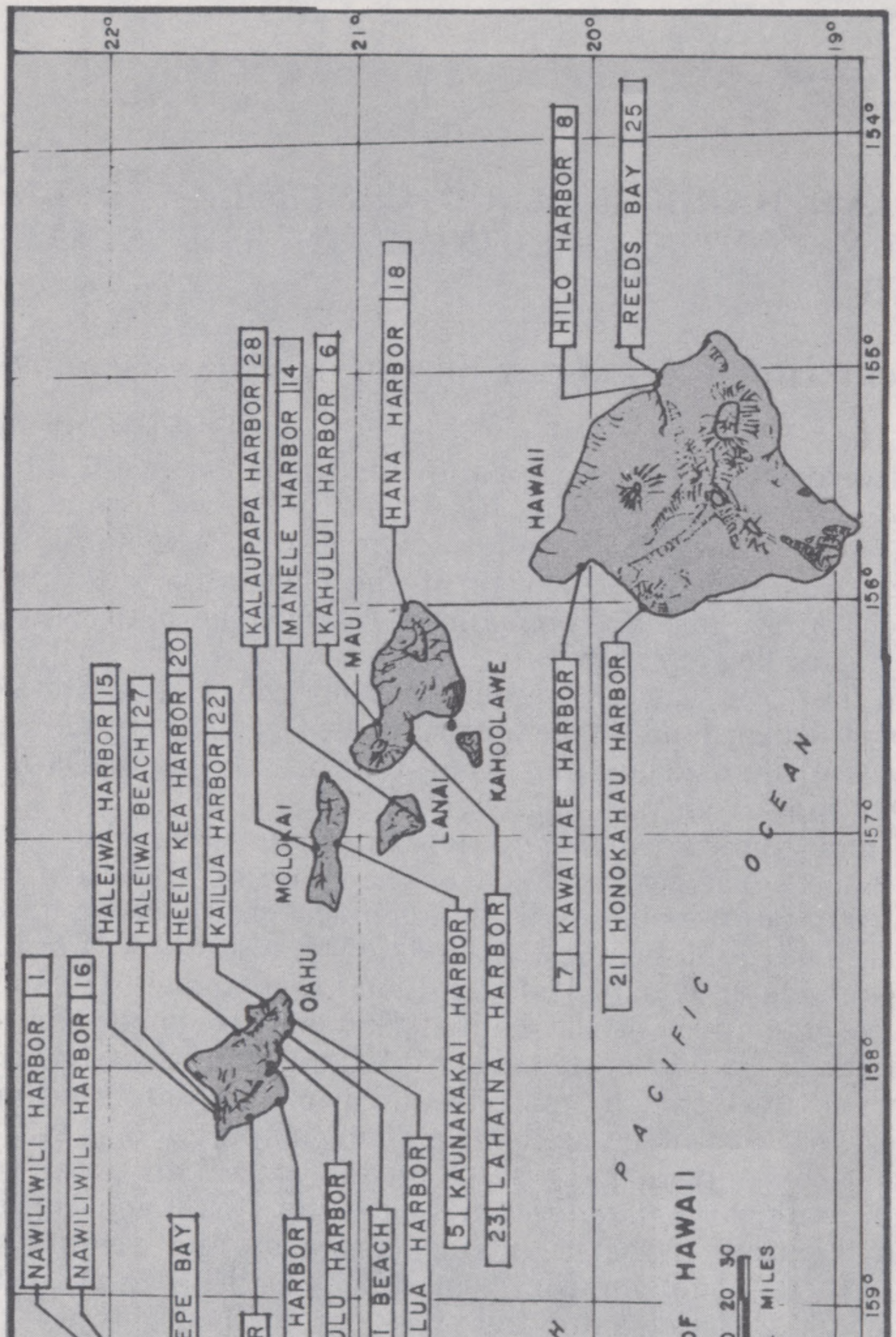
Hawaii, last U.S. organized territory, called the Paradise of the Pacific, succeeded in its long campaign for statehood in 1959, becoming the 50th State. By plebiscite June 27, 1959, Hawaii voted to join the Union by a vote of 132,773 to 7,971. On March 12, 1959, Statehood for Hawaii was approved by vote of the Congress, and President Eisenhower, on August 21, proclaimed Hawaii the 50th State and ordered a 50-star flag effective July 4, 1960.

It is the first overseas and second noncontiguous U.S. State, separated from the mainland by the north Pacific Ocean, lying 2,090 miles from San Francisco, 2,900 miles from Juneau, Alaska, and approximately 5,000 miles from Washington, D.C.

The volcanic islands comprising the Hawaiian Archipelago stretch 1,600 miles across the central Pacific. The State of Hawaii, farthest west of the 50 States, includes all islands in the chain except for Midway Island. The eight principal islands of the State of Hawaii are Hawaii, Maui, Oahu, Kauai, Molokai, Lanai, Niihau, and Kahoolawe.

No other community in the United States is so dependent upon shipping as these islands located about 2,100 miles southwesterly from San Francisco. Navigation interests and commerce are continually alert to keep pace with the needs of a rising population (744,000 on July 1, 1966) by putting more ships on the Hawaiian water routes and by improving harbor facilities in the islands. Water sports provide the main recreation in the islands for residents and visitors alike, pointing up the need for improved small boat facilities and for beach erosion control. Federal water resources development projects completed, underway, or under study by the Corps of Engineers are geared to meet the needs of each of the islands.

The island of Hawaii is the youngest and largest in the Hawaiian group and is 4,021 square miles in area. The population on July 1, 1966, was 58,997. Hilo, the county seat, is the second largest city in the State and has the bulk of the island's population with 26,107. The economy of the island is primarily agricultural, with the growing of sugarcane, beef cattle, coffee, and truck crops predominating. Beef cattle are raised on one of the world's largest privately owned ranches. The tourist industry is the major nonagricultural activity with the greatest growth potential and this is reflected in the rapidly expanding resort developments on the Kona coast of the island. Two of the seven deepwater harbors in the State of Hawaii are located on the island of Hawaii at Hilo and Kawaihae.



River and harbor and beach erosion control projects, State of Hawaii

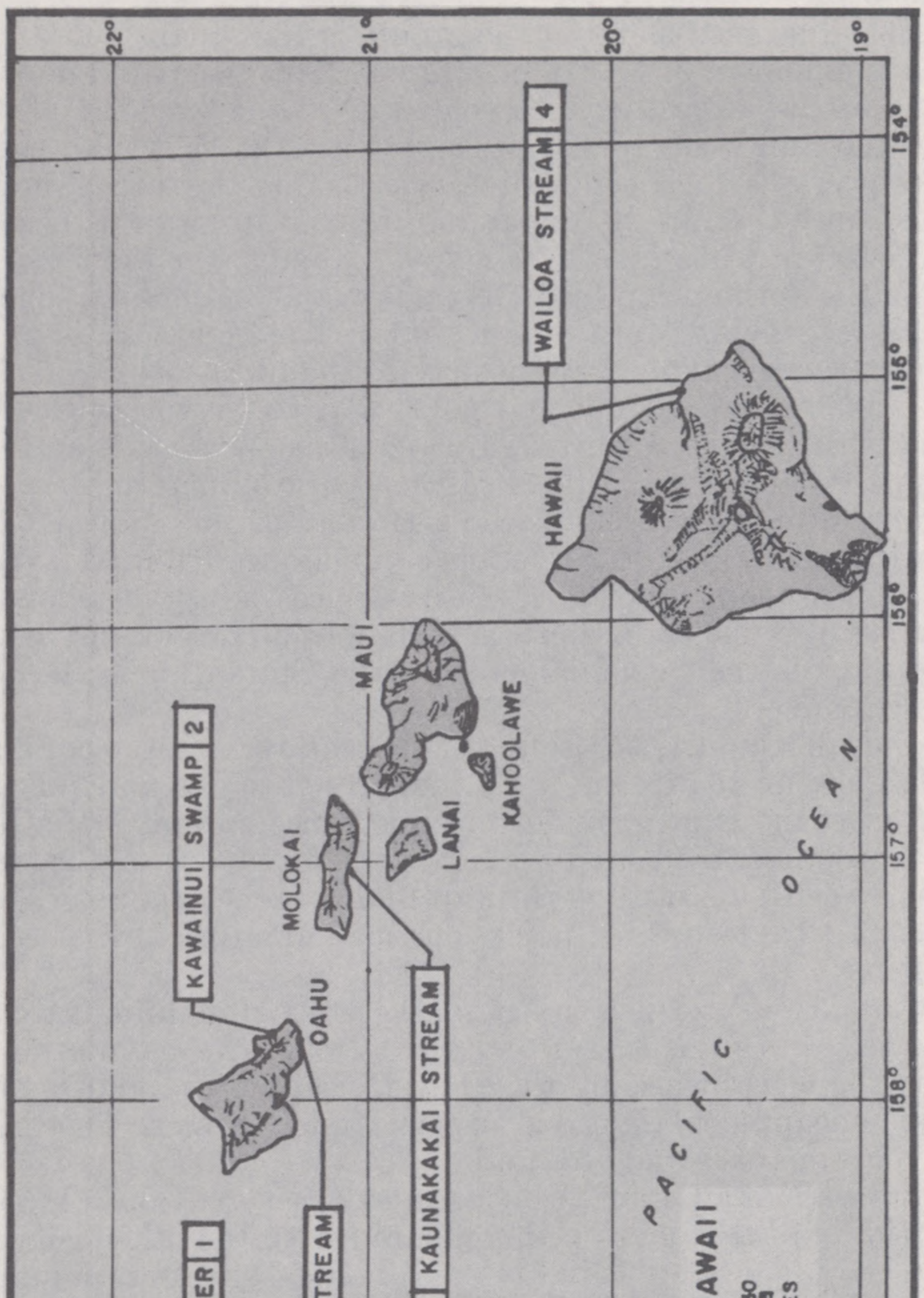


FIGURE 1.—Flood control projects—State of Hawaii

Maui, second largest island of the group, is 728 square miles in area and had a population of 38,316 on July 1, 1966. Maui is famous for having one of the largest extinct volcanoes in the world, Haleakala, "House of the Sun." Sugar and pineapple are the basic industries of Maui. However, various types of service industries are gaining in importance since the rapidly expanding tourist industry is becoming a major factor in the island's economy. Lahaina, on the west coast of Maui, is the former capital of the Hawaiian Kingdom. The lone deepwater port serving Maui is at Kahului. The breakwaters protecting this harbor recently underwent major rehabilitation.

Oahu is the hub of economic and political activity within the State. The island is third in size with an area of 602 square miles and had a population of 611,948 on July 1, 1966. Approximately 70 percent of this population is in Metropolitan Honolulu, the capital of Hawaii. Retail trade, agriculture, manufacturing, and tourist expenditures are of growing importance with service industries showing a predominance of economic importance. Honolulu Harbor, "Crossroads of the Pacific," is the principal port in the State and is the major transpacific commercial harbor in the islands.

The island of Kauai is 553 square miles in area with a population on July 1, 1966, of 25,545. Its basic industry is sugar and pineapple with the tourist industry growing in importance. Mount Waialeale is the highest peak on this island and claims fame as one of the wettest spots on earth with an average rainfall of 465 inches annually. Kauai is serviced by two deepwater ports, one at Nawiliwili and the other at Port Allen.

Lanai, the sixth in size, is 58 miles southeast of Honolulu, Oahu, and is 141 square miles in area. As of July 1, 1966, the population was 2,925. This island is owned by the Dole Pineapple Co. and is one of the largest pineapple plantations in the United States. There is no deepwater port on the island of Lanai.

The island of Niihau is off the southwest coast of Kauai. It is privately owned and little developed compared with the other islands in Hawaii. It is 72 square miles in area and had a Hawaiian population of 285 as of July 1, 1966. The basic industry is an islandwide cattle ranch.

The island of Kahoolawe, smallest of the eight islands, is off the southwest coast of Maui. It is 45 square miles in area, and is a barren, uninhabited island under military control.

REPORT OF INSPECTION

The inspection party headed by Senator Stephen M. Young, left Washington on November 18, and returned on Saturday, November 23, 1968.

In addition to Senator Young, the inspection party included members of the committee's professional staff. Representatives of the Corps of Engineers and members of the staffs of Senators Daniel Inouye and Hiram Fong joined the inspection party in Honolulu.

The inspection party left Honolulu by light plane, flying over the various islands comprising the State of Hawaii. Stops were made at various localities, including Kona and Hilo, Hawaii.

At Kona the party motored to the site of the Honokahau smallboat harbor project which is in the early stages of construction. Captain Leonard Hasse, Jr., of the Honolulu district of the Army Corps of Engineers, briefed the party, explaining the various work items that were in progress. The project when completed will provide a protected harbor basin having an area of 14.5 acres and will accommodate about 450 small craft. It was explained by Captain Hasse that the project, in addition to serving the needs of the local fishing and recreational boat fleet, will also provide shelter for small craft during periods of stormy weather along the Kona coast.

The inspection party stayed overnight at Hilo and met with officials of the County of Hawaii. Projects located on the island of Hawaii were discussed including the Hilo Harbor tsunami project. Discussions centered around the reason for delay in proceeding with construction of the authorized breakwaters at Hilo. Recommendations concerning this project are contained elsewhere in this report.

Many projects were viewed from the air and explained in detail by representatives of the Corps of Engineers. One of the project sites viewed was the deep-draft harbor at Barbers Point on the island of Oahu. Construction of this project has not been started, but it was quite obvious in seeing the extensive industrial development in the area that the harbor is greatly needed in order to accommodate the shipning needs of the Honolulu-Barbers Point area. Later the inspection party met with State and local officials interested in the development of this harbor as well as in the development of other water resource projects located in the State of Hawaii.

Details concerning each of the projects or project sites viewed or inspected are set forth on the following pages.

HONOLULU HARBOR

(See p. 23 for project drawing.)

Honolulu Harbor, main harbor of the State of Hawaii, lies on the southern coast of the island of Oahu approximately 2,090 nautical miles southwest of San Francisco. The deepwater harbor is protected from prevailing northeasterly winds by the Koolau Mountains. The main entrance (Fort Armstrong Channel) is on the eastern end of the harbor basin and extends seaward in a southwesterly direction.

The harbor was originally authorized by the River and Harbor Act of March 1905, and subsequent modifications were completed under the authorities contained in the River and Harbor Acts of 1917, 1930, 1935, 1946, and 1954. The harbor consists of (1) an entrance channel (Fort Armstrong Channel) 500 feet wide, 4,000 feet long and 40 feet deep, (2) a main harbor basin about 1,520 feet wide, 3,300 feet long and 35 feet deep, (3) a west harbor basin (Kapalama Basin) about 1,000 feet wide, 3,400 feet long and 35 feet deep, (4) a connecting channel (Kapalama Channel) between the two basins, 1,000 feet wide for the first 1,000 feet at its easterly end, and 600 feet wide for the remaining 2,400 feet, and 35 feet deep, (5) a slip 1,000 feet long and 35 feet deep at the easterly side of pier 39 in the Kapalama Basin, (6) a second entrance channel (Kalihi Channel) extending 10,300 feet seaward from Kapalama Basin, varying in width from 450 feet at its inner end to a maximum of 960 feet in the emergency turning basin in Keehi Lagoon, and 400 feet for the remaining length seaward, and 35 feet deep, and (7) a double-leaf bascule drawbridge, with a clear horizontal opening of 250 feet.

Controlling depths in March 1968 were 41.7 feet in Fort Armstrong Channel, 35.2 feet in the Kalihi Channel, 35.8 feet in the main harbor basin, 35.5 feet in Kapalama Channel, 35.9 feet in Kapalama Basin, and 34.2 feet in the slip at the east side of pier 39.

The mean tidal range between mean lower low water and mean higher high water is 1.9 feet. The usual extreme range is 2.3 feet. The lowest tide of record has been minus 1.3 feet, and the highest tide has been plus 3.1 feet.

Honolulu Harbor is of vital importance, not only to the State, but also the military community. In the last year of available statistics (1966) a total of 6,180,798 tons of shipping and 160,565 passengers passed through Honolulu Harbor. A total of 4,883 vessels, including one with a draft of 36 feet, passed through the harbor in 1966. These statistics include commercial shipping tonnage and military cargoes other than goods for the use of U.S. Armed Forces abroad.

A project modification was authorized in the River and Harbor Act of October 27, 1965, and published as House Document No. 96, 89th Congress, first session. The modification provides for deepening of the seaward 3,600 feet of the Fort Armstrong Channel to 45 feet and removing a narrow strip of the shoreline on Sand Island at the northeast corner of the island. Removal of this narrow strip has been deferred indefinitely at request of State. The project also provides for deepening of most of the main harbor basin and all of Kapalama Channel to 40 feet, and widening Kapalama Channel by 60 feet along the Sand Island side for a distance of 2,500 feet and removing a lesser width from the Sand Island shoreline along Kapalama Basin for an additional distance of 600 feet.

The Corps of Engineers advises that the draft of the general design memo for the modification is scheduled for completion in the third quarter of fiscal year 1969. The authorized modification costs are estimated as follows:

1st cost	$5,330,000
Federal cost	2,710,000
Non-Federal cost	2,620,000



Honolulu Harbor, principal port for the State of Hawaii

WAIKIKI BEACH, OAHU

(See p. 24 for project drawing.)

Waikiki Beach, the most famed of Hawaii's beaches and the most economically important, is located just east of central Honolulu on the southern coast of Oahu. It extends northwest from Diamond Head to the Ala Wai Harbor and includes the shore fronting Kapiolani Park, Prince Kuhio Beach Park, several luxury hotels, and the Army's R. & R. center of Ft. DeRussy.

Early in 1947 the Territory of Hawaii requested Federal assistance for improvement of publicly owned sections of Waikiki Beach. As a result, a report published as House Document No. 227, 83d Congress, first session, recommended artificial placement of sand and construction of a terrace wall in Kuhio Park and two groins at or near the ends of the wall. The Territory began construction in 1951 which was completed in 1957. The Federal Government reimbursed one-third of the construction cost or $214,356. Two years after completion of the improvement, 18,700 cubic yards of sand were required for nourishment of the project. Since that time, groin construction and additional placement of sand have been used to reduce erosion but the basic erosion problem has not been solved and the present beach area is inadequate for peak period attendance.

Again, in 1959, the State requested Federal assistance. A report of the Federal study was published as House Document No. 104, 89th Congress, first session. The project was authorized by the River and Harbor Act of October 27, 1965, and provides for artificial placement of about 2 miles of beach from the Duke Kahanamoku Beach to the Elks Club with the addition of new groins, modification of three existing groins, and appurtenant drainage facilities. Project beach width would average 180 feet except in the Elks Club section where the average would be 75 feet.

The plan for improvement provides for a coral base fill covered by a 2- to 3-foot blanket of beach sand. The level beach berm is at elevation 6 feet and slopes from the crest at 1 to 10 to mean lower low water, then continues seaward at 1 on 20 to existing bottom, The new groins would be of rubble-mound construction with the outer layer composed of 800-pound to 1-ton stone. The four new and three modified groins would be located as shown on the project drawing.

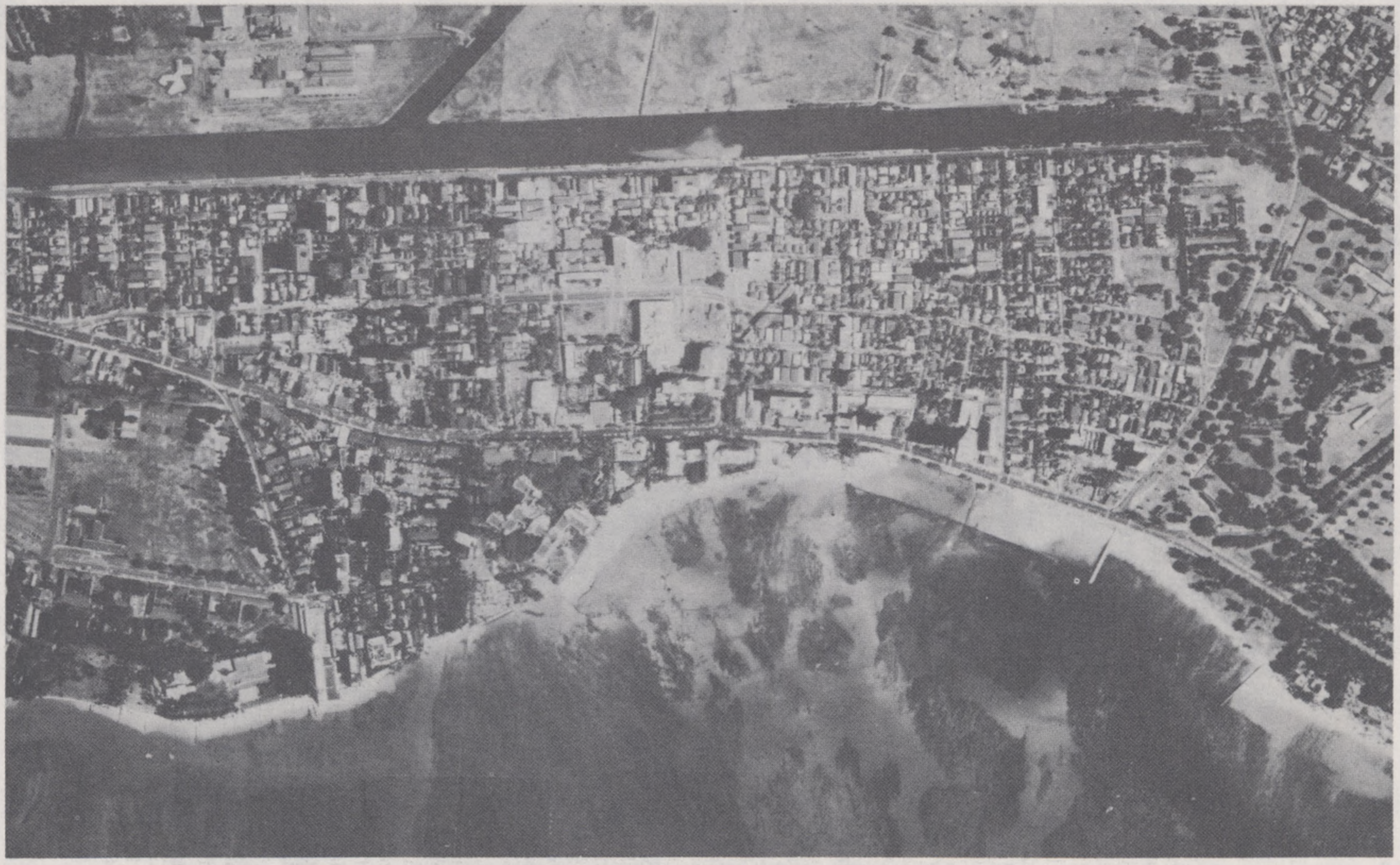
The State of Hawaii is proceeding with the detail design of the Kuhio Beach section. No Federal work has been done on the project since 1963 because funding has not been provided.

Lately there has been increased interest in Waikiki, and State and local groups led by Senator Fong have been active in attempting to have design funds made available for this project. The President's 1968 budget did not include any funds for Waikiki, and an attempt to add $82,000 during hearings of the House Appropriations Committee in July was not successful.

Since no Federal funds were appropriated for design, the State of Hawaii on October 30, 1968, provided to the Corps of Engineers $56,000, to initiate preconstruction planning on the project. This amount will be credited against the required local contribution for the project at such time as Federal funds for construction are appropriated by Congress.

The estimated costs and project economics are as follows:

1st cost	$4,660,000
Federal cost	$3,050,000
Non-Federal cost	$1,610,000
Annual benefits	$3,638,000
Annual costs	$249,600
Benefit-cost ratio	14.6

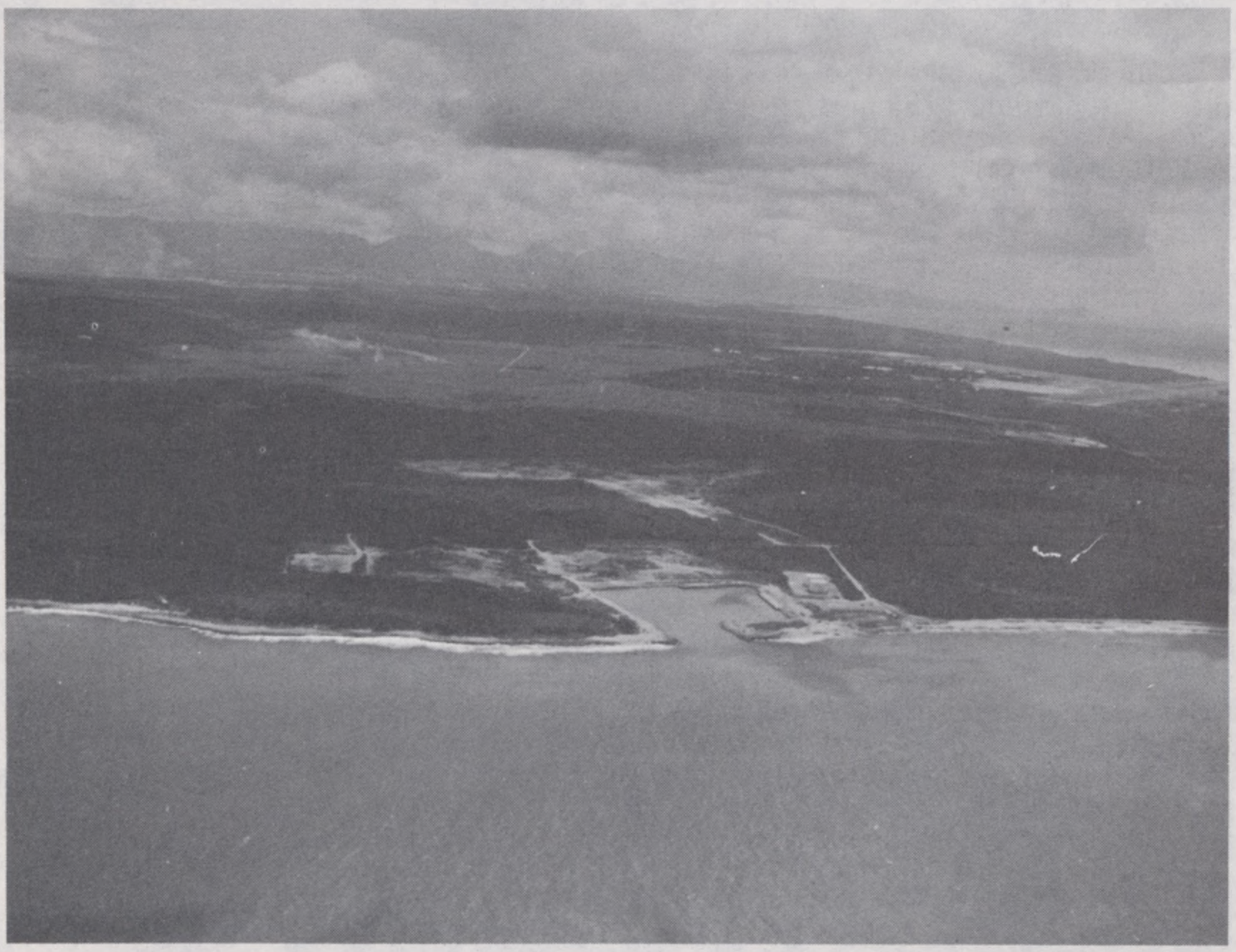


A new beach erosion control project has been authorized for world-famous
Waikiki Beach

DEEP-DRAFT HARBOR AND SMALL BOAT HARBOR FOR BARBERS POINT, OAHU

(See p. 25 for project drawing.)

Barbers Point is at the southwest corner of Oahu, 25 miles west of downtown Honolulu and Honolulu Harbor. Honolulu Harbor is presently the only deep-draft commercial harbor on the island of Oahu. Pearl Harbor, about midway on the south shore between Honolulu and Barbers Point, is used exclusively by the military except for oil tanker servicing of the Waiau electric plant. At Barbers Point is an 800-acre industrial zone development. Thirty-nine industries are in operation or have leases in the industrial zone. The area is located on the downwind side of the island so the smoke, odors, and noises do not affect the residential areas of the island. Some 15,000 homesites will ultimately be developed in the foothills overlooking the area. A variety of industries use the industrial area. They include: an oil refinery; steel mill; cement plant; manufacture of concrete hollow tile, water and sewer pipe, piling and roof beams; steel fabrication; various warehousing and storage; packaging of fertilizer, chemicals, and soda pop. Prospective waterborne commerce utilizing the proposed deep-draft harbor at Barbers Point is projected to total approximately 680,000 tons in 1970, 940,000 tons in 1980, and 1,700,000 tons in 2020.



The project was authorized by the River and Harbor Act of October 27, 1965. The report is published as House Document 93, 89th Congress, first session. The allotment for advanced engineering studies is $268,000, of which $12,000 were expended in fiscal year 1967 and $107,000 expended in fiscal year 1968. The $149,000 balance is programed for fiscal year 1969 to complete the general design memorandum in early third quarter and initiate plans and specifications in fourth quarter. The State has programed construction funds for fiscal year 1970.

The proposed plan of improvement for the deep-draft harbor consists of a straight, offshore entrance channel 3,000 feet long, 450 feet wide, and 42 feet deep; an inshore channel 1,100 feet long, 450 feet wide, and 38 feet deep; an inshore basin of about 83 acres, approximately 2,300 feet long by 1,500 feet wide, and 38 feet deep; an inshore wave trap from 20 to 38 feet deep, approximately

500 feet long by 500 feet wide; and wave absorbers along the inshore channel, basin, and wave trap, totaling 6,400 feet in length.

The plan of improvement for the small boat harbor would entail dredging of a main access channel approximately 1,200 feet long, with a minimum width of 80 feet, and from 8 to 12 feet deep. The tentative berthing area will accommodate about 300 boats.

The estimated costs are as follows:

BARBERS POINT—SMALL BOAT HARBOR

1st cost	$295,000
Federal cost	$115,000
Non-Federal cost	$180,000
Design capacity (at year 1980)	300

BARBERS POINT—DEEP-DRAFT HARBOR

1st cost	$17,580,000
Federal cost	$15,332,000
Non-Federal cost	$2,248,000
Design capacity (basin depth) (feet)	38

KAUNAKAKAI HARBOR, MOLOKAI

(See p. 26 for project drawing.)

Kaunakakai is on the south-central coast of the island of Molokai. At present the barge harbor is the only receiving port for bulk goods from Oahu. Interisland air service is provided daily by two airlines which transport perishable goods and other general commodities.

The existing barge harbor cannot accommodate deep-draft vessels; therefore, waterborne commerce must be transhipped by barge to and from Honolulu. This condition results in high transportation costs. Also, the absence of mooring and protective facilities for small craft at Kaunakakai has handicapped the growth of fishing and recreational boating and endangers the few craft of this type that moor in the existing harbor.

Modification of the existing harbor was authorized by the River and Harbor Act of 1962 and provides for a deep-draft harbor of approximately 62 acres, a separate light-draft harbor of approximately 10 acres, and necessary protective structures. Plans for the deep-draft harbor have been deferred because of the indefinite plans for construction of industrial facilities (pineapple cannery) upon which justification of construction of the harbor was based. A general design memo for the associated light-draft harbor was approved on August 19, 1965. The plan of improvement provides for a rubblemound breakwater 220 feet long, a revetted mole 1,150 feet long, and a main access channel 1,430 feet long which would extend to the northeast from the existing barge channel. The inner 580 feet of the channel would have a width of 100 feet and a depth of 10 feet. A 50-foot long transition would connect the inner channel to an outer channel 120 feet wide, 15 feet deep, and 800 feet long. This outer channel would connect to a seaward 200-foot section which would flare from a 120-foot width to 180 feet. Preparation of plans and specifications has been deferred until the State is in a position to furnish the required local funds.

KAUNAKAKAI STREAM, MOLOKAI

(See p. 27 for project drawing.)

The flood plain of Kaunakakai Stream, prior to the construction of flood control works in 1950, covered practically all of the business area of the town and a large portion of the residential area, totaling 125 acres. In addition to business and residential damages, losses also included such items as disruption of communications, filling and caving in of cesspools, uprooting of trees, washing out of bridges, and spreading of mud and debris through the town. Damages ranged from $5,000 to $130,000 for each flood. Several floods of damaging proportions, which have occurred since the completion of the project, have been completely controlled. Floods occur principally during the 5-month period, November through March, as a result of severe rainfall intensities. Up to 13 inches of rain have been recorded within a 24-hour period in this community.

The existing Corps of Engineers project provided for an enlarged stream channel flanked by earth levees with rock facing on the streamside slope. The left bank levee extends for a distance of 3,520 feet from the bluff adjacent to the stream and north of the town of Kaunakakai to the Pacific Ocean. The right bank levee extends for a distance of 1,050 feet downstream from the opposite bluff past the Kaunakakai Homesteads. The project was completed in 1950.

KALAUPAPA BARGE LANDING, MOLOKAI

(See p. 28 for project drawing.)

Kalaupapa barge landing is on the northern coast of the island of Molokai. This northern coast is characterized by towering cliffs which make this side of the island inaccessible except by small boat during very good weather, and by light aircraft. The Kalaupapa barge landing is the only supply port for bulk goods to the Hansen's disease settlement which had a population of 245 on January 1, 1965. Interisland tugs and barges call at this small boat harbor three times a year, during May through September. Calm seas necessary for barge landing prevail during these months because the Makanalua Peninsula to the east of the existing harbor provides protection from prevailing winds from the northeast. Tugs and barges do not call during October to May because high waves generated by winds from the north and northwest would force these vessels to anchor offshore in deep water or return to Honolulu to await better weather and sea conditions.

Improvement of the barge landing was authorized under section 107 of the River and Harbor Act of 1960. Construction of the project was completed in September 1967, at a contract cost of $134,543. The existing breakwater was lengthened and is now 105 feet long. This structure is protected by an armor layer of 6.5- to 12-ton minimum stone and the small natural basin was dredged to a width of 110 feet at the seaward end, decreasing to a width of 70 feet at the shoreward end. The dredged basin is 360 feet long with a 13-foot depth extending 270 feet shoreward from the seaward end, a 10-foot wide transition from 13 to 8 feet, and an 8-foot depth for the remaining distance of 80 feet. An area 30 feet wide and 80 feet long on the north side of the basin was dredged to a depth of 10 feet.

KAHOMA STREAM, MAUI

(See p. 29 for survey map.)

The Kahoma Stream drainage basin which comprises an area of 5.6 square miles is on the western slopes of the West Maui Mountains. It is approximately 60 nautical miles southeast of Honolulu. Kahoma Stream and its main tributary, Kanaha Stream, originate at about 5,000 feet mean sea level. These streams are confined to narrow canyons until they reach the outwash plain near their confluence at about the 260-foot elevation. Below this confluence, Kahoma Stream flows in a westerly direction for a distance of 7,500 feet where it enters the Pacific Ocean. The average slope of the stream above the coastal area is approximately 700 feet per mile. The slope in the coastal area averages about 200 feet per mile.

A detailed project study, conducted under the authority of section 205 of the 1948 Flood Control Act, as amended, was completed in April 1967. The flood control plan proposed by this study consisted of realining 4,950 feet of the lower reach of the stream, and deepening and widening the next 480 feet of the stream. The proposed channel was concrete-lined and trapezoidal in shape with base widths varying from 30 to 50 feet. A minimum of two debris barriers was proposed for the upstream end of the improvement. The total cost of this plan was estimated at $2.4 million. The statutory Federal limitation of $1 million required that local interests provide a cash contribution of $1.4 million—$800,000 for Federal costs exceeding the $1 million limitation, and another $600,000 for acquisition of land easements and rights-of-way, and for the replacement of four bridges. This high cash contribution requirement led to the termination, at local interests' request, of further study under the small projects authority. The investigation for flood control will be completed under the outstanding survey study which was authorized by section 208 of the Flood Control Act of 1960. This study is partially funded this year, and is expected to be fully funded in fiscal year 1970. The study is scheduled to be completed in 1970.

LAHAINA HARBOR, MAUI

(See p. 30 for project drawing.)

Lahaina, with a population of about 3,500, is located on the west coast of Maui about 22 road miles from Wailuku, the Maui County seat. It is the third largest town on the island of Maui, next in size to Kahului and Wailuku, both located on the northern side of the island. As a historic whaling center and first capital of Hawaii, Lahaina is becoming increasingly important as a tourist attraction. The Lahaina judicial district, the tributary area of the proposed project, had a population of 4,844 in 1960. The Auau Channel between west Maui and the island of Lanai, often called Lahaina Roads, is relatively calm most of the year and affords one of Hawaii's best recreational boating areas. Consequently, Lahaina is a traditional stopping place for cruising craft running up and down the island chain. An 80,000 square foot harbor, located adjacent to the center of town is protected by a 1,000-foot breakwater seated on the coral reef fronting the town. This small craft harbor can accommodate about 30 boats, but is inadequate to meet the berthing needs of the growing boat population of the area.

The proposed plan of improvement provides for a new harbor with an interior basin of about 5.3 acres to be located immediately northwest of the existing facility. The harbor basin, designed to accommodate 160 small boats, would be protected by an offshore breakwater 950 feet long, with a revetted mole 620 feet long. The offshore breakwater would be a rubblemound structure. The entrance channel 515 feet long and 150 feet wide would be dredged to a depth of 20 feet in the seaward 230-foot reach and to a depth of 15 feet for the remaining distance. A wave absorber 180 feet long would be situated at the shoreward end of the channel to reduce reflected wave energy in the turning area.

The exact location of this harbor facility has not been determined. Local interests such as the Lahaina Historical Restoration Society, the State department of land and natural resources, American Factors, Ltd., Lahaina Business Men's Association, and the coordination agency (State harbor division, department of transportation) all strongly support the project but are not in agreement on location and shoreside parking areas. The department of land and natural resources engaged an architect-engineering firm to recommend a plan of improvement. This plan, known as the Warnecke plan, has not been submitted to the Corps. It is also known that the Lahaina Historical Restoration Society and American Factors have each engaged architect-engineers to do some planning in connection with this harbor. Securing agreement among local interests will be a coordination problem on this project. It is also expected that reanalysis of the boating needs in the tributary area will show an increased harbor capacity requirement resulting from rapid resort development.

The estimated total first cost of the project in 1968 dollars is $901,000 of which $474,000 would be borne by the Federal Government and $427,000 by local interests. The benefit-cost ratio is 1.3.

Funds for advance design have been made available this fiscal year.

MAALAEA LIGHT- AND DEEP-DRAFT HARBOR, MAUI

(See pp. 31 and 32 for project drawing and survey map.)

Maalaea Harbor lies on the southern coast of Maui at the western end of Maalaea Bay, about 83 nautical miles southeast of Honolulu Harbor, Oahu. The present State harbor was originally developed in 1952 by dredging an entrance channel and basin, and constructing the south breakwater with an access roadway and parking area on the inboard side. The east breakwater was completed in 1955. In 1959, the State deepened the channel, dredged an entirely new commercial basin, and constructed a paved wharf. The existing facility consists of a 100-foot-wide entrance channel 12 feet deep, a harbor basin 7.5 acres in area with depths of 8 and 12 feet, a 1,000-foot-long combination breakwater and mole structure on the south side, an 840-foot-long east breakwater, a 308-foot-long by 50-foot-wide paved wharf, berthing facilities for 60 boats, and a launching ramp. The harbor serves the cities of Wailuku and Kahului which have a total population of about 31,000. The tributary area is predominantly agricultural but tourism is a fast growing and important facet of business activity.

At present, navigation by light-draft vessels entering and leaving Maalaea Harbor is made hazardous by swell and wave action generated by southerly storms. Inside the harbor, surge conditions which are aggravated by the vertical bulkheads of the wharf cause damages to moored pleasure craft and commercial fishing vessels making it necessary to either move the boats to other harbors or to use crewmembers as line tenders.

The survey report "Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels" which was prepared in June 1967, under authority of section 110 of the River and Harbor Act of May 17, 1950, proposed a plan of improvement which would alleviate the present undesirable conditions and increase the berthing area to 16.6 acres with a capacity of about 260 craft. The recommended plan of improvement provides for an entrance channel 780 feet long, 150 feet wide and 15 feet deep; a 150-foot-long transition area with a change in depth from 15 to 12 feet, and a flaring of the width from 150 feet to about 250 feet at the entrance of the turning basin; a 6.9-acre turning basin; a main access channel 80 feet wide, 720 feet long, 8 feet deep; and a 650-foot extension to the south breakwater. The existing east breakwater would be removed from station 2+00 to its seaward terminus and the head of the remaining structure would be reinforced with a layer of armor stone. The existing south breakwater would be extended 650 feet in an easterly direction from its present terminus. The seaward revetment of 200 feet of the existing south breakwater structure from station 11+00 to station 13+00 would be modified from the existing 1 on 1 slope to 1 on 2 slope with 1-ton stone. Dredged coral material would be used to fill the existing entrance channel to a depth of 5 feet from the proposed breakwater extension to 100 feet seaward, and then at 1 on 15 minimum slope to the existing bottom.

Total first cost (1968) of construction for this project is estimated at $724,000 of which $249,000 is to be non-Federal. The benefit-cost ratio is 2.3.

The Honolulu district is also conducting a survey study for a deep-draft harbor for the Maalaea Bay area under the combined authorities of the River and Harbor Act of 1960 and House resolutions of 1960 and 1951 The study was initiated in December 1965, and a public hearing was held on February 24, 1966

KIHEI BEACH EROSION CONTROL, MAUI

(See p. 33 for project drawing.)

Kihei Beach is located on the west coast of East Maui, 9-road miles from Wailuku the principal town and county seat of the island of Maui. The shores in the Kihei area have been eroding at a number of locations for over 50 years. This erosion has been exceptional during "kona" storms and hurricanes such as occurred in 1951, 1955, 1959, and 1963. The erosion resulted in loss of substantial public beach area and private beach frontage. In some instances, houses and related structures have been undermined and the beach road has been threatened.

A public hearing for this project was held on September 27, 1963. At that time, local interests pointed out that Kihei public beaches, especially at Kalama Park, are major recreational areas for Maui and that the loss of these shores is a general loss of recreational facilities to the island's population at large as well as a local community loss.

The Kihei Beach erosion control project was approved effective September 4, 1968, under section 103 of the 1962 River and Harbor Act, as amended, and funds for construction were made available October 11, 1968 The authorized project would protect the beach at Kalama Park by constructing a 25-foot wide berm the length of the park. This berm would be protected by a stone revetment approximately 3,000 feet long, armored with 1,000-pound stone placed on a 1 on 2 slope. The revetment should also encourage accretion of sand building the beach seaward from the berm. The completed project would insure the continued existence of a public beach facility while creating no hazard to adjacent private properties.

The estimated first cost of the project is $474,000, of which $237,000 would be borne by the Federal Government and $237,000 by the State of Hawaii and the county of Maui. Formal approval of the Kihei Beach project is particularly significant because the State and Federal Governments were joined by the county of Maui for responsibility of project funding. The county of Maui also provided the necessary local assurances of ownership, rights-of-way, maintenance, and usage.

HANA SMALL BOAT HARBOR, MAUI

(See p. 34 for project drawing.)

The town of Hana is on the east coast of the island of Maui, approximately 59 road-miles from Wailuku, the county seat. This relatively isolated community had an estimated population of 1,100 in 1960. Beef raising on one large ranch and several smaller ones provides the economic base for the area. The coastline of east Maui is rugged and in many areas access by land is difficult or impossible. Hana Bay which has an entrance about three-quarters of a mile wide, faces due east and is exposed to prevailing trade winds and consequent frequent periods of high or relatively high waves.

This harbor project was authorized by the River and Harbor Act of 1965. The plan of improvement for this harbor was included in the "Interim Report on Survey of the Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels," which has been published as House Document 353–88–2. The plan of improvement provides for construction of a breakwater 1,230 feet long, the landward 250 feet of which would be a revetted mole. This breakwater would shelter a turning area and harbor basin of about 200,000 square feet. No initial dredging would be required because existing depths of the bay are adequate for small craft, and commercial tugs and barges which are expected to use the harbor.

This harbor has been authorized for construction but is currently unfunded. The estimated first cost of construction is $2,361,000, of which $2,127,000 is Federal and $234,000 is non-Federal.

KAHULUI HARBOR, MAUI

(See p. 35 for project drawing.)

Kahului Harbor is located on the north coast of the island of Maui, about 94 miles from Honolulu Harbor, Oahu. It is the only deep-draft harbor on Maui, an island of 730 square miles with a population of 40,000.

The existing project, completed in 1962, provides for rubble-mound breakwaters on the west and east sides of the harbor, 2,315 and 2,766 feet long; an entrace channel 600 feet wide between the breakwaters; and a harbor basin 35 feet deep, 2,050 feet wide, and 2,400 feet long. In 1966, the harbor underwent major rehabilitation in which a portion of the breakwaters were rebuilt using 35- and 50-ton tribars rather than the usual quarry stone as the principal structural members. The rehabilitated sections have had no significant damage.

In December 1967, another section of the west breakwater was damaged by storm waves. The Honolulu engineer district completed a report on emergency repair of the breakwater and, in May 1968, the repair work was authorized by the Chief of Engineers. In September 1968, the district awarded a contract to E. T. Ige Construction, Inc., in the amount of $346,300 for the repair work consisting of the casting and placement of about 260 19-ton tribar units on the seaward slope of the west breakwater and repair of the damaged stone breakwater, beginning about 2.010 feet from the shore end and ending at about 2,155 feet. The uppermost tribars will be buttressed by a heavy row of concrete ribs connected by lateral beams. Field stones will be used to replace stone washed out of the breakwater core.

The periodic repair of the Kahului breakwaters is the result of the severe wave climate to which the harbor is exposed during winter months. Long-period waves caused by the arctic swell and storm waves, sometimes in excess of 30 feet high, both occur seasonally on northern coasts of the Hawaiian Islands.

A study is presently being conducted to determine the feasibility of constructing a second deep-draft harbor on Maui at Maalaea. This study is scheduled for completion in mid-1970.

IAO STREAM FLOOD CONTROL, MAUI

(See p. 36 for project drawing.)

Iao Stream, which originates in Iao Valley on the island of Maui, flows a distance of 8 miles through the town of Wailuku to the Pacific Ocean. The stream drains a basin of approximately 10 square miles. The slope of the drainage basin is approximately 1,800 feet per mile in the headwater area, flattening to about 120 feet per mile near the mouth of the stream. The mean annual precipitation for this drainage basin ranges from about 400 inches at the summit to about 25 inches near the coast, making this basin one of the wettest spots in the State. Approximately 27 percent of the population of Wailuki, which had an estimated population of 7,600 in 1965, reside in the flood plain. The principal industry in the flood plain is sugarcane production and processing.

The Iao Stream flood control project was authorized by the Flood Control Act of 1968. A favorable survey report which was submitted to higher authority on April 5, 1966 has been published as House Document 151–90–1. This project document provides for partial protection of the lower 3 miles of Iao Stream. The plan of improvement includes approximately 2 miles of channel improvement from the Market Street Bridge to the ocean and a debris basin approximately 3 miles upstream from the mouth of the stream. The 2 miles of channel improvement consist of paved inverts in various reaches of the stream, realinement of portions of the stream, channel widening and deepening with bottom width varying from 60 feet at the downstream side of Market Street Bridge to 175 feet near the mouth of the stream, reinforced concrete vertical walls under the Wailuku Sugar Co. bridge, increased heights of portions of existing banks, and low levees along sections of both banks.

Funds for advanced engineering and design have not been appropriated.

HAWAII

KAWAIHAE HARBOR

(See p. 37 for project drawing.)

Kawaihae Harbor lies at the north end of Kawaihae Bay on the northwest coast of the island of Hawaii. The existing harbor was created by dredging part of an extensive coral reef which extends seaward 4,000 feet and runs along the shore more than a mile to the south of Kawaihae. The harbor is protected from northeastern and southern storms by the Kohala Mountains and the promontory at the south end of the bay. However, the harbor is exposed to storm waves generated from the northwest, west, and southwest.

Winds from the northwest to southwest sector dominate at Kawaihae and are highly unpredictable. In addition, the harbor is affected by squalls which occasionally sweep down the mountainside and make vessel handling in the entrance channel difficult. Ships may suddenly be set off course and out of the center of the channel before the helmsman can make the required steering adjustments. Adverse winds and surge have often caused delays in docking operations and, in some instances, have frustrated vessel calls and caused diversion of ships to Hilo Harbor.



Kawaihae Harbor, the second largest harbor on the island of Hawaii, serves an area from Milolii on the southwest coast to Honokaa on the northeast coast of the island. This area includes all of the Kona coffee-producing land, the majority of the island's cattle ranches, the Kamuela agricultural area, and approximately one-third of the northeast coast sugar-producing land. The harbor now

serves both transpacific and interisland traffic, but transpacific service is limited to bulk cargo Twice weekly, interisland barge service is augmented by irregular calls by chartered barges. Transpacific vessels now calling at Kawaihae Harbor are primarily C–3-class freighters and T–2 tankers. The *Californian* and the *Hawaiian*, both 633-foot freighters, each called once, but they were then removed from Kawaihae Harbor because navigation into the harbor was considered too hazardous. The proposed harbor modifications will open it to vessels of the jumboized C–4 and modified T–2-class vessels, and shipping interests have indicated that they will begin use of these larger vessels as soon as the harbor will safely accommodate them.

There are two recommended plans of improvement: (1) A modification of the existing deep-draft harbor; and (2) the small boat harbor. The plan of improvement for the deep-draft harbor calls for the following modification of the existing Federal project: the widening of the seaward 1,450 feet of the entrance channel along its northerly side by 100 to 120 feet; widening the seaward side of the harbor basin by a maximum of 200 feet to create an additional maneuvering area of about 9.5 acres; lengthening the harbor basin on its south side by a maximum of 500 feet to create an additional maneuvering area of about 8.5 acres; and planting and landscaping the spoil area.

The second plan of improvement concerns itself with a small boat harbor. This plan would entail Federal dredging of a main access channel and construction of a protective wave absorber and mole. The rubble wave absorber, about 1,075 feet long, would parallel much of the existing fill revetment which forms the south shoreline of the deep-draft harbor. A sheltered water area of about 10 acres would thereby be formed between the wave absorber and the shore revetment; this area would be dredged to create the new basin. The main access channel would be 900 feet long, 80 to 100 feet wide, with an outer depth of 10 feet and an inner depth of 8 feet.

The proposed harbor improvements were model tested at W.E.S. and the general design memorandum was approved by OCE in June 1968. In September, the State requested that the small boat harbor be relocated outside the deep-draft basin. This will necessitate additional design studies.

HONOKAHAU HARBOR

(See p. 38 for project drawing.)

Honokahau Harbor will be located in the Kona coast resort region on the west coast of the island of Hawaii approximately 28 nautical miles southwest of the Federal deep-draft harbor at Kawaihae and 2 miles northwest of the Kona Airport at Kailua. This region is characterized by its pleasant climate and outstanding natural beauty which, together with a number of historical sites and excellent coastal and deep-sea fishing grounds, make Kona a popular sports-fishing and tourist center. An estimated 185,000 tourists visited the island of Hawaii in 1966 and most of these stopped in Kailua.

Due to the influence on the normal trade wind pattern caused by the mountain peaks of Mauna Loa and Mauna Kea (each almost 14,000 feet high), southwesterly winds predominate; however, westerly and southerly winds do frequently occur. Wind velocities over 24 miles per hour are recorded two or three times each year, usually in the winter months. These winds sometimes reach gale force. At present there are no ports of refuge south of Kawaihae to provide shelter for small craft during storm periods. The proposed harbor at Honokahau would provide this shelter in addition to the normal function of being a base of operations for local fishing and recreational boats, and an attractive stopping point or cruise destination.

In 1962 the State of Hawaii planned to construct Honokahau Harbor without Federal aid, but when engineering studies showed construction costs substantially greater than anticipated, the State sought Federal assistance. The Honokahau Harbor was then studied under the survey authority for the "Coasts of the Hawaiian Islands" and was authorized under the River and Harbor Act of 1965, House Document 68, 89th Congress, first session.

Various plans of improvement for this harbor were model tested in Honolulu, Hawaii. Model testing of the selected plan of improvement was completed after submission of the survey report. The plan of improvement presented in the general design memorandum provides for a protected harbor basin of 14.5 acres to accommodate about 450 boats. The design memorandum was approved by OCE in March 1968. During the preparation of plans and specifications for

the project, the dimensions of the harbor were modified to provide for an entrance channel 965 feet long, 120 and 160 feet wide with a depth of 20 and 15 feet; a main access channel 782 feet long, 120 feet wide with a depth of 15 and 12 feet; and wave absorbers with combined lengths of 500 feet along both sides of the entrance channel and a 285-foot wave trap at the shoreward end of the entrance channel.

In June 1968, a construction contract was awarded to Stewart-Pacific in the amount of $1,988,974.33 for the authorized Federal project and portions of the State berthing area. The total Federal cost is $808,068. Construction is proceeding on schedule.

The inspection party visited this project on November 20, 1968. The resident engineer, Capt. Leonard Hasse, Jr., of the Honolulu district, briefed the party, explaining the various work items that were in progress.

KAIMU BLACK SANDS BEACH

(See p. 39 for project drawing.)

Kaimu Black Sands Beach has a seasonal ebb and flow of sand deposits, and a permanent erosion in the width of the beach. The width of the beach has decreased approximately 400 feet in 60 years, or 6.5 feet per year. In 1966 the county of Hawaii requested a study of the Kaimu Beach erosion under the small projects authority of the River and Harbor Act of 1962.

This beach lies along the southeast coast of the island of Hawaii, just northeast of the village of Kalapana, and is popularly known as Kalapana Beach. Kaimu Black Sands Beach, about 1,000 feet long, varies in width from 70 feet during late winter to 118 feet in early fall. The sand is composed almost entirely of volcanic glass and lava fragments (glass predominating) which gives the sand its famed black color. The sand is only moderately well sorted and is very coarse in size, with some gravel-size components. Erosion of the beach during winter exposes an underlying boulder layer at the northeast end of the beach. The back shore is black sand within a coconut grove which, farther inland, terminates against basaltic rock. This lava also forms projecting points at either end of the beach. Offshore, the bottom is predominantly rock. Waves are generally rather large, as can be seen by the steep foreslope, and a strong rip current periodically flows off the southwest end of the beach.

Kaimu is the most publicized, and has the easiest access from Hilo, of all of the small black sand beaches. Future plans for this area are based on expansion of recreation facilities coupled with creation of a low-density resort complex. With the completion of the Puna Coast Highway and the Chain of Craters Road, Kalapana-Kaimu will become the gateway to the Hawaii Volcanoes National Park.

A reconnaissance report indicated the need for further study. A detailed project study is scheduled to be completed in 1969.

HILO HARBOR TSUNAMI AND NAVIGATION PROJECTS

(See p. 40 for project drawing.)

Hilo Harbor, second largest seaport in the State, is on the northeast coast of the island of Hawaii. The harbor facilities have made the city of Hilo which is adjacent to the harbor the center of economic activity for the entire island.

The existing harbor was constructed in 1930 and consists of a rubblemound breakwater 10,080 feet long, an entrance channel 35 feet deep, and a harbor basin 1,400 feet wide, 2,300 feet long and 35 feet deep. Modifications to this harbor were authorized by the River and Harbor Acts of 1907, 1912, 1925, 1960, and 1962.

The harbor modification project authorized by the River and Harbor Act of 1960 intended to provide protection from tsunamis and to improve navigation conditions in the harbor. The initial plan of improvement proposed to strengthen and raise the existing breakwater, to extend the breakwater to a total length of 10,570 feet, and to construct a 4,000-foot west breakwater and a 6,600-foot land dike. Hydraulic model studies of this plan and other alternative plans have been completed and the report of these model studies published. Further work on this project has been deferred indefinitely because the State of Hawaii is unwilling to provide firm assurances of cooperation.

A Hilo Harbor modification study was authorized by House Resolution No. 739 of May 9, 1967, to determine the feasibility of harbor modifications, particularly enlargement and surge reduction. Currently, the University of Hawaii, under contract to the Honolulu Engineer District, is conducting a gaging program in Hilo Harbor. This program, presently estimated to be complete in 1 year, should produce data which will permit analysis of the surge problem and model testing of the various engineering solutions to this problem.



Hilo Harbor, one of two ports on the island of Hawaii

In order to assure continued beneficial use of Hilo Harbor for commercial navigation during the studies for the surge problem and harbor modification, the Chief of Engineers authorized the emergency repair of the breakwater. This work was completed on July 22, 1968, under a contract administered by the Honolulu Engineer District.

This project was inspected and reviewed on November 20–21. Discussions were held with various individuals in an attempt to determine the reason for delay in proceeding with construction of the authorized breakwaters. It was learned that the principal reason for delay was the inability of the State of Hawaii to meet the large cash contribution required by the authorizing legislation. In order to determine the equity of the conditions of local cooperation it is recommended elsewhere in this report that the Secretary of the Army determine any adjustment of the cash contribution required of local interests as authorized by the River and Harbor Act of 1962.

REEDS BAY SMALL BOAT HARBOR

(See p. 41 for project drawing.)

Reeds Bay, a small inlet in the shoreline of Hilo Bay, is shoreward of the existing Federal deepwater harbor. Reeds Bay is protected from direct wave attack by deep water waves but may be subjected to 5-foot wind waves generated in Hilo Bay. Prevailing winds are from the south and southwest. The bottom at Reeds Bay is composed of hard lava formations with a superficial layer of silt and sand; the shore is rocky except for a short sandy beach at its west end.

The "Interim Report of Survey of the Coasts of Hawaiian Islands, Harbors for Light Draft Vessels" recommended Federal adoption of a small boat harbor at Reeds Bay to provide for a breakwater 870 feet long extending eastward from the existing shoreline to shelter a flared harbor basin of about 9 acres in area and suitable for the accommodation of approximately 270 boats. The entrance channel would be 120 feet wide and 12 feet deep. The State of Hawaii would develop the berthing and shoreside facilities. The Reeds Bay Boat Harbor project was authorized by Congress in the River and Harbor Act of 1965. No funds for advance design or construction have been appropriated.

The estimated cost and economics of the project are as follows:

1st cost	$656,000
Annual cost	$32,000
Annual benefits	$60,400
Benefit-cost ratio	1.9
Federal cost	$320,000
Non-Federal cost	$336,000
Design capacity (boats by 2015)	270

WAILOA STREAM FLOOD CONTROL

(See p. 42 for project drawing.)

Wailoa Stream and its tributary streams, Waiakea and Kawili, are in the Waiakea section of the city of Hilo on the northeastern side of the island of Hawaii. The drainage basin comprises about 19.6 square miles and extends from about the 2,500-foot elevation of Mauna Loa to the ocean, draining through Waiakea Pond and Wailoa River

The project, authorized by the Flood Control Act of September 3, 1954, provided for clearing the natural stream bed of Kawili Stream in the upper reaches, a combination channel 355 feet long and levee 88 feet long to divert the Kawili Stream flow into Waiakea Stream, a combination channel 333 feet long and levee 350 feet long to divert the combined flows of Waiakea and Kawili Streams into a long and narrow swale area. It also provided for a combination channel 1,100 feet long and levee 800 feet long to protect the University of Hawaii Hilo campus dormitory, with a diversion levee 325 feet long to divert the flows from the swale area to a new excavated channel 4,680 feet long. Earth levees totaling 6,510 feet border the excavated channel. The project also includes a new 122-foot concrete box culvert, an 80-foot concrete bridge, and an interior drainage structure. The project was completed in August 1965, at a cost of $1,075,857.

In July 1966, heavy rains caused flooding in the Hilo area. An estimated 3,000 to 4,000 cubic feet per second passed through the flood control channel as the first test of the works. The channel carried the runoff and prevented considerable damage in the area. The flow did expose the toe of the slope protection at two locations of the channel. These are not considered serious enough to warrant repairs at this time.

22

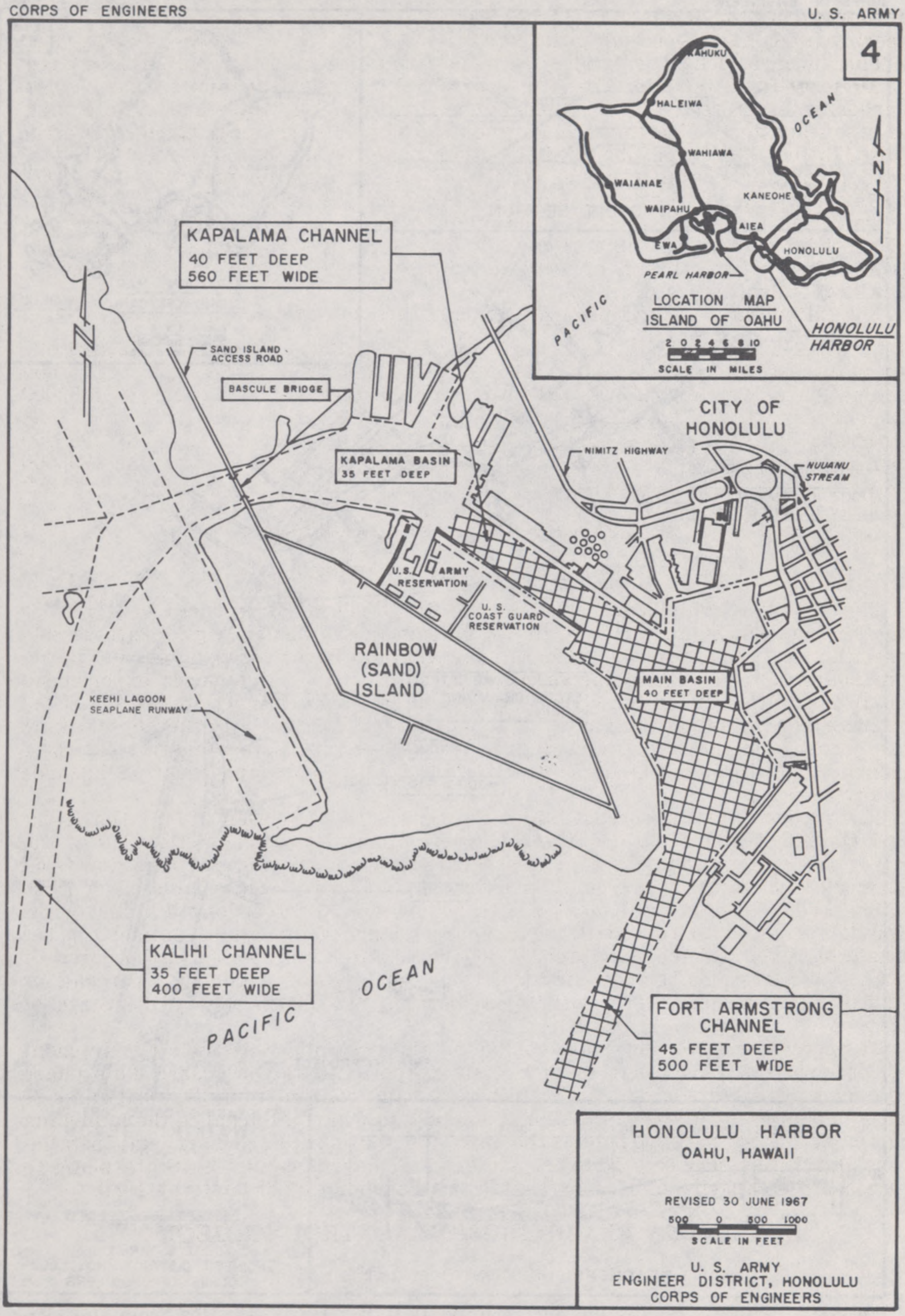
WAIPIO RIVER, KOHALA-HAMAKUA COAST

(See p. 43 for survey map.)

This study was authorized by the Flood Control Act of 1962 and provides for a multiple-purpose feasibility study to determine the need for improvement and development of the stream and basins of the Waipio River and Kohala-Hamakua coast area. The Kohala-Hamakua coast area is located on the northeast slope of Kohala Mountain at the northern end of the island of Hawaii. Waipio River is located in Waipio Valley, the most prominent valley on the Hamakua coast.

The total objective of this study is to consider potential flood control measures, water supply, power generation and recreational aspects of the valley, its watershed and adjacent drainage areas in the Kohala Mountains. The investigations completed to date were confined to the drainage basin of Waipio Valley, which covers an area of approximately 25 square miles. The coastal area which encompasses approximately 1 square mile, is subjected to recurring floods which has been a discouraging factor in the development of Waipio Valley. Also, development of Waipio's water for use on lands adjacent to Waipio Valley is a matter of special concern to the State of Hawaii. Development of additional water supply sources in the Waipio drainage basin or in adjacent drainage areas is a major resources requirement of the State to develop the leeward coast of Hawaii due to the serious water shortages in recent years and an expanding demand resulting from economic growth.

Investigations to date show that improvements for flood control within Waipio Valley are not economically justified. Possible multi-purpose reservoir sites were also investigated, but because of fractional benefit-cost ratio were eliminated. Future studies will concentrate on alternative reservoir sites in the upper reaches of Kohala Mountain. This study is scheduled for completion in fiscal year 1970.

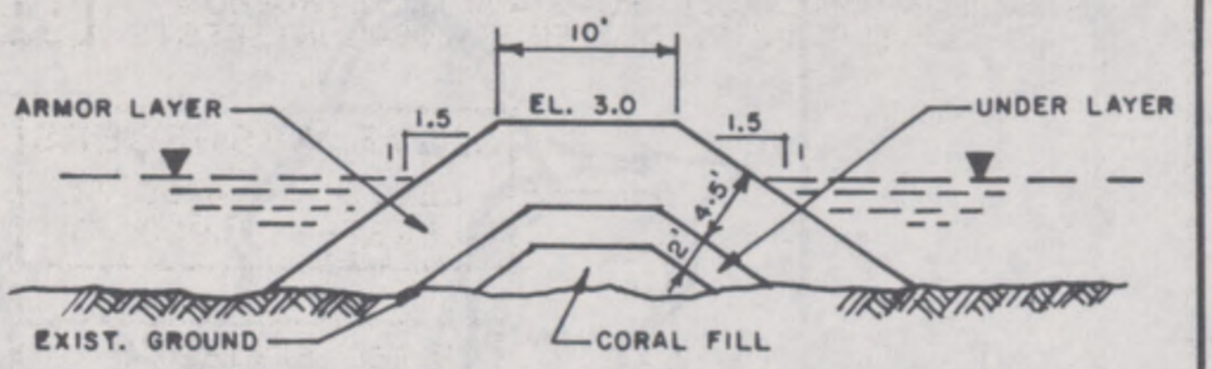

CORPS OF ENGINEERS
U. S. ARMY
4
KAHUKU
HALEIWA
WAHIAWA
WAIANAE
WAIPAHU
KANEOHE
AIEA
EWA
HONOLULU
PEARL HARBOR
PACIFIC
OCEAN
LOCATION MAP
ISLAND OF OAHU
2 0 2 4 6 8 10
SCALE IN MILES
HONOLULU HARBOR
KAPALAMA CHANNEL
40 FEET DEEP
560 FEET WIDE
SAND ISLAND ACCESS ROAD
BASCULE BRIDGE
KAPALAMA BASIN
35 FEET DEEP
CITY OF HONOLULU
NIMITZ HIGHWAY
NUUANU STREAM
U.S. ARMY RESERVATION
U. S. COAST GUARD RESERVATION
RAINBOW (SAND) ISLAND
MAIN BASIN
40 FEET DEEP
KEEHI LAGOON SEAPLANE RUNWAY
KALIHI CHANNEL
35 FEET DEEP
400 FEET WIDE
OCEAN
PACIFIC
FORT ARMSTRONG CHANNEL
45 FEET DEEP
500 FEET WIDE
HONOLULU HARBOR
OAHU, HAWAII
REVISED 30 JUNE 1967
500 0 500 1000
SCALE IN FEET
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

21–793 O—69——3

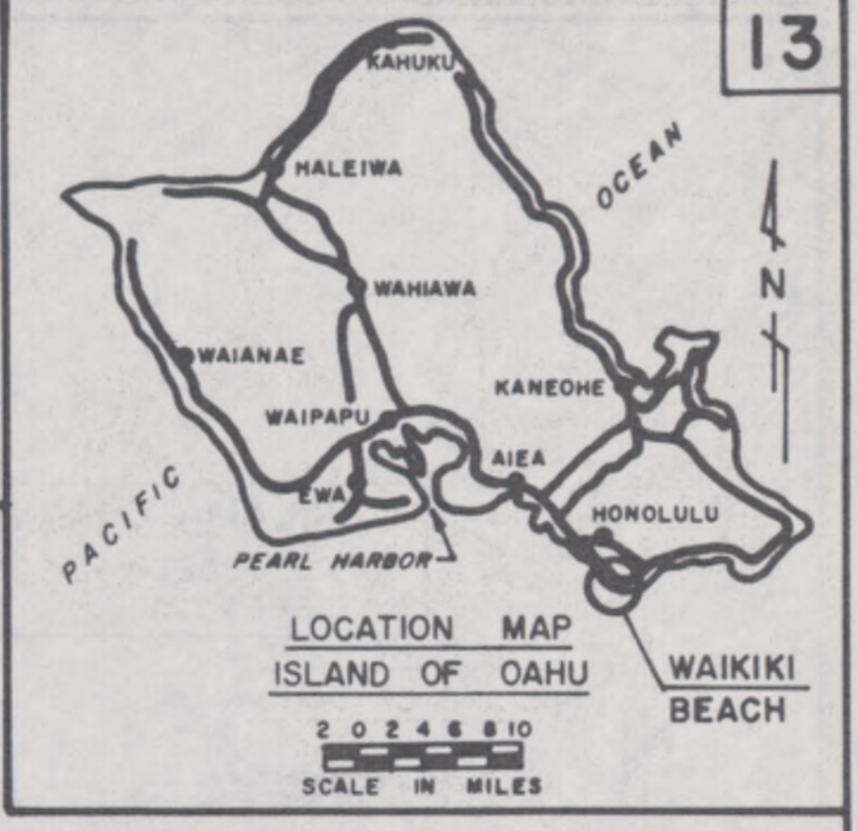
CORPS OF ENGINEERS

U. S. ARMY

13

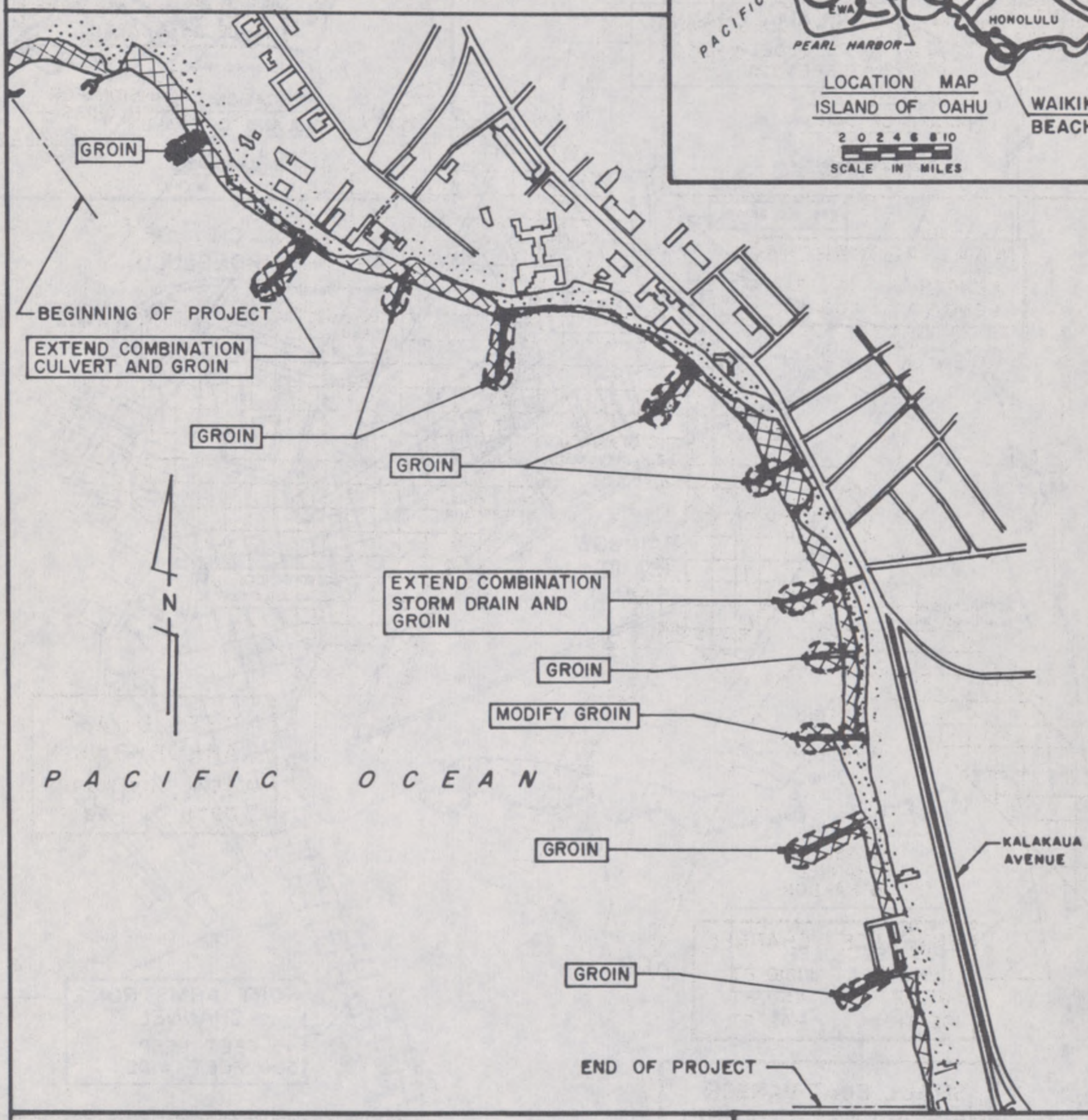


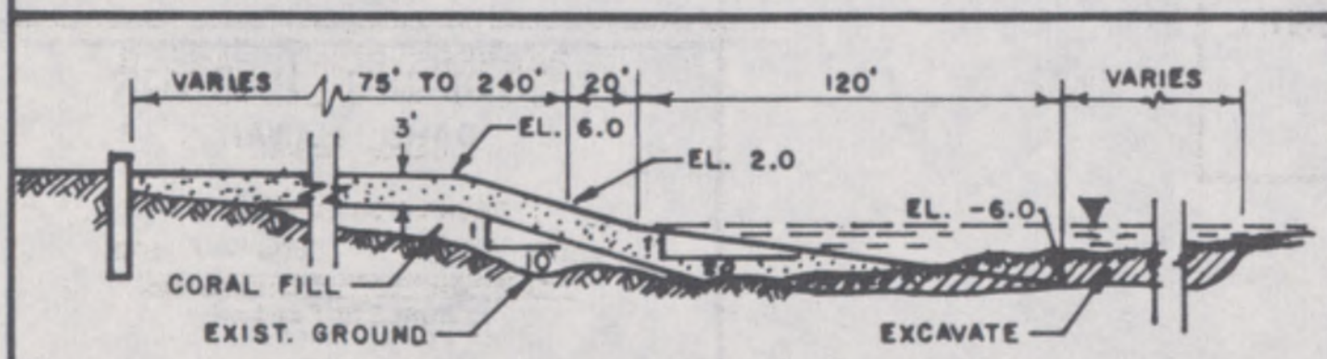
TYPICAL GROIN SECTION



LOCATION MAP
ISLAND OF OAHU

2 0 2 4 6 8 10
SCALE IN MILES





BEACH FILL

BEACH EROSION CONTROL
WAIKIKI BEACH
OAHU, HAWAII

REVISED 30 JUNE 1967

500 0 500 1000
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY

17



EXISTING MALAKOLE ROAD AND 8" PETROLEUM PIPELINE TO BE RELOCATED BY LOCAL INTERESTS

WAVE ABSORBERS
LENGTH 4100 FT.
LENGTH 900 FT.

UNITED STATES INFORMATION AGENCY BUILDING AND ANTENNA TO BE RELOCATED

FUTURE EXPANSION FOR LARGER SHIPS

WAVE ABSORBERS
LENGTH 1100 FT.
LENGTH 800 FT.

ANTENNA FIELD

N

EXISTING BARGE PIER

EXISTING BARGE CHANNEL & HARBOR

DEEP DRAFT HARBOR BASIN
AREA 116 ACRES
DEPTH -38 FT.

ENTRANCE CHANNEL
LENGTH 3100 FT.
WIDTH 450 FT.
DEPTH -42 FT.

SMALL BOAT HARBOR MAIN ACCESS CHANNEL
LENGTH 1200 FT.
WIDTH (MIN) 80 FT.
DEPTH 8 & 12 FT.

BARBERS POINT HARBOR
(DEEP-DRAFT & LIGHT-DRAFT)

OAHU, HAWAII

REVISED 30 JUNE 1968

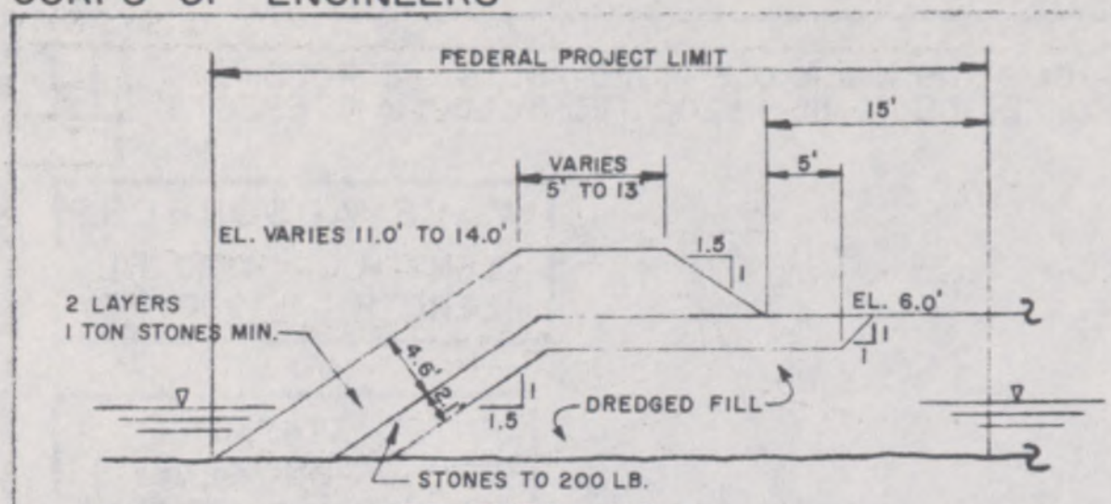
400 0 400 800
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

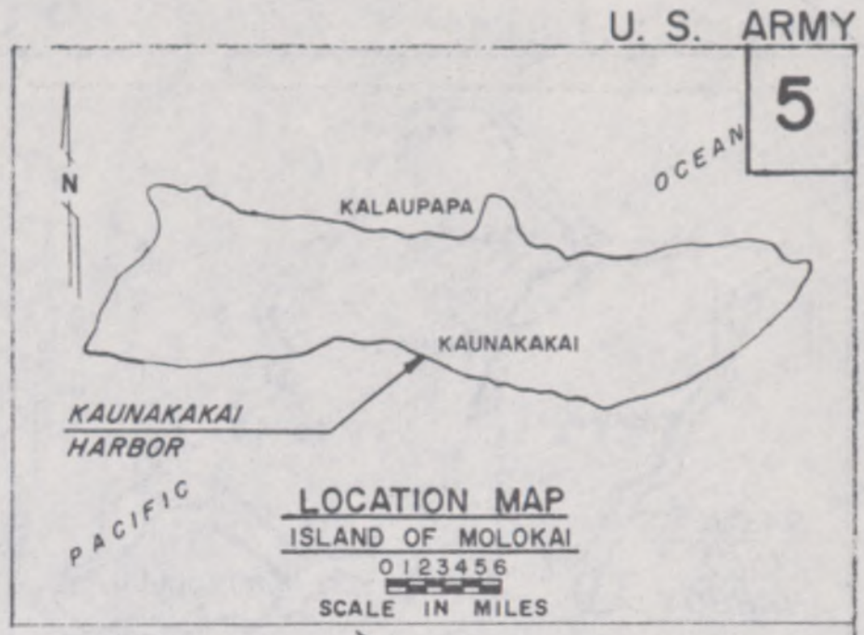
U. S. ARMY

5

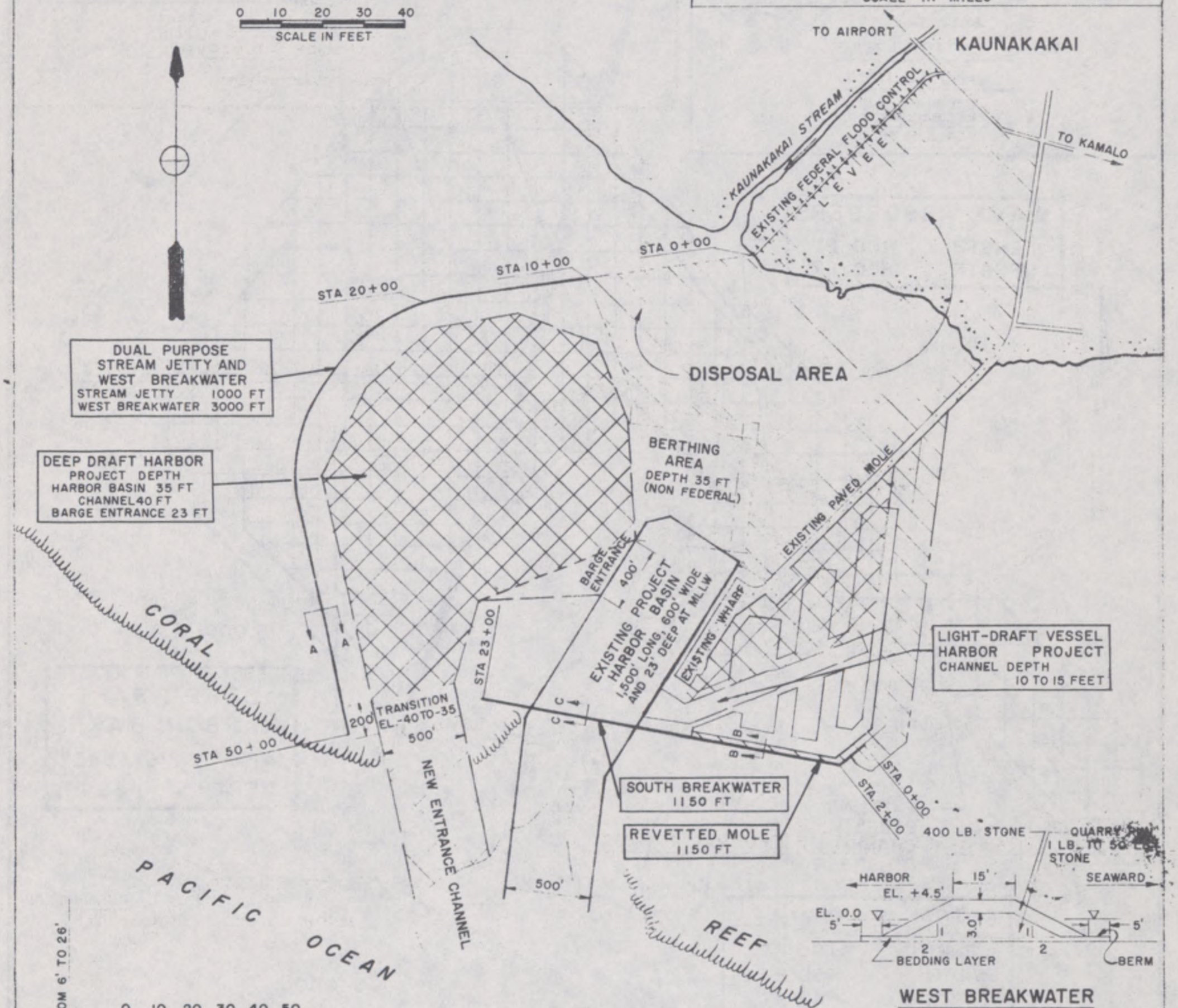


REVETTED MOLE
TYPICAL SECTION B-B

0 10 20 30 40
SCALE IN FEET



LOCATION MAP
ISLAND OF MOLOKAI
0 1 2 3 4 5 6
SCALE IN MILES

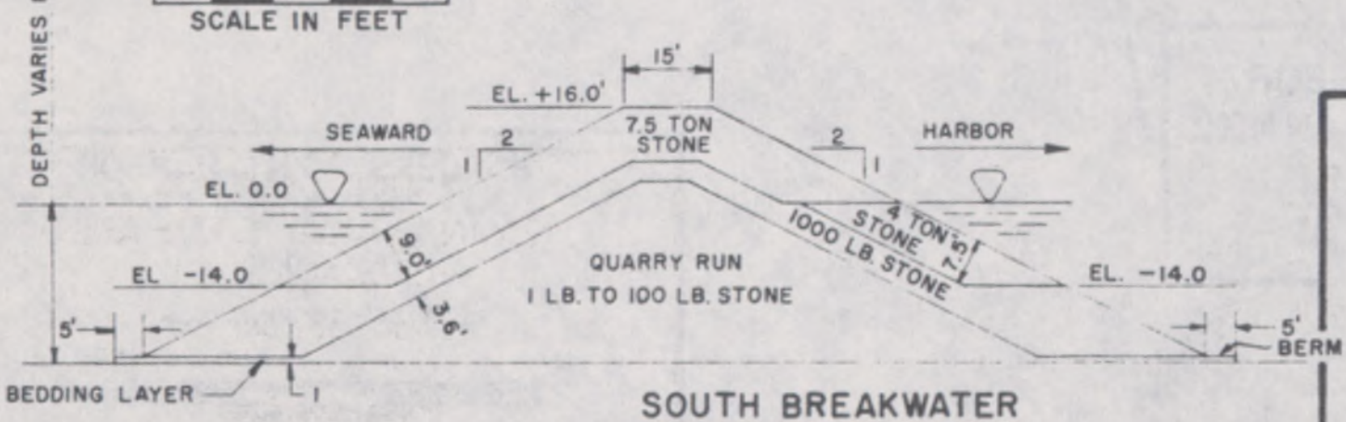


WEST BREAKWATER
TYPICAL SECTION A-A

0 10 20 30 40
SCALE IN FEET

DEPTH VARIES FROM 6' TO 26'

0 10 20 30 40 50
SCALE IN FEET



SOUTH BREAKWATER
TYPICAL SECTION C-C

ELEVATIONS AND DEPTHS BASED ON MLLW

KAUNAKAKAI HARBOR
(DEEP-DRAFT & LIGHT-DRAFT VESSELS)

MOLOKAI, HAWAII

REVISED 30 JUNE 1967

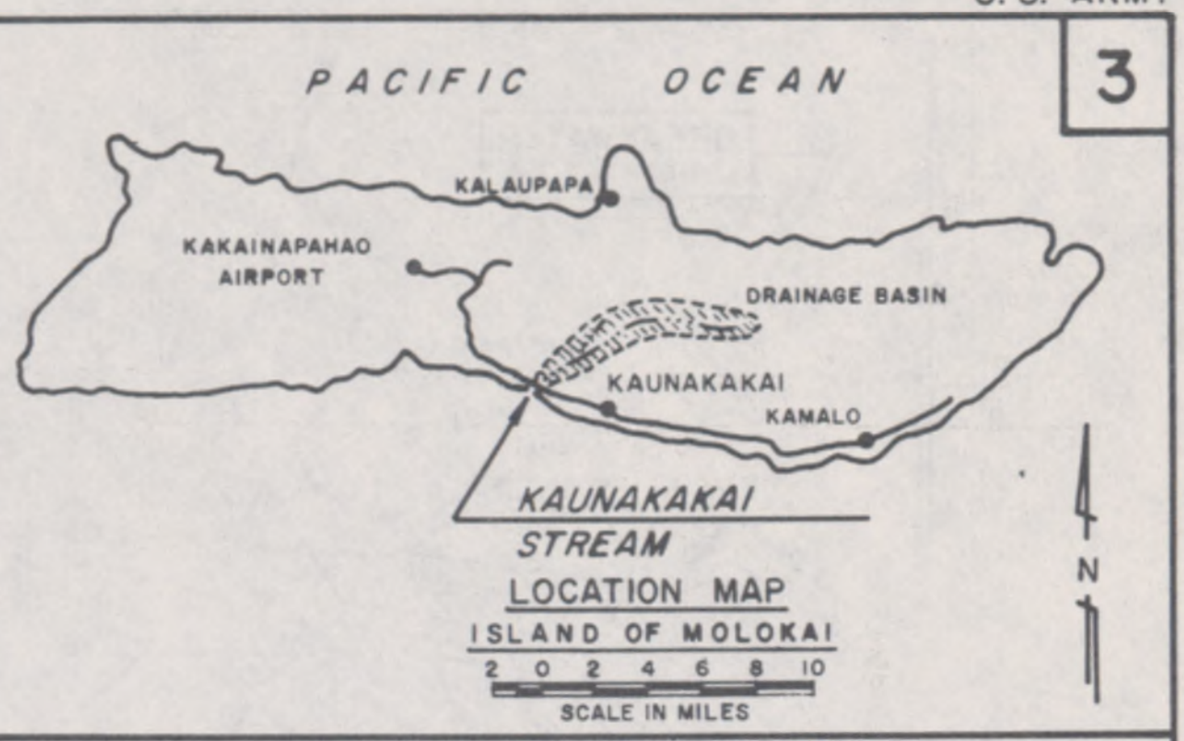
300 0 300 600
SCALE IN FEET

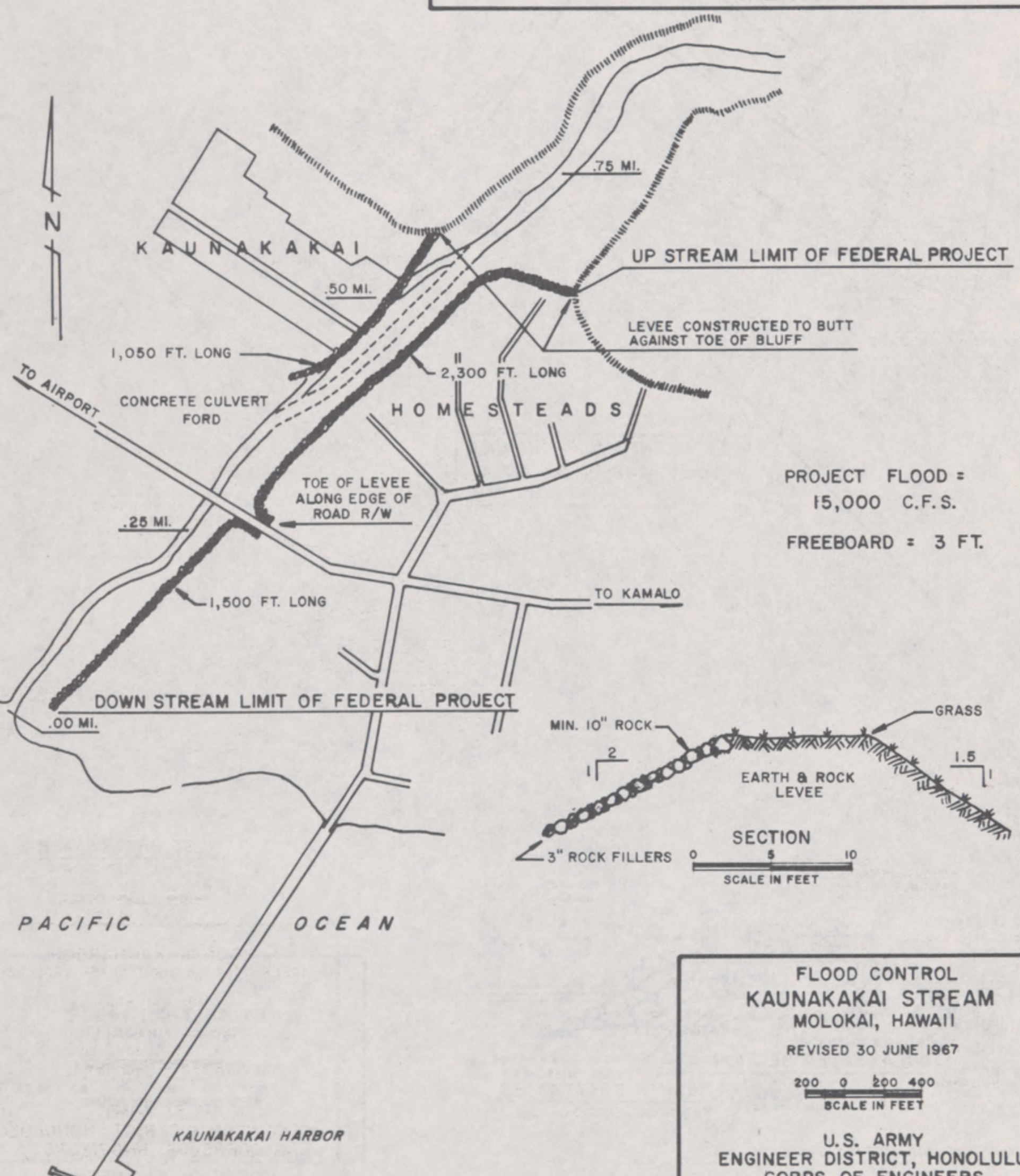
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY

3





FLOOD CONTROL
KAUNAKAKAI STREAM
MOLOKAI, HAWAII

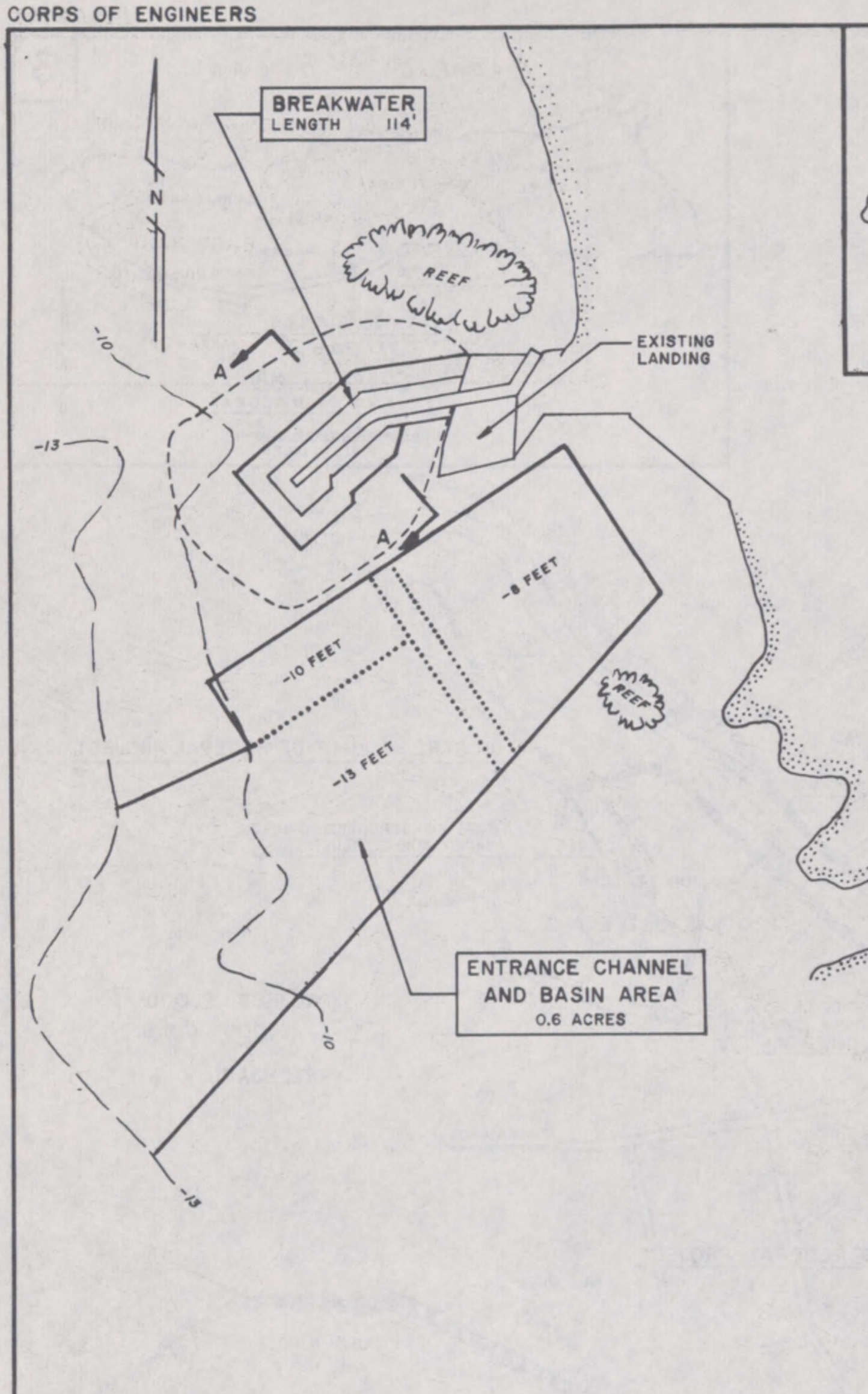
REVISED 30 JUNE 1967

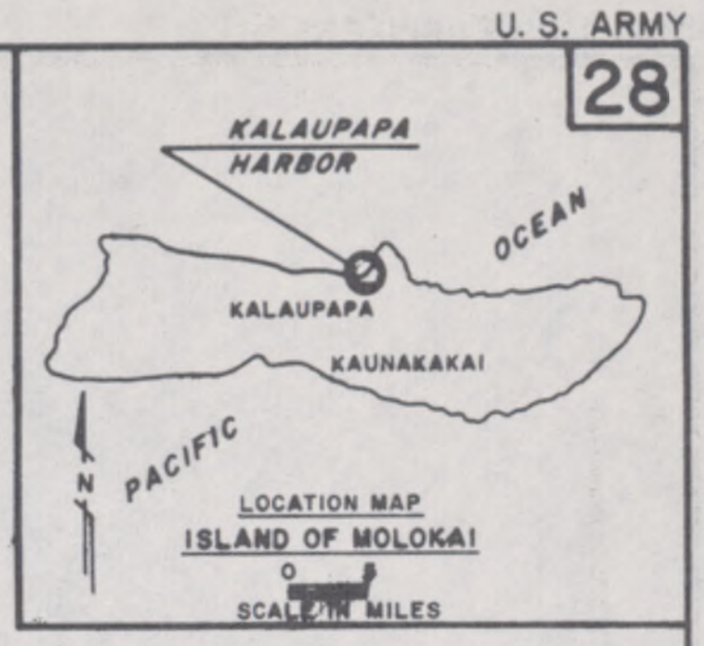
200 0 200 400
SCALE IN FEET

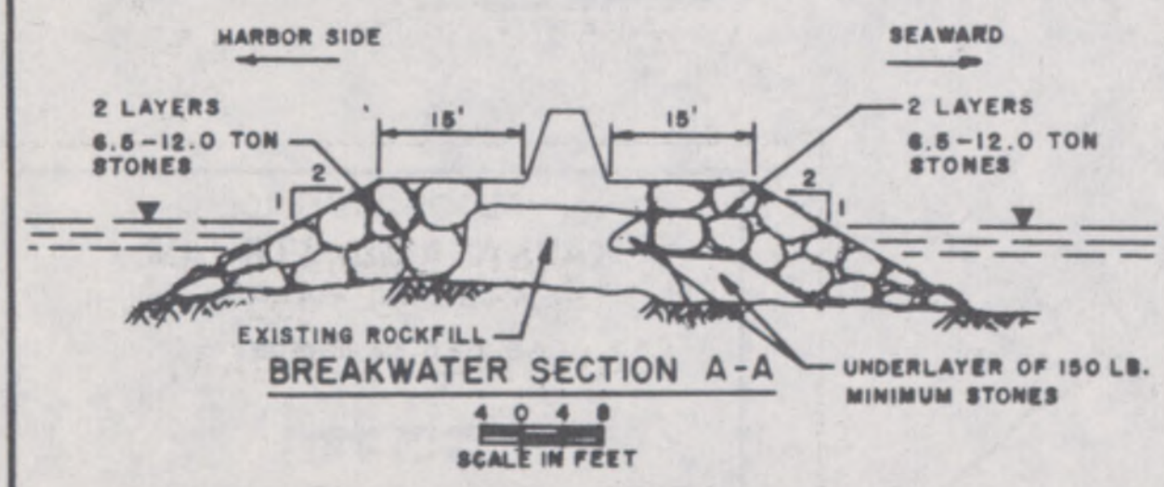
U.S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY







BREAKWATER SECTION A-A

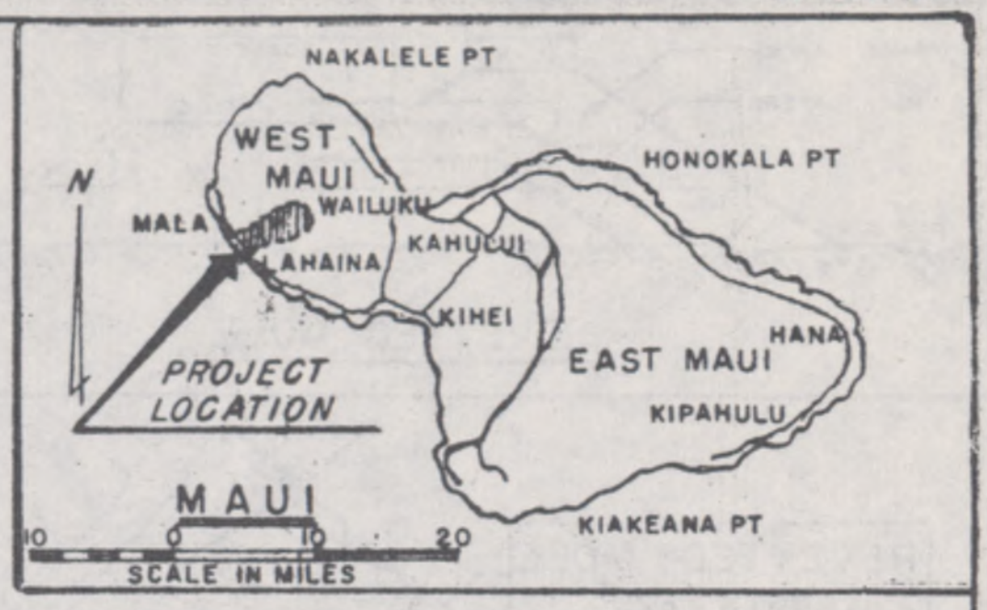
KALAUPAPA HARBOR
MOLOKAI, HAWAII

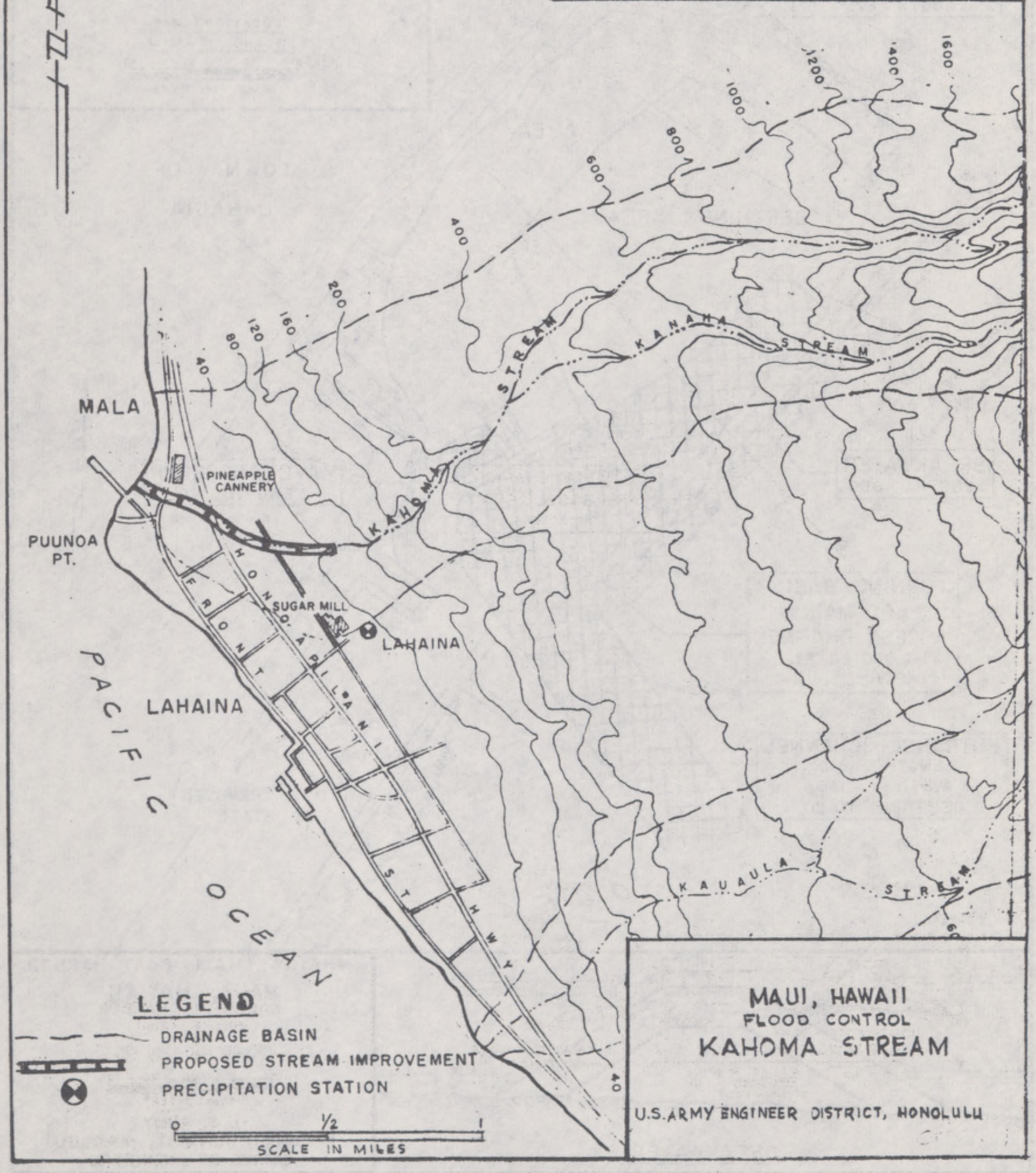
REVISED 30 JUNE 1968

20 0 20 40 60
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS U.S. ARMY





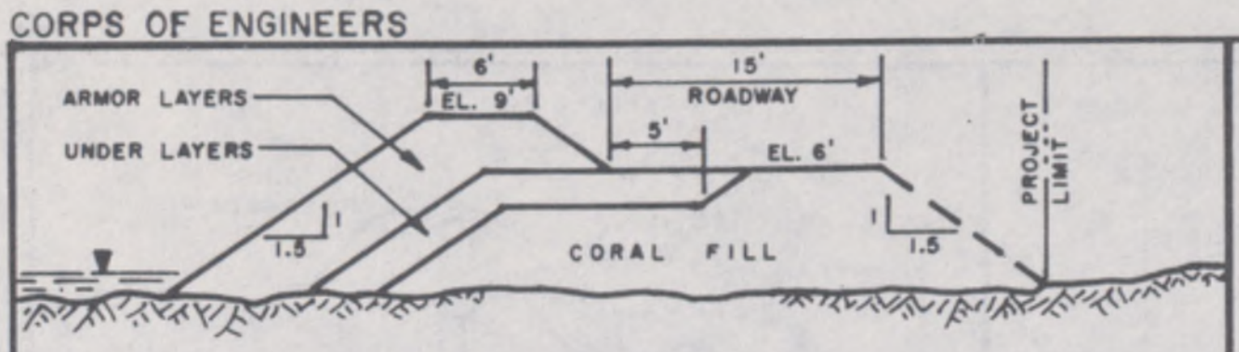
MAUI, HAWAII
FLOOD CONTROL
KAHOMA STREAM

U.S. ARMY ENGINEER DISTRICT, HONOLULU

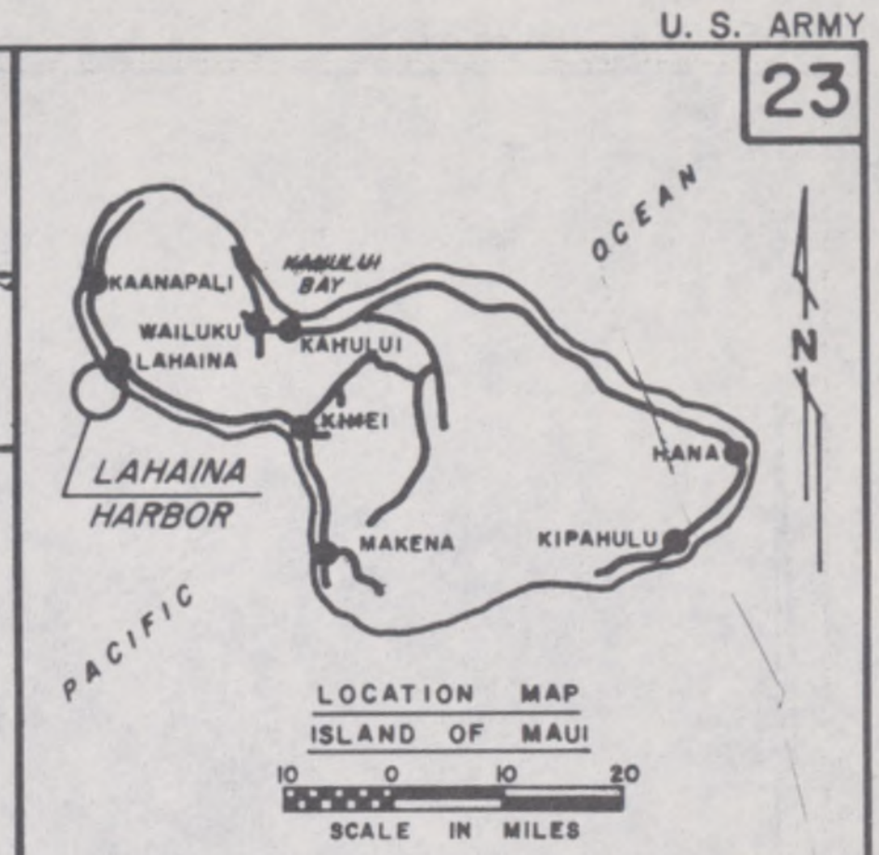
CORPS OF ENGINEERS

U. S. ARMY

23



REVETTED MOLE



REVETTED MOLE
LENGTH 620'

FILL AREA

BERTHING AREA

TOWN OF LAHAINA

CORAL REEF

SERVICE FACILITIES

RAMP

BREAKWATER
LENGTH 950'

WAVE ABSORBER
LENGTH 180'

LIGHTHOUSE

TURNING BASIN AND MAIN ACCESS CHANNEL
140,000 SQ. FT.
DEPTH 12'

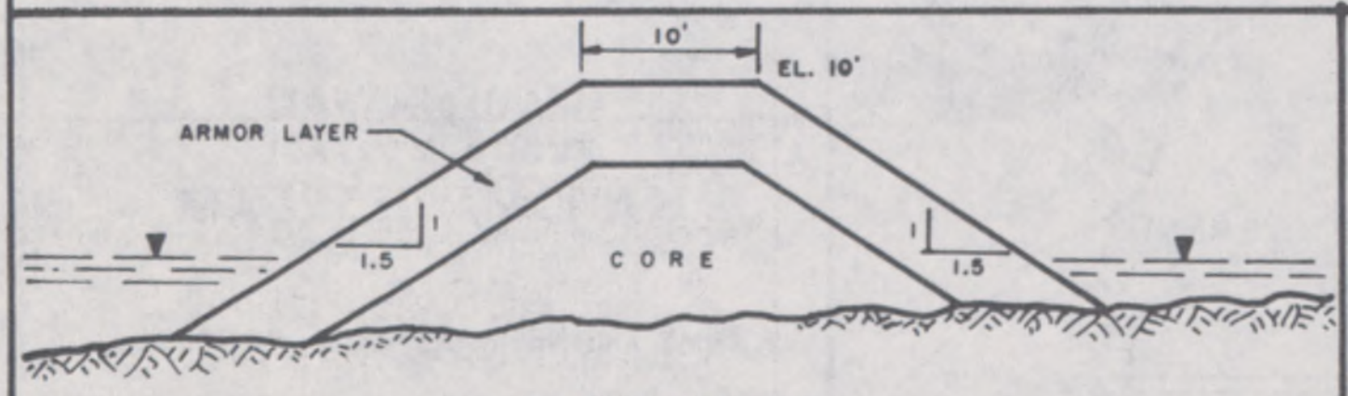
EXISTING HARBOR

(TO BE REMOVED BY STATE)

ENTRANCE CHANNEL
LENGTH 515'
WIDTH 150'
DEPTH 15' TO 20'

PACIFIC OCEAN

N



BREAKWATER

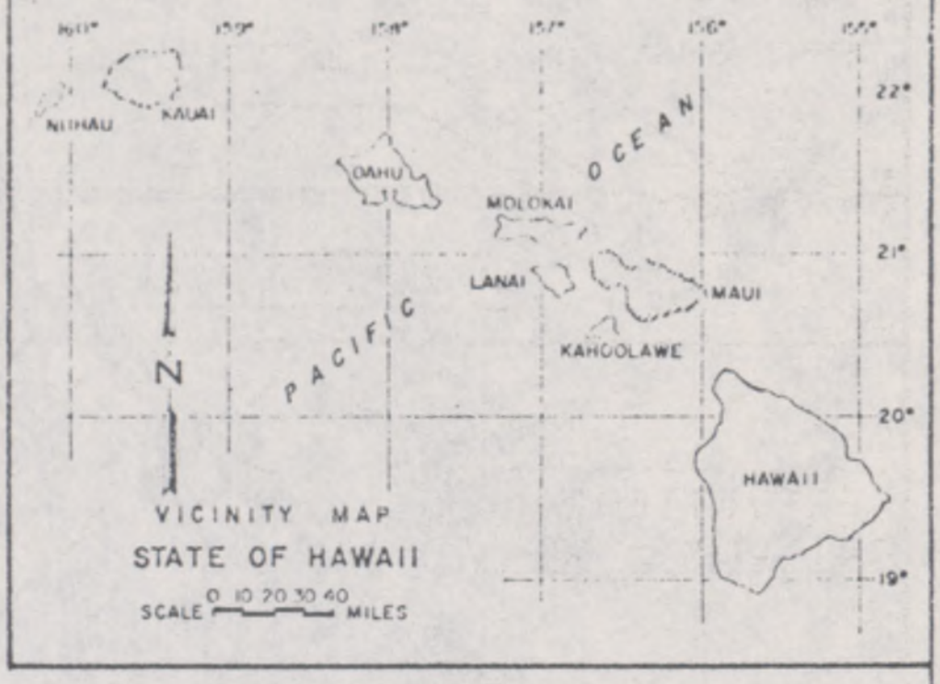
LAHAINA SMALL BOAT HARBOR
MAUI, HAWAII

REVISED 30 JUNE 1967

100 0 100 200
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

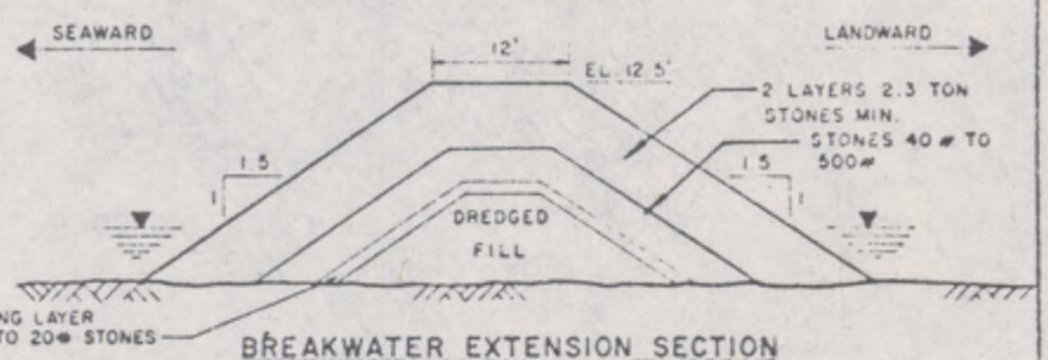
U S ARMY



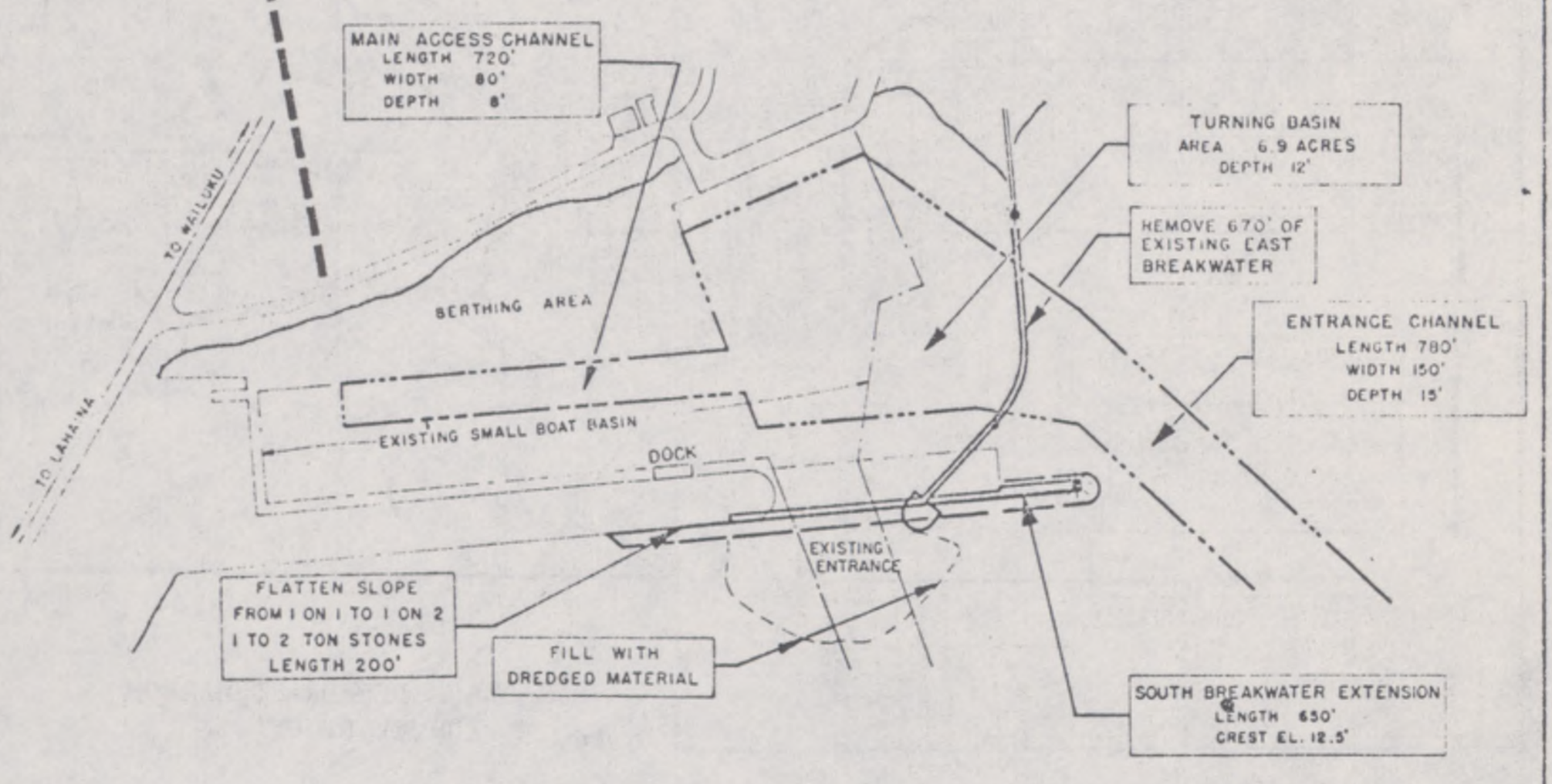
VICINITY MAP
STATE OF HAWAII
SCALE 0 10 20 30 40 MILES



LOCATION MAP
ISLAND OF MAUI
0 10 20 30
SCALE IN MILES



BREAKWATER EXTENSION SECTION
10 0 10 20
SCALE IN FEET



MAALAEA HARBOR

200 0 200 400
SCALE IN FEET

COASTS OF HAWAIIAN ISLANDS — HAWAII

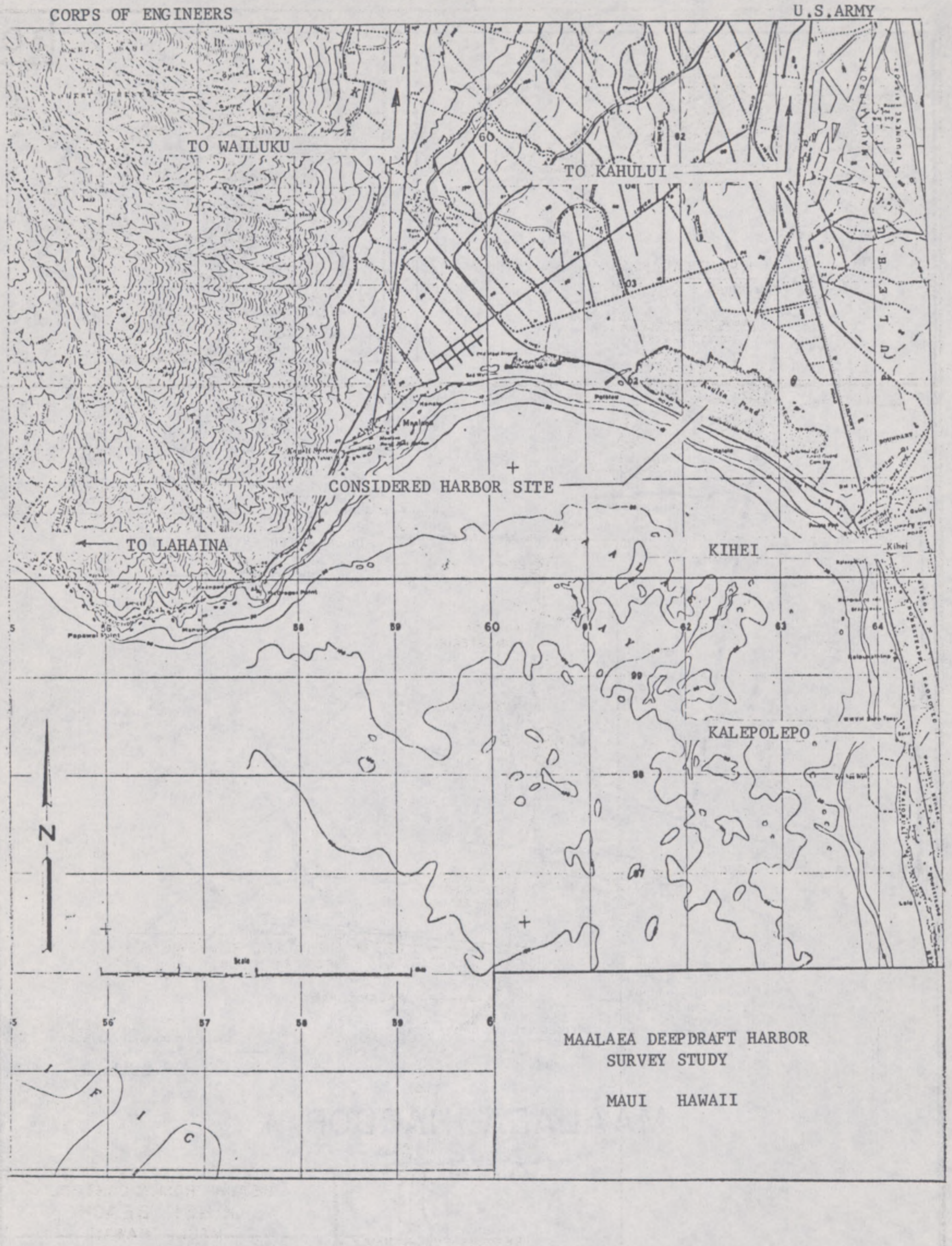
REPORT ON SURVEY OF
HARBORS FOR LIGHT-DRAFT VESSELS

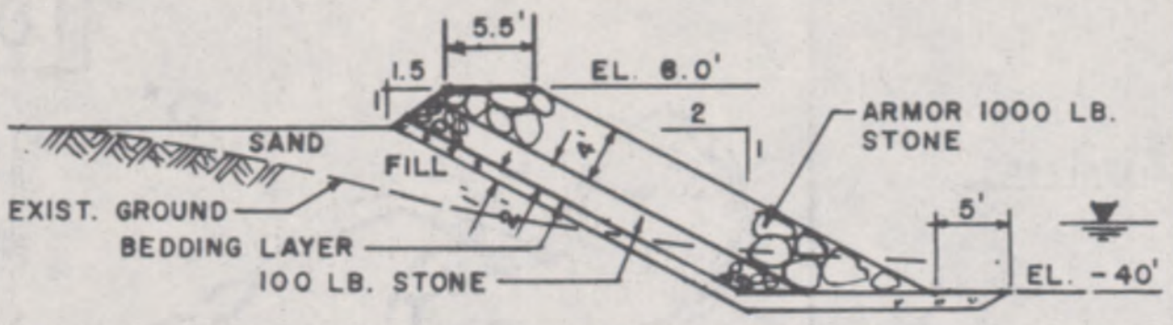
GENERAL PLANS
(ISLANDS OF KAUAI AND MAUI)

U S ARMY ENGINEER DISTRICT, HONOLULU

SUBMITTED	APPROVAL RECOMMENDED	APPROVED
Fred A Zebuhr, CHIEF, CIVIL WORKS BRANCH	Warren Fujii, CHIEF, ENGINEERING DIVISION	William F Tye, COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

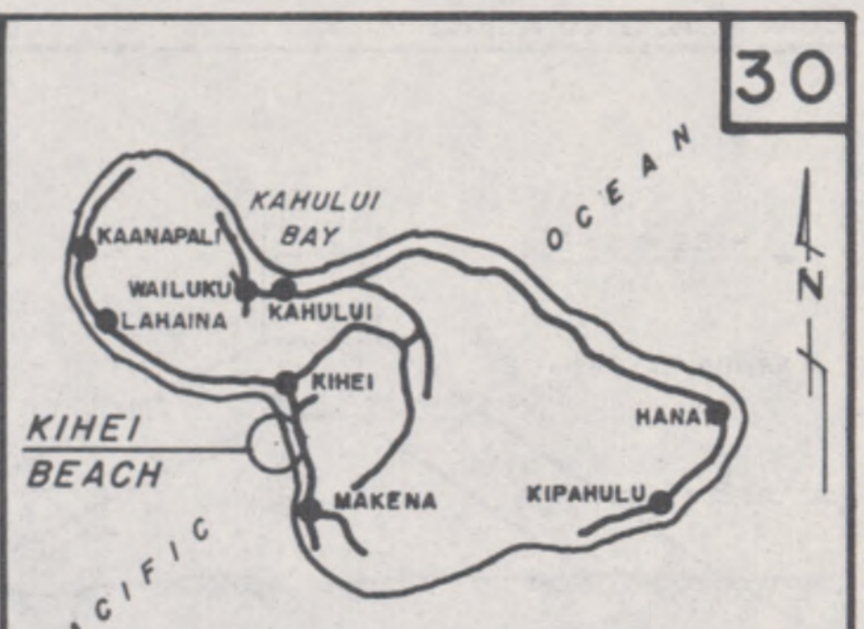
DRAWN G.Y. TRACED CHECKED H.V.K.	TO ACCOMPANY REPORT DATED 30 JUNE 1967	FILE NO RH-42/100.1


CORPS OF ENGINEERS
U.S.ARMY
TO WAILUKU
TO KAHULUI
CONSIDERED HARBOR SITE
TO LAHAINA
KIHEI
KALEPOLEPO
N
MAALAEA DEEPDRAFT HARBOR
SURVEY STUDY
MAUI HAWAII



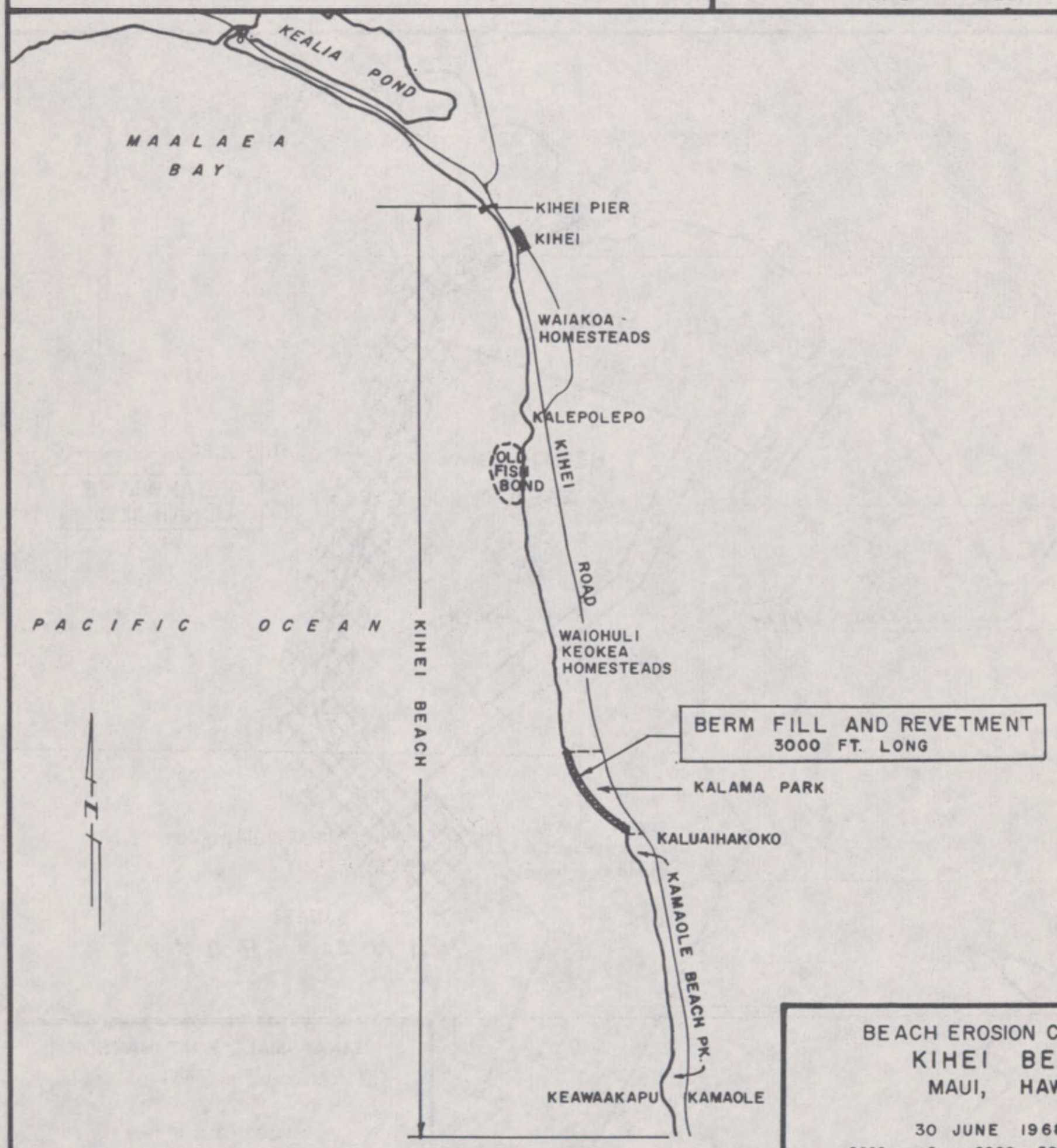
REVETMENT
TYPICAL SECTION

0 5 10 15 20
SCALE IN FEET



LOCATION MAP
ISLAND OF MAUI

10 0 10 20
SCALE IN MILES



BEACH EROSION CONTROL
KIHEI BEACH
MAUI, HAWAII

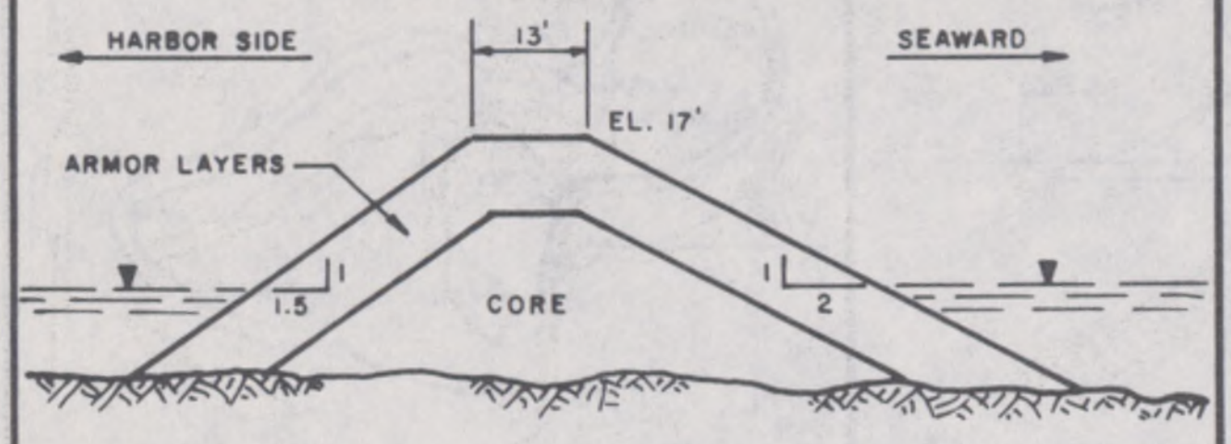
30 JUNE 1968

2000 0 2000 3000 6000
SCALE IN FEET

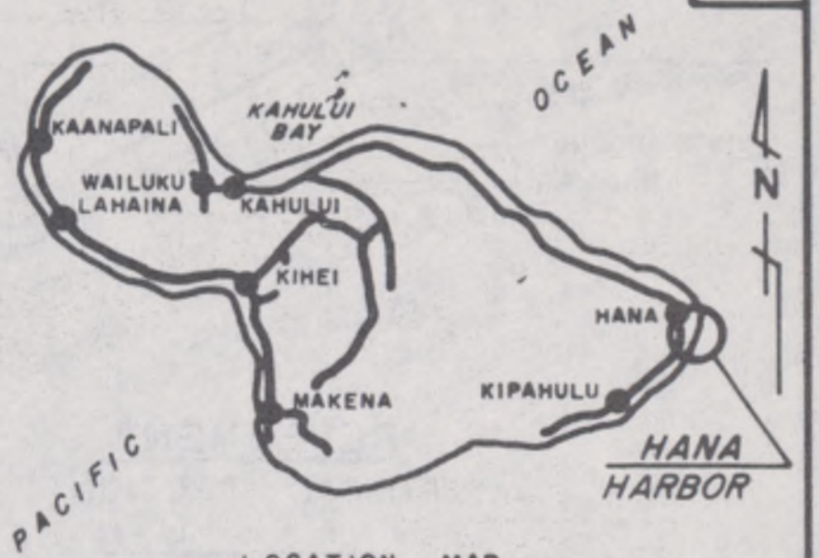
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

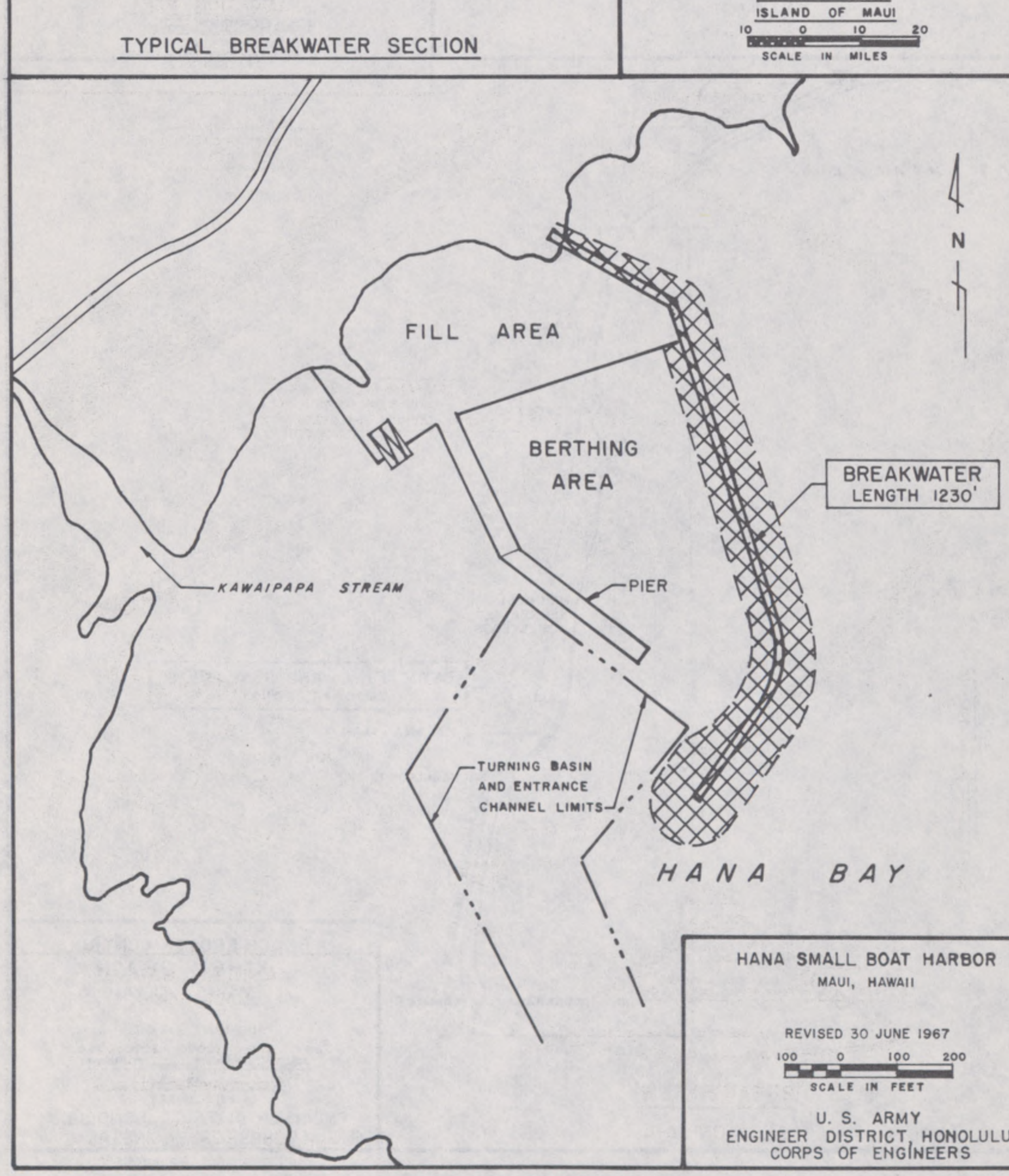
CORPS OF ENGINEERS U. S. ARMY

18



TYPICAL BREAKWATER SECTION





HANA SMALL BOAT HARBOR
MAUI, HAWAII

REVISED 30 JUNE 1967

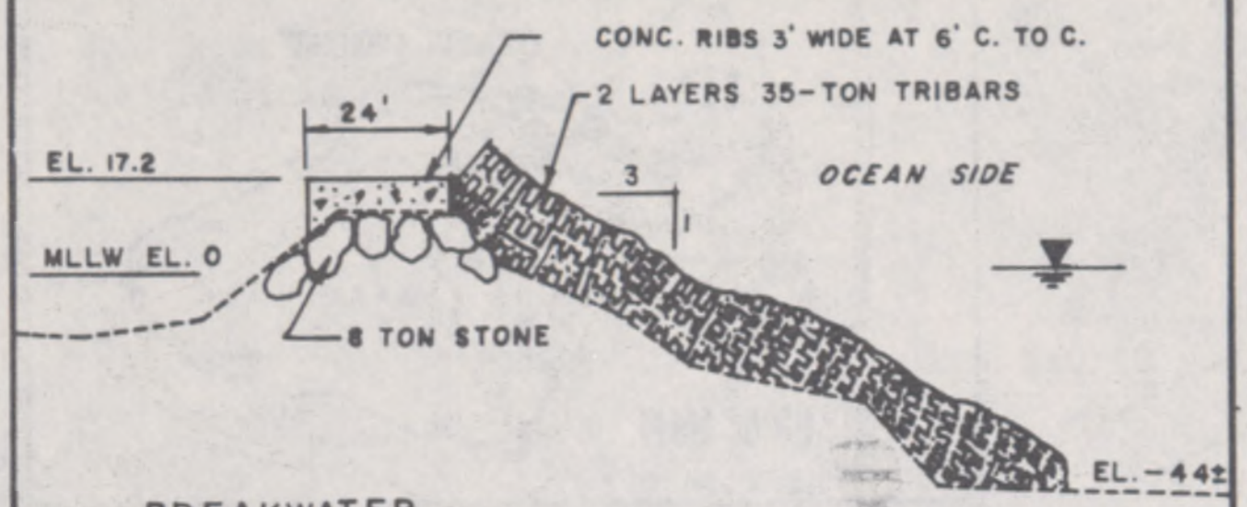
100 0 100 200
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

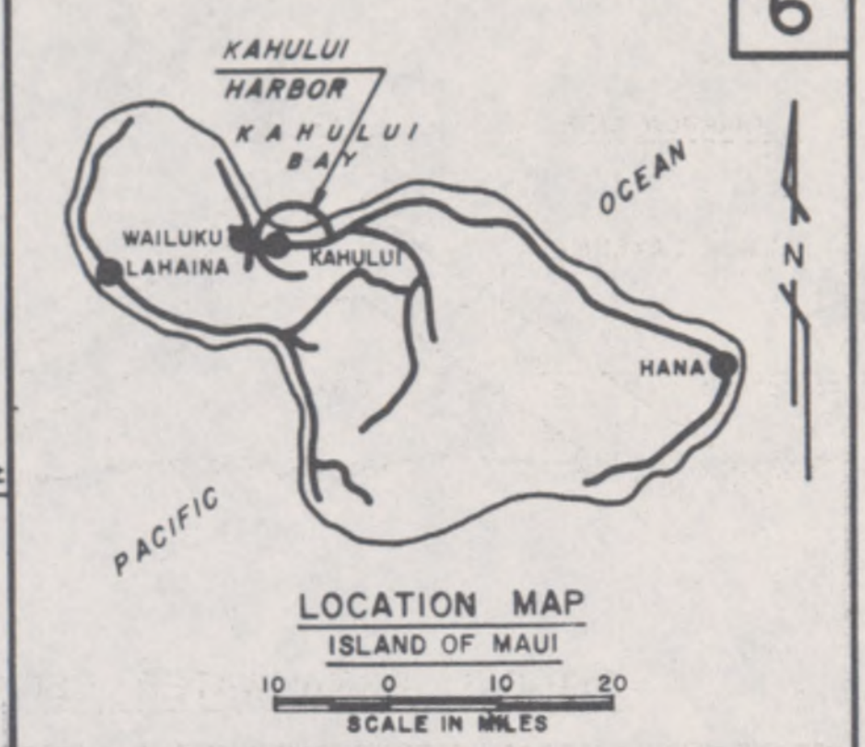
CORPS OF ENGINEERS

U. S. ARMY

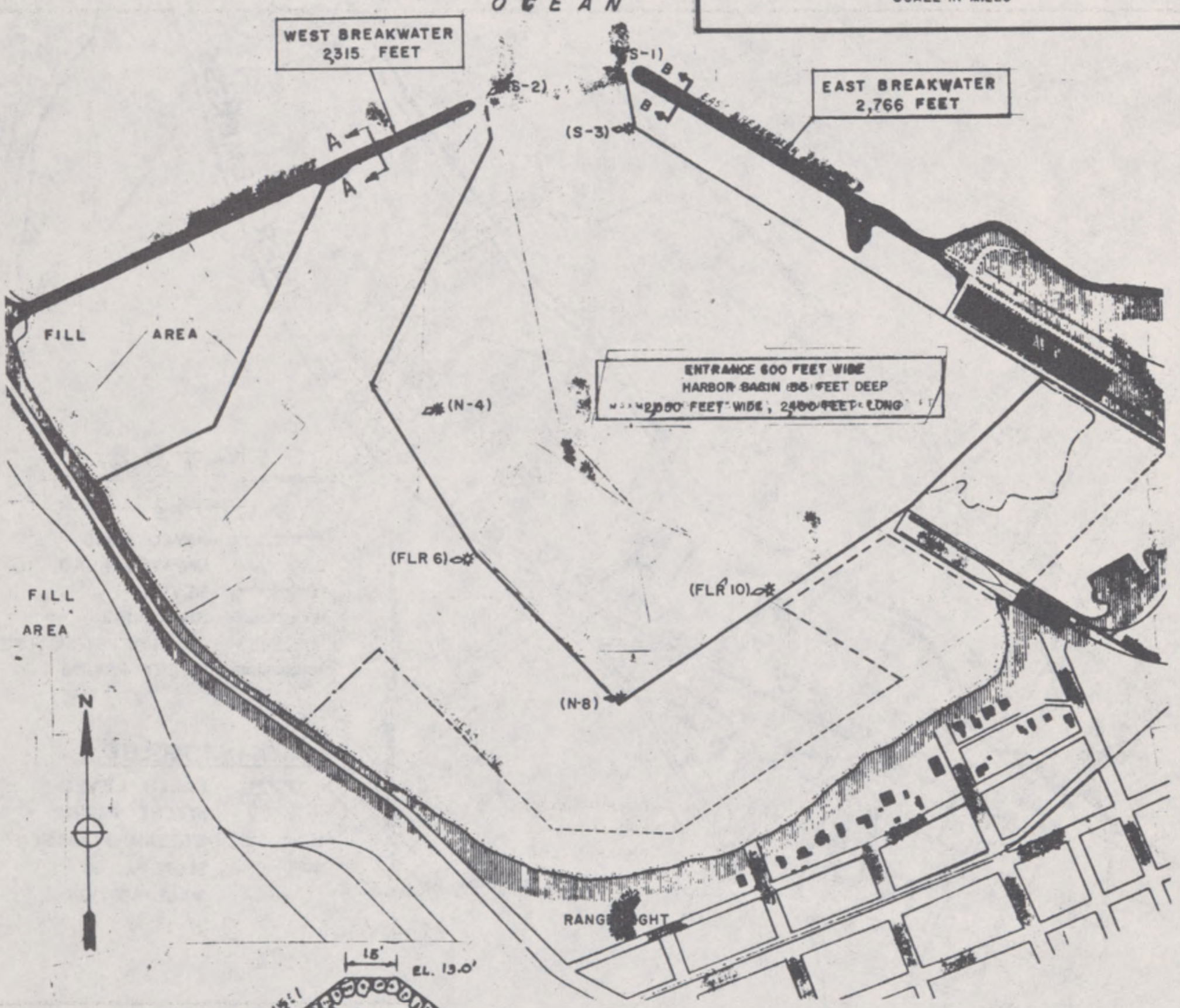
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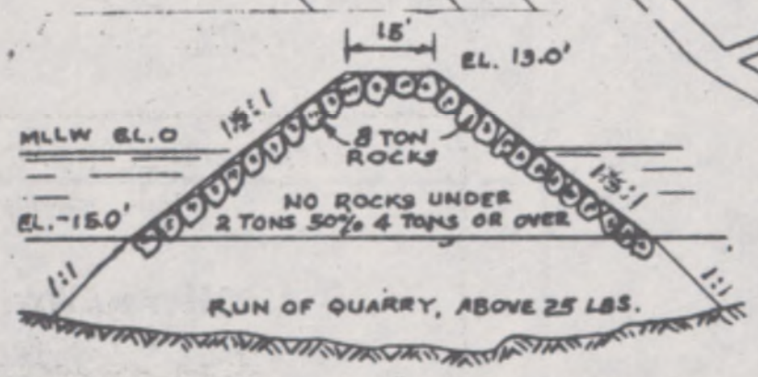


BREAKWATER
SECTION B B



LOCATION MAP
ISLAND OF MAUI
10 0 10 20
SCALE IN MILES





BREAKWATER
SECTION A-A

KAHULUI HARBOR
MAUI, HAWAII

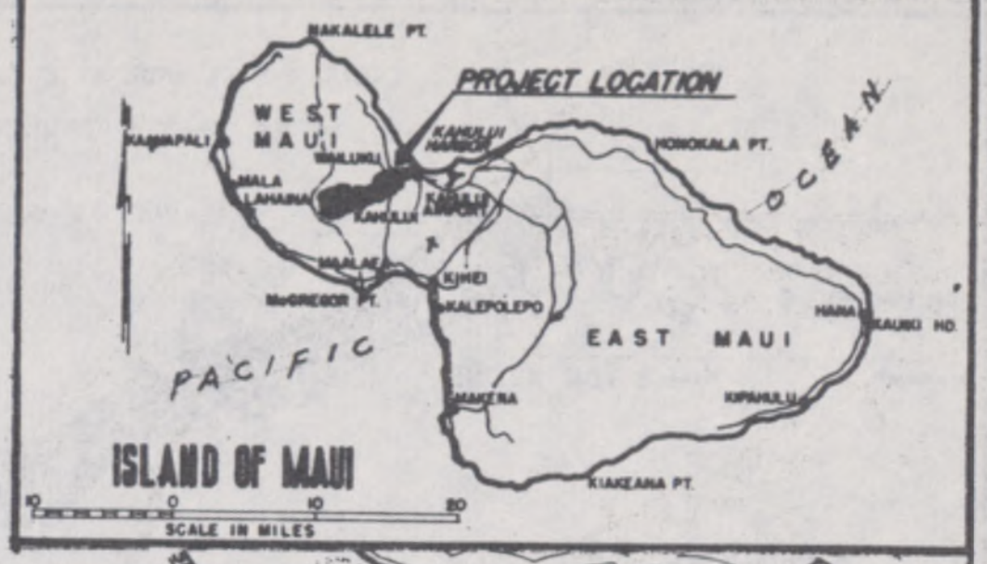
REVISED 30 JUNE 1968

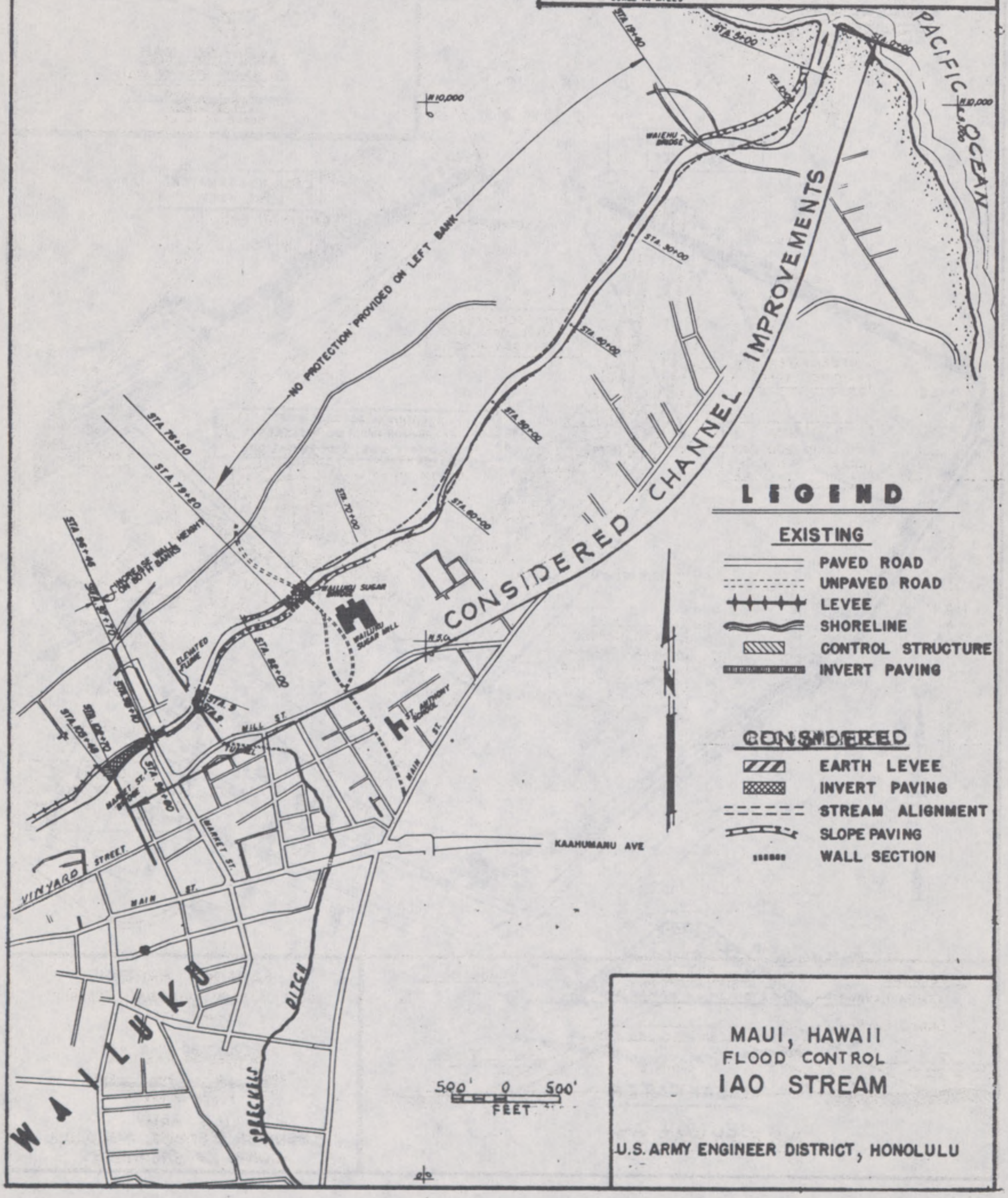
500 0 500
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY





LEGEND

EXISTING

- PAVED ROAD
- UNPAVED ROAD
- LEVEE
- SHORELINE
- CONTROL STRUCTURE
- INVERT PAVING

CONSIDERED

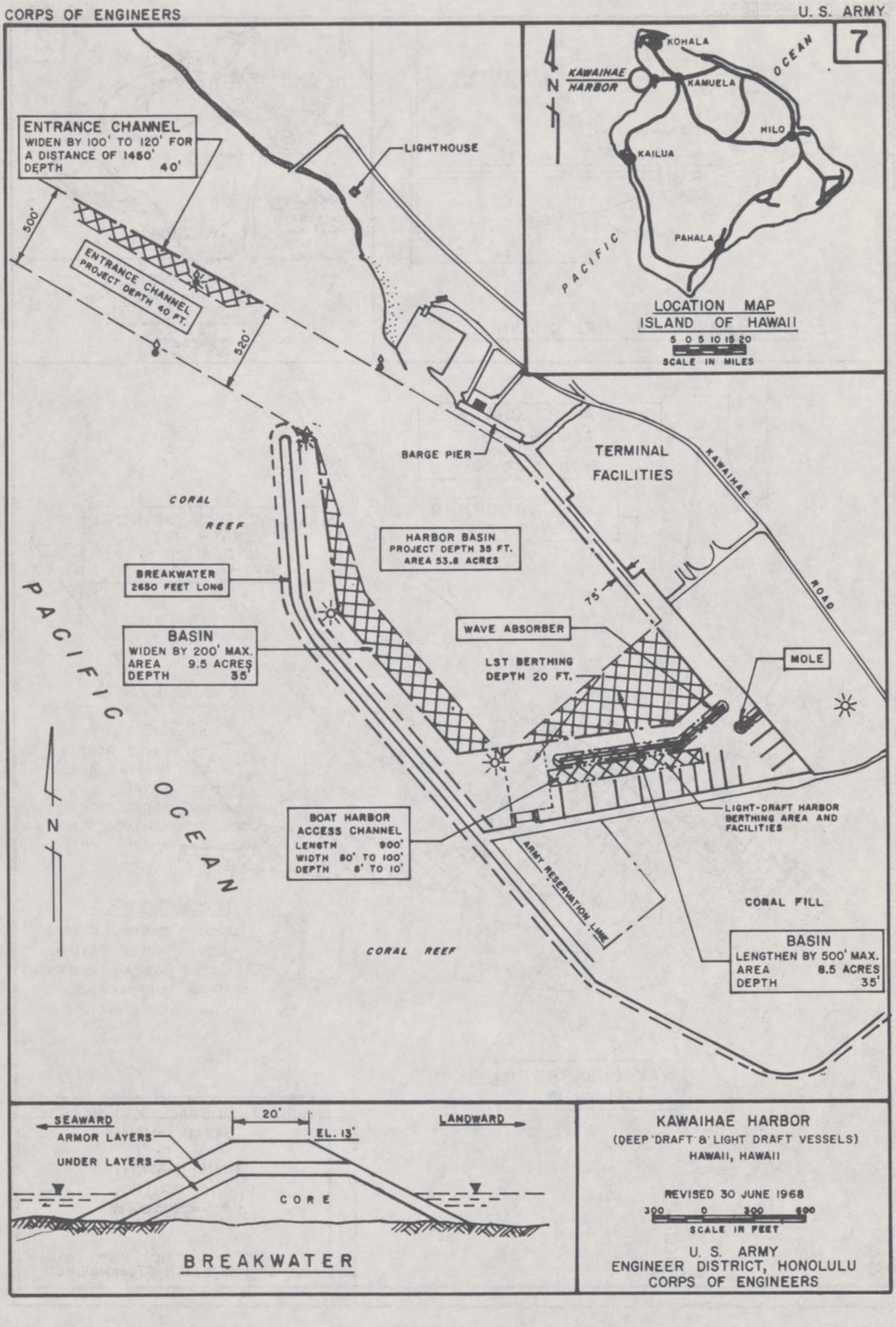
- EARTH LEVEE
- INVERT PAVING
- STREAM ALIGNMENT
- SLOPE PAVING
- WALL SECTION

MAUI, HAWAII
FLOOD CONTROL
IAO STREAM

U.S. ARMY ENGINEER DISTRICT, HONOLULU

CORPS OF ENGINEERS

U. S. ARMY



BREAKWATER

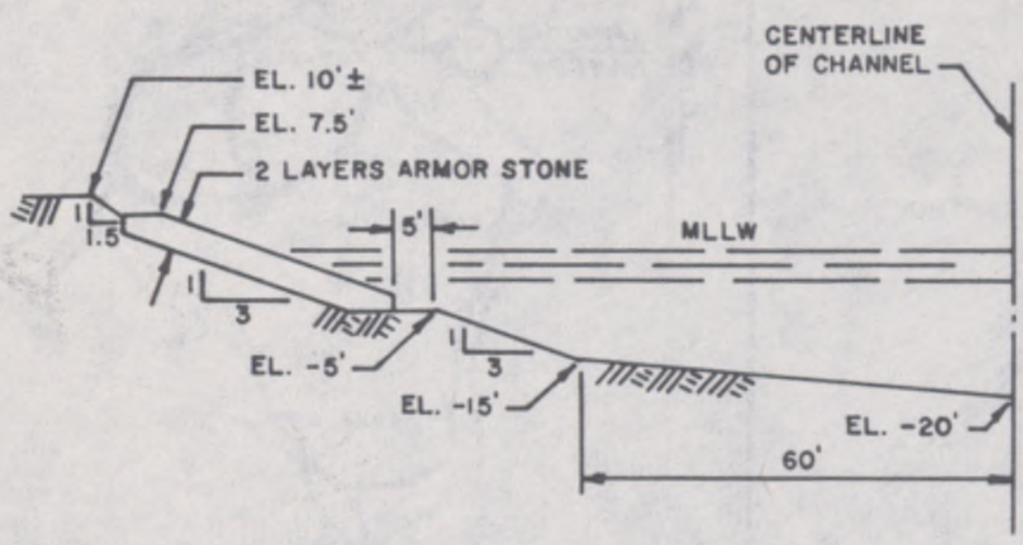
KAWAIHAE HARBOR
(DEEP DRAFT & LIGHT DRAFT VESSELS)
HAWAII, HAWAII

REVISED 30 JUNE 1968

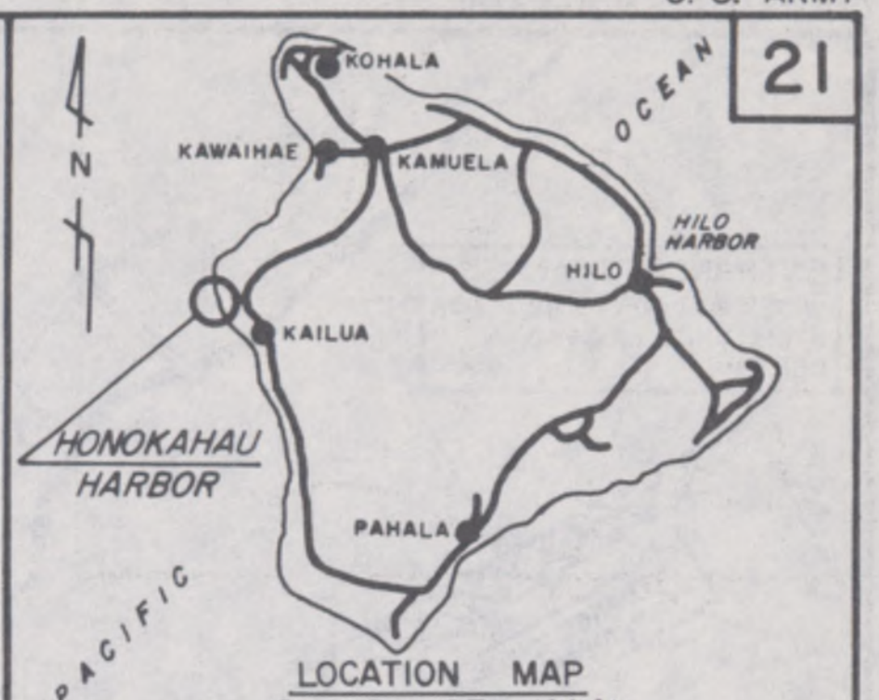
300 0 300 600
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

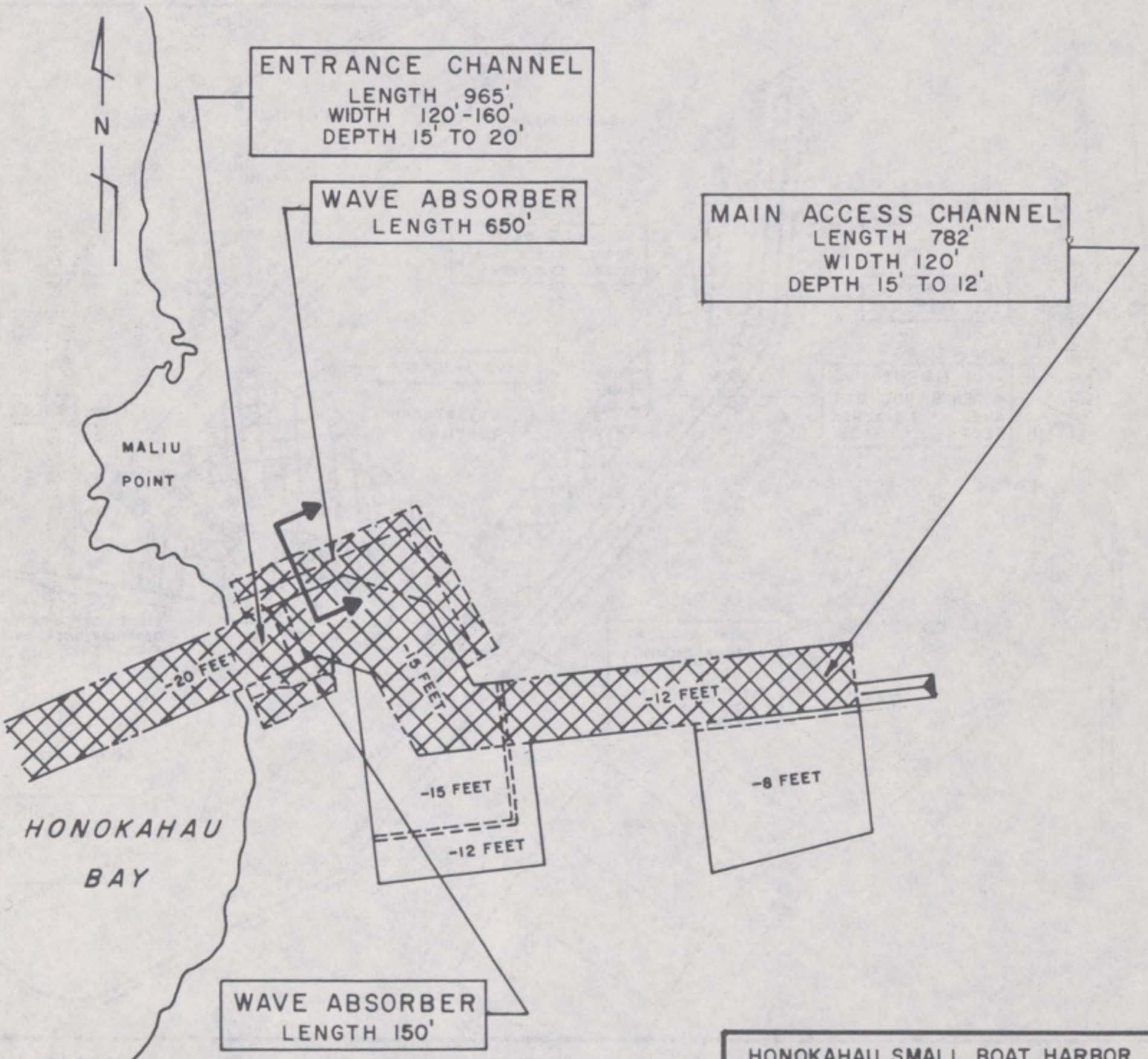
CORPS OF ENGINEERS U. S. ARMY



WAVE ABSORBER AND CHANNEL



LOCATION MAP
ISLAND OF HAWAII
5 0 5 10 15 20
SCALE IN MILES

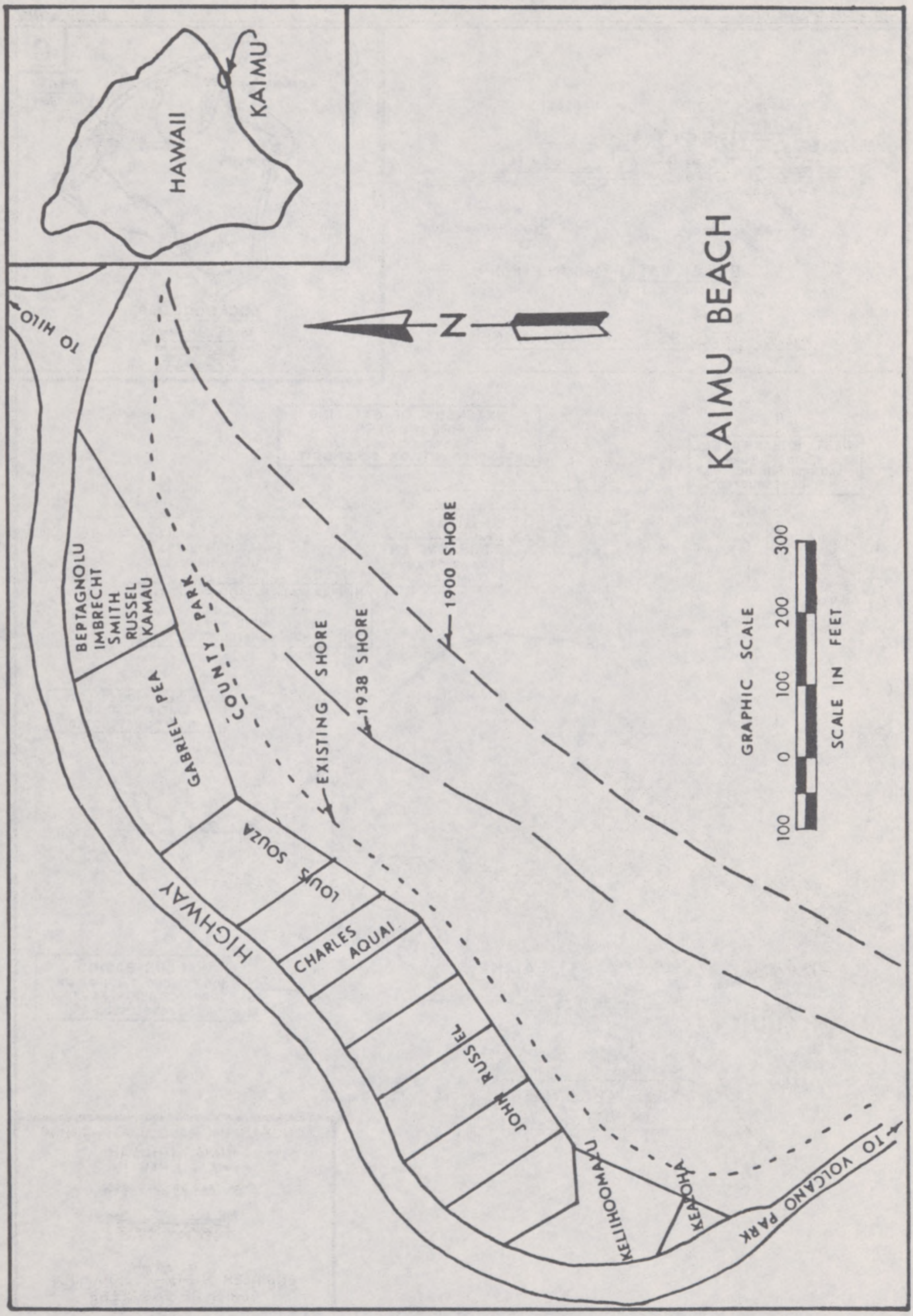


HONOKAHAU SMALL BOAT HARBOR
HAWAII, HAWAII

REVISED 30 JUNE 1968

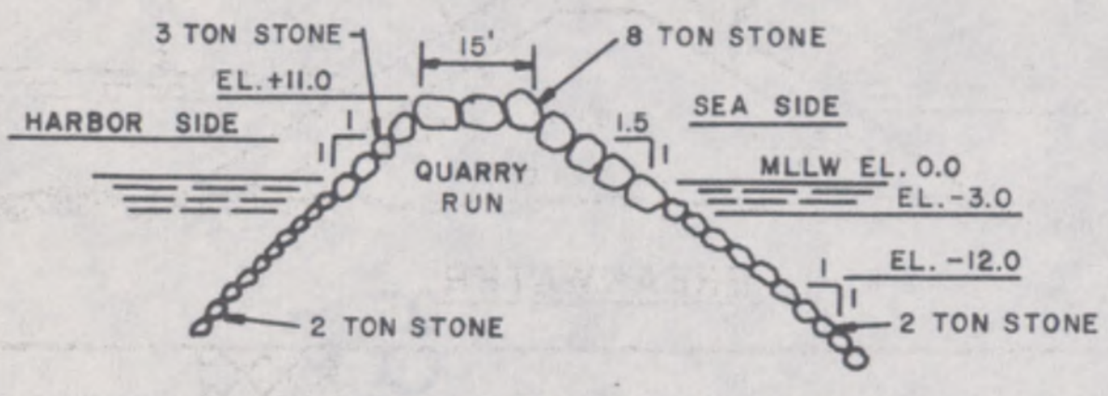
100 0 100 200
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

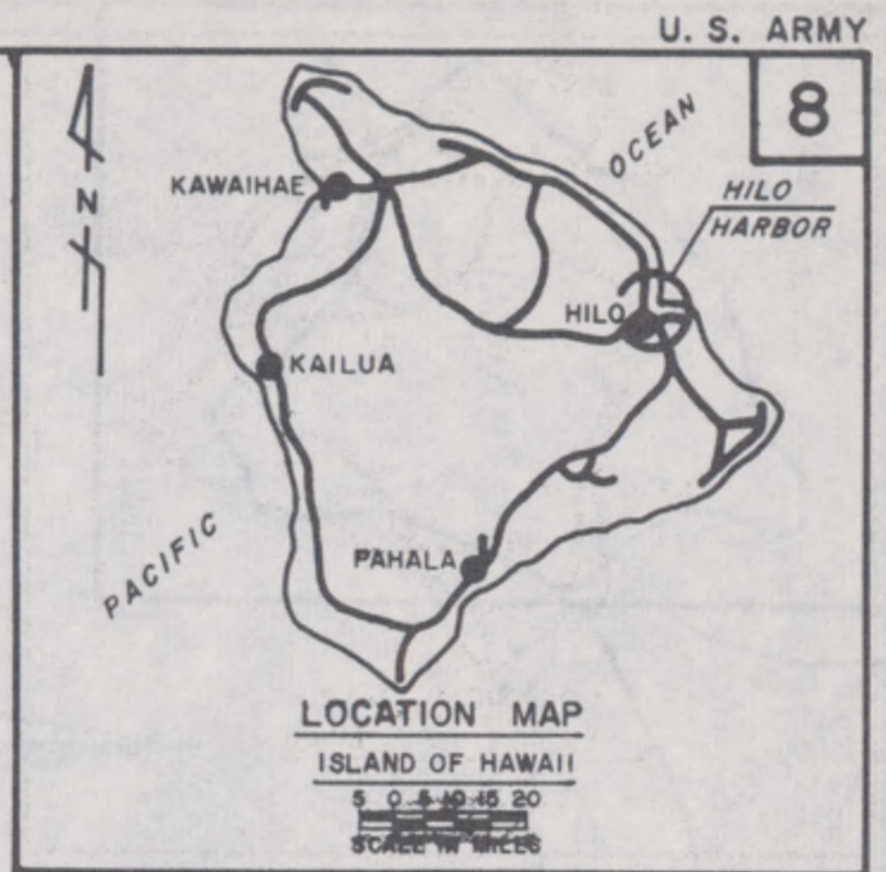

HAWAII
KAIMU
TO HILO
KAIMU BEACH
N
1900 SHORE
1938 SHORE
EXISTING SHORE
COUNTY PARK
GRAPHIC SCALE
100 0 100 200 300
SCALE IN FEET
BEPTAGNOLU
IMBRECHT
SMITH
RUSSEL
KAMAU
GABRIEL PEA
SOUZA
LOUIS
CHARLES
AQUAI
RUSSEL
JOHN
KELIIHOOMALU
KEAOHA
TO VOLCANO PARK
HIGHWAY

CORPS OF ENGINEERS

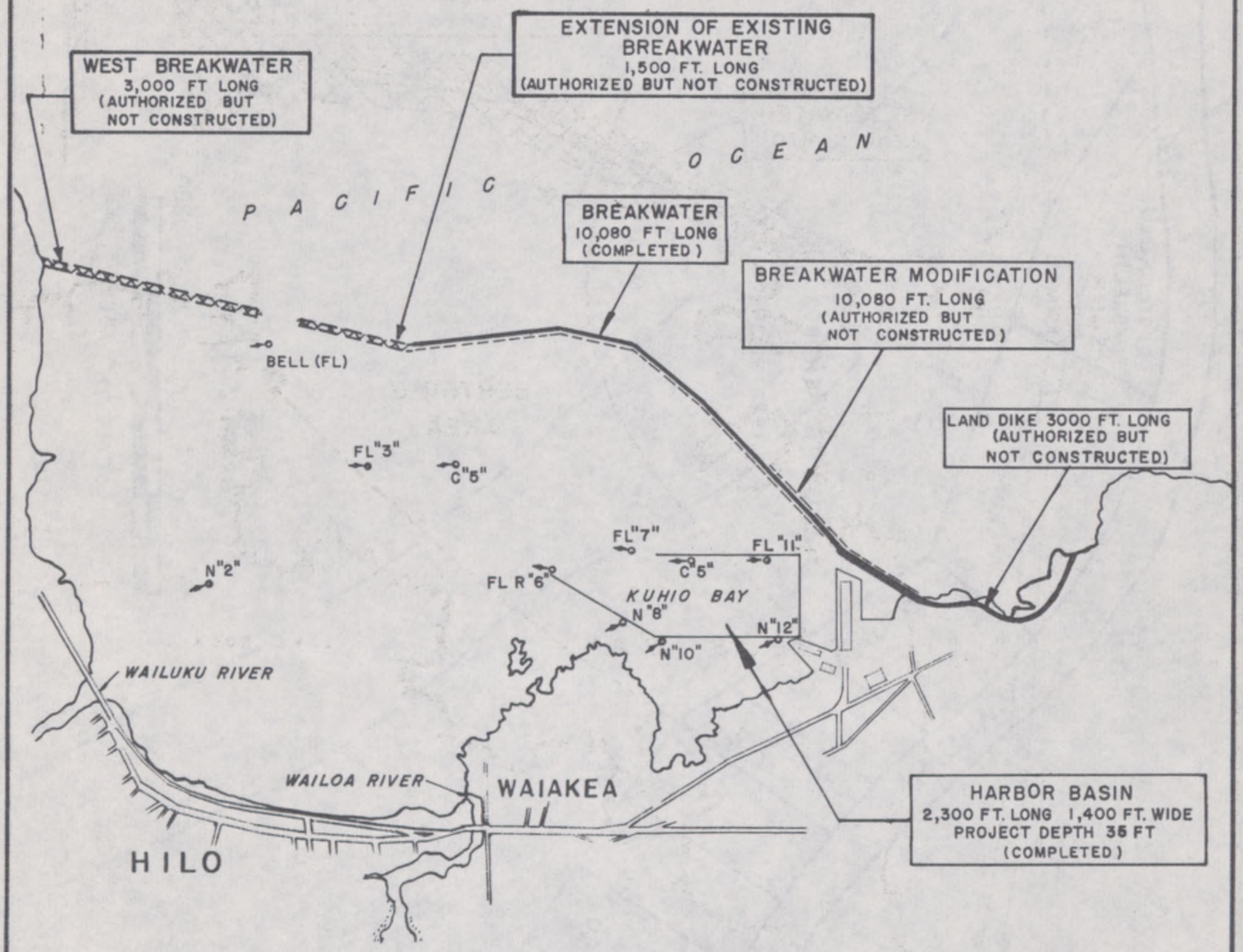
U. S. ARMY



BREAKWATER (COMPLETED)
TYPICAL SECTION



LOCATION MAP
ISLAND OF HAWAII
5 0 5 10 15 20
SCALE IN MILES



HILO HARBOR
HAWAII, HAWAII

REVISED 30 JUNE 1968

500 0 1000 2000
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

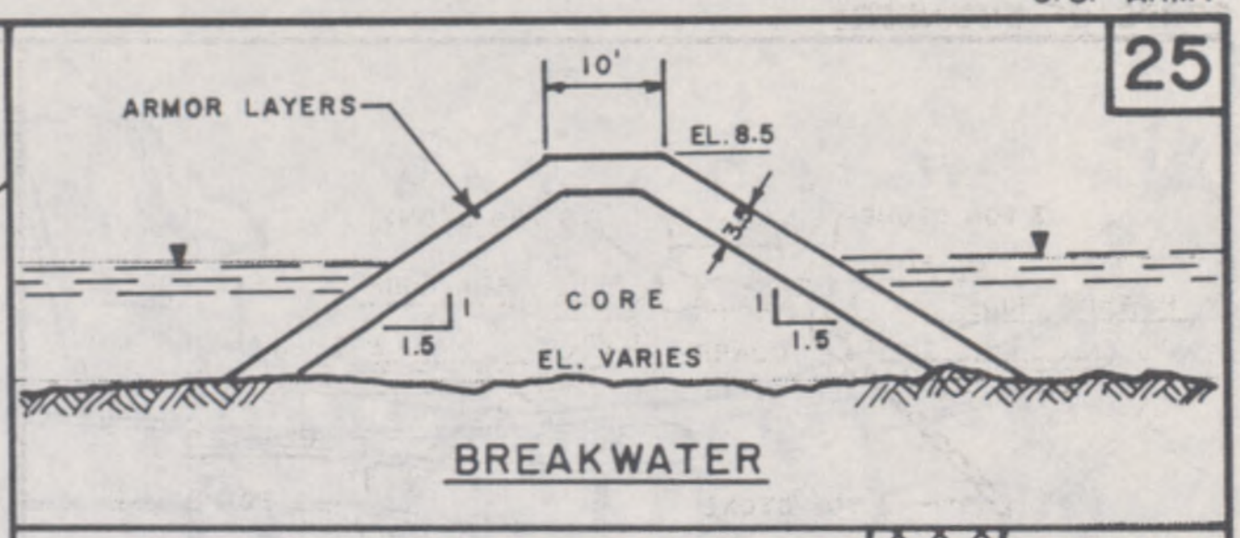
U.S. ARMY

25

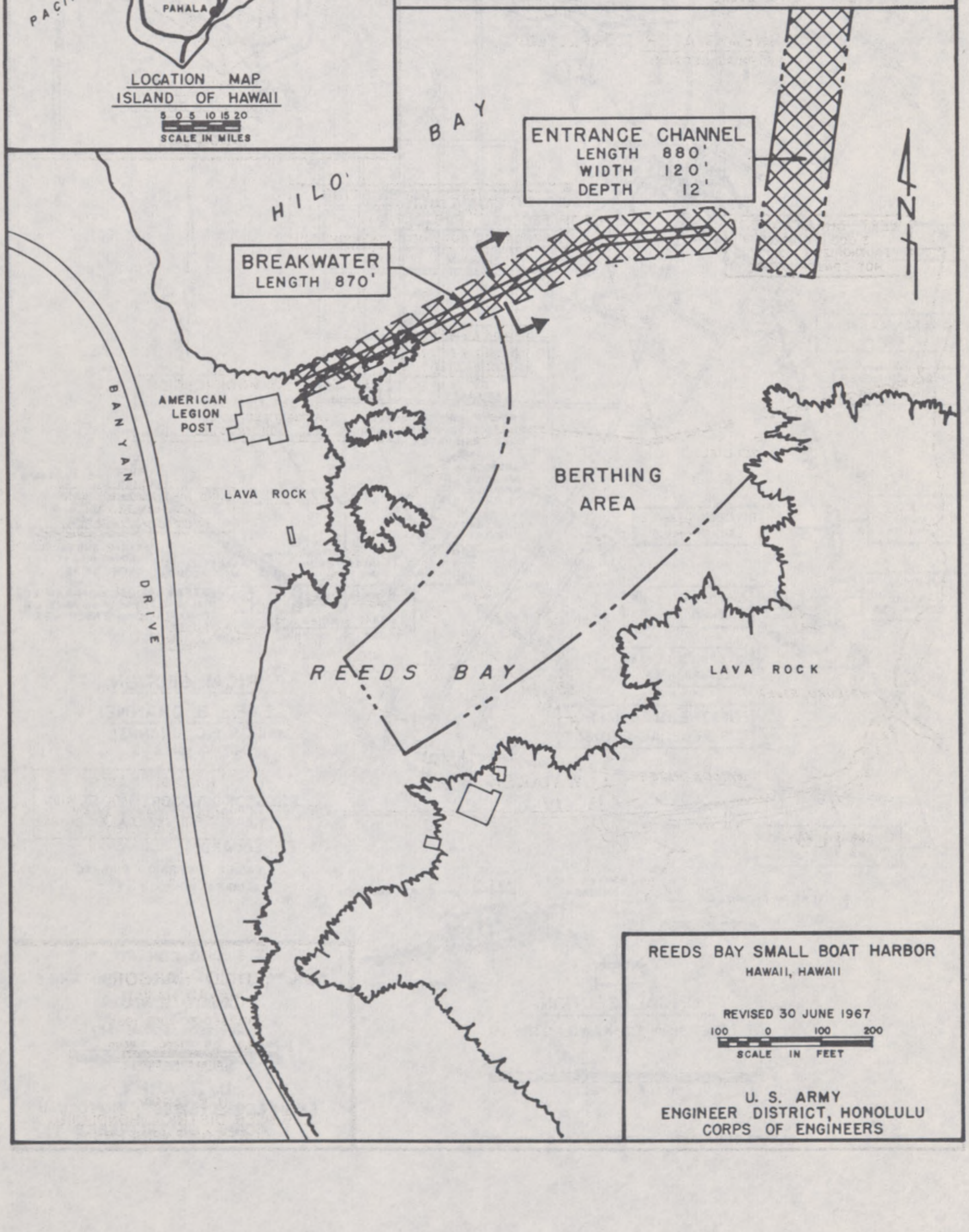


LOCATION MAP
ISLAND OF HAWAII

5 0 5 10 15 20
SCALE IN MILES



BREAKWATER



REEDS BAY SMALL BOAT HARBOR
HAWAII, HAWAII

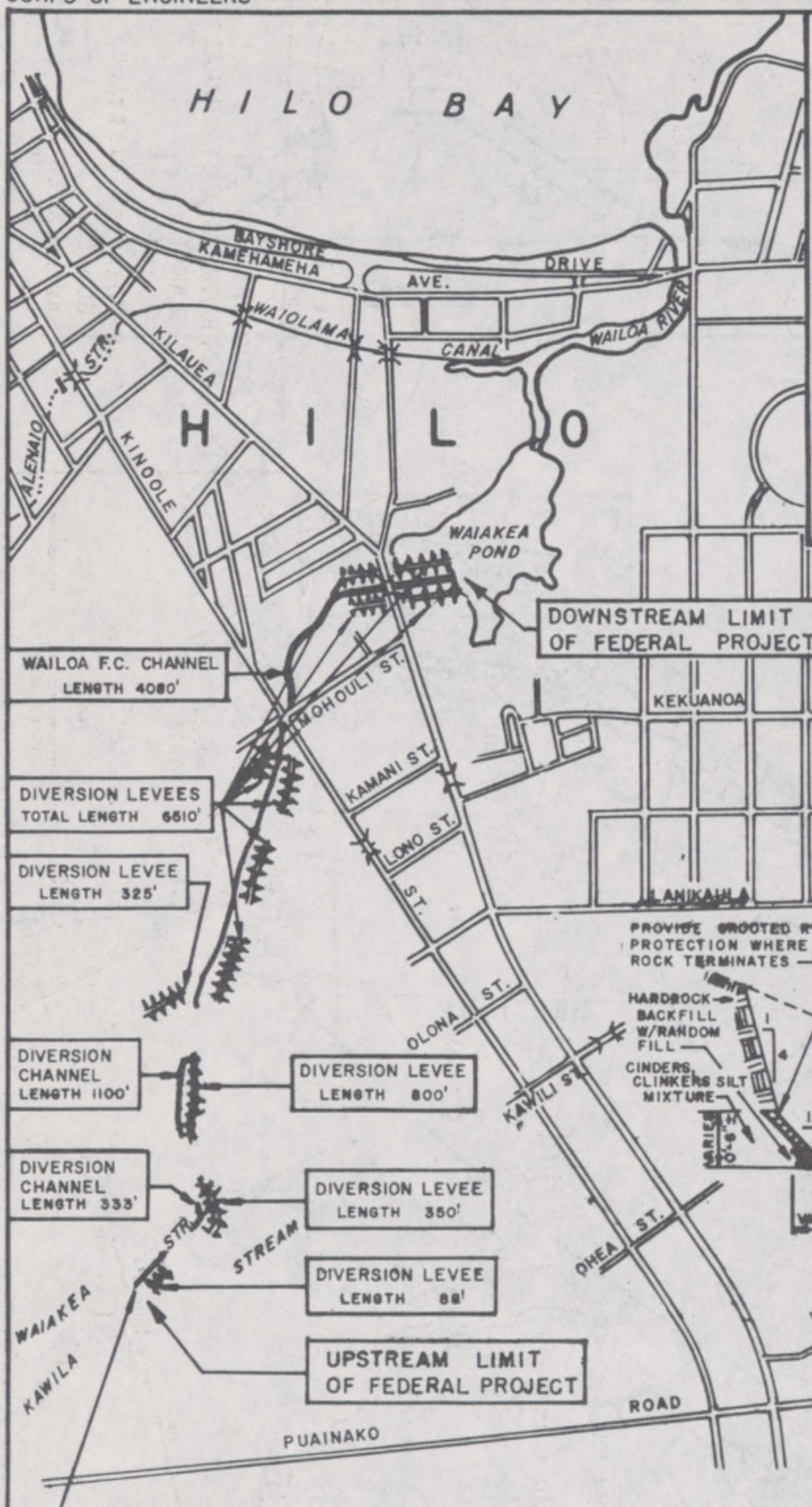
REVISED 30 JUNE 1967

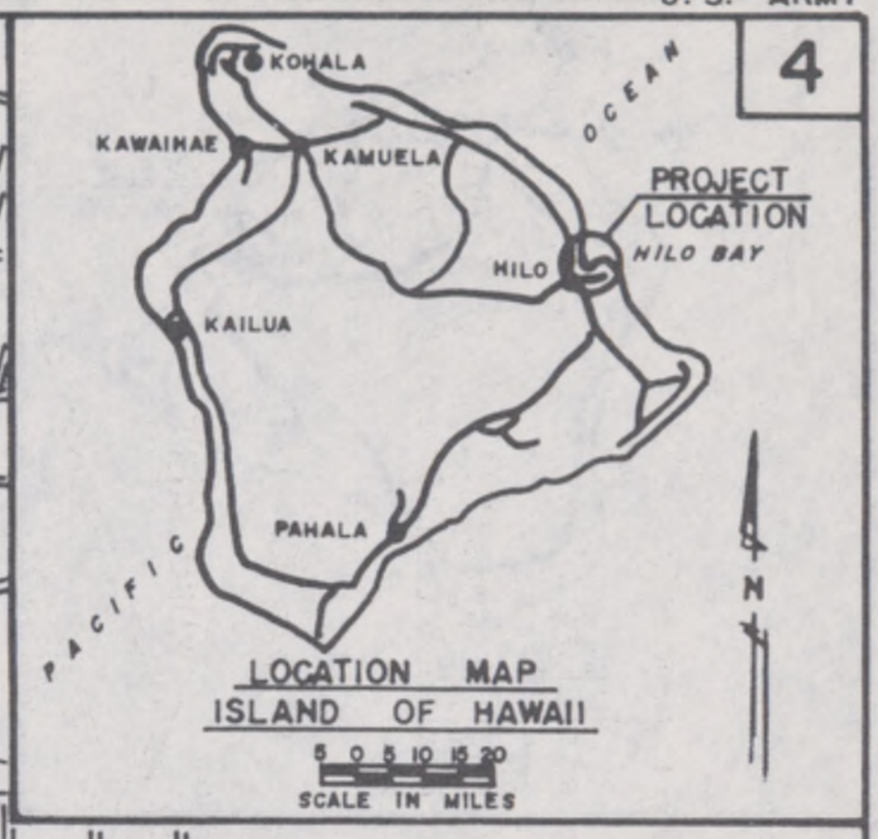
100 0 100 200
SCALE IN FEET

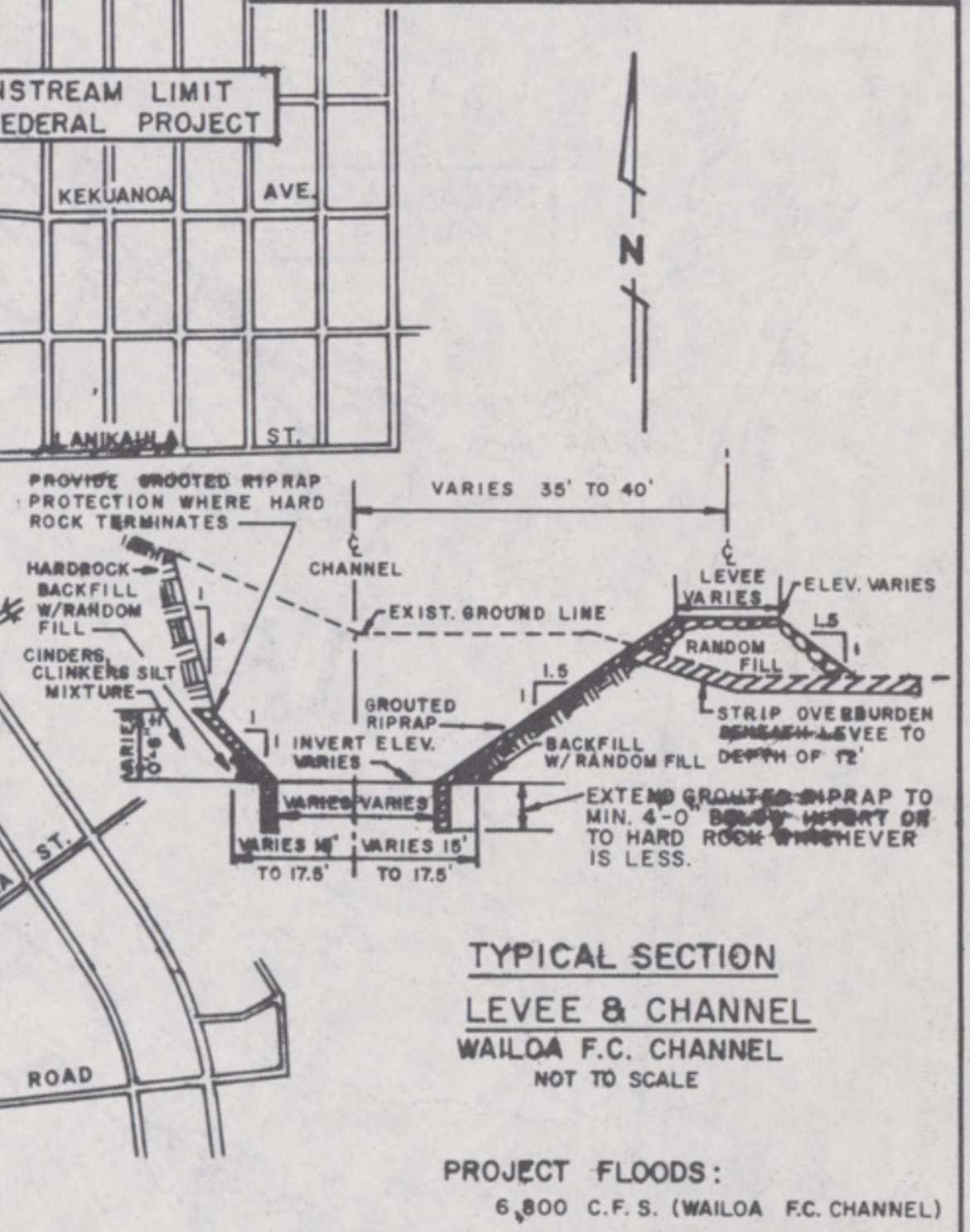
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY







TYPICAL SECTION
LEVEE & CHANNEL
WAILOA F.C. CHANNEL
NOT TO SCALE

PROJECT FLOODS:
6,800 C.F.S. (WAILOA F.C. CHANNEL)

FREEBOARD:
WAILOA DIVERSION DIKE TO WAIAKEA POND. 3 FEET

TYPICAL SECTION
AT DIVERSION OF KAWILI STREAM

20 0 20 40
SCALE IN FEET

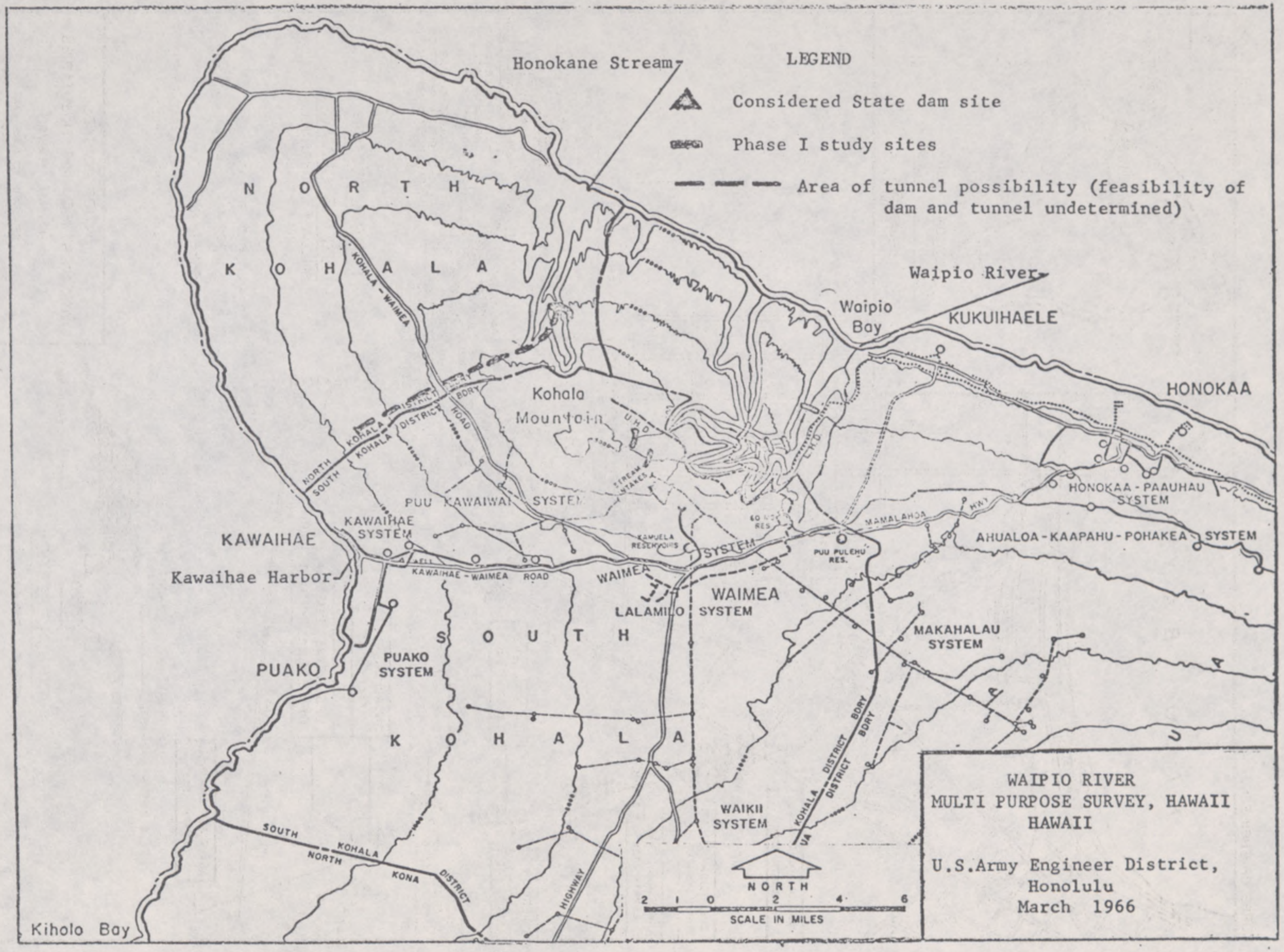
ELEVATIONS AND DEPTHS BASED ON MSL

FLOOD CONTROL
WAILOA STREAM AND TRIBUTARIES
HAWAII, HAWAII

REVISED 30 JUNE 1967

1000 0 1000 2000
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS


Honokane Stream
LEGEND
Considered State dam site
Phase I study sites
Area of tunnel possibility (feasibility of dam and tunnel undetermined)
Waipio River
Waipio Bay
KUKUIHAELE
HONOKAA
NORTH KOHALA
KOHALA - WAIMEA
Kohala Mountain
KOHALA DISTRICT ROAD
NORTH KOHALA
SOUTH KOHALA
PUU KAWAIWAI SYSTEM
KAWAIHAE SYSTEM
KAWAIHAE
Kawaihae Harbor
KAWAIHAE - WAIMEA ROAD
KAMUELA RESERVOIRS
WAIMEA
LALAMILO
WAIMEA SYSTEM
PUU PULEHU RES.
HONOKAA - PAAUHAU SYSTEM
AHUALOA - KAAPAHU - POHAKEA SYSTEM
MAKAHALAU SYSTEM
SOUTH KOHALA
PUAKO SYSTEM
PUAKO
WAIKII SYSTEM
KOHALA DISTRICT BDRY
SOUTH KOHALA
NORTH KONA DISTRICT
HIGHWAY
Kiholo Bay
NORTH
2 1 0 2 4 6
SCALE IN MILES
WAIPIO RIVER
MULTI PURPOSE SURVEY, HAWAII
HAWAII
U.S.Army Engineer District,
Honolulu
March 1966

RECOMMENDATIONS

As a result of the on-site inspection made during the period November 18–23, 1968, the following recommendations are made to the Committee on Public Works and the Congress:

1. *Hilo Harbor, tidal wave project, Hawaii.*—This project was authorized by the Congress in 1962 in order to provide protection to a portion of the city of Hilo, Hawaii, from the disastrous effects of tsunamis or so-called tidal waves. However, the project has not been undertaken, due largely to the excessively high contribution that must be made by the State of Hawaii. It is noted that the River and Harbor Act of 1962 authorized a modification of the authorized project to provide for adjustment of the cash contribution required of local interests in accordance with recommendations by the Secretary of the Army and approved by the President. Accordingly, it is recommended that the Secretary of the Army determine the amount of cash contribution adjustment at an early date and submit his recommendation to the President in the light of any change in conditions that have occurred since the project was authorized and in the light of the State's inability to meet the requirements of local cooperation.

2. *Barbers Point Harbor, Oahu.*—Since 1957, extensive industrial growth has occurred at Barbers Point in a 1,300-acre tract zoned for noxious industry which was essentially undeveloped wasteland prior to that time. The area has been developed into the first large-scale industrial complex to be founded on the island of Oahu outside the environs of Metropolitan Honolulu. Over 30 firms have bought or leased land for new plants or facilities at this industrial park, and a considerable number of other companies have evidenced interest in locating there. Basic industries include a major oil refinery, a steel mill, and a cement plant. Other operations range from the manufacture of building materials through a variety of processing, fabricating, storage, and service activities including chemical, fuel, and construction industries. Also, a large penfattening operation of island beef barged in from the other islands is located in the area.

This great industrial complex created the need for a second deep-draft harbor on the island of Oahu. Accordingly, in 1965 Congress authorized the construction of the Barbers Point deep-draft harbor project on the west coast of Oahu about 16 miles due west of Honolulu Harbor. In view of the great need for early completion of this harbor, it is recommended that funds for construction be made available to the Corps of Engineers at an early date.

3. *Project survey investigations.*—There is need for additional improvements throughout the State of Hawaii in the interest of navigation, flood control, and beach erosion control. The economic growth in the last few decades, with its resultant increase in inter island and

mainland commerce, points up the need for additional harbor and navigation facilities. Many cities and towns and agricultural areas continue to experience devastating floods. Control of this destructive force is necessary if economic growth is to continue unabated. Erosion of the island beaches is also a major problem. Recreation plays a major role in the State's economy, and corrective measures must be taken to stop the recession of the beaches so vital to the island economy.

In order to determine the economic justification and engineering feasibility of projects to meet the water resource needs of the State of Hawaii, surveys must be prepared by the Corps of Engineers. Therefore, it is recommended that necessary action be taken by the Committee on Public Works, the Senators from the State of Hawaii, and the Congress to authorize investigations at the following localities:

(*a*) *Navigation*

(1) Kaneohe Bay, Oahu, in the interest of pollution abatement, navigation, recreation, and overall bay development.

(2) Interisland ferry, with a view to determining the practicability of utilizing existing and proposed Federal harbors as a means of meeting proposed ferry system requirements.

(3) Shuttle ferry, alternative means of transportation between Honolulu International Airport and Waikiki area, utilizing the Ala Wai Canal.

(*b*) *Flood control*

(1) Kapaa Stream, Kauai
(2) Waikomo Stream, Kauai
(3) Hanalei River, Kauai
(4) Waikane Stream, Oahu
(5) Moanalua Stream, Oahu
(6) Waihee Stream, Oahu
(7) Waikele Stream, Oahu
(8) Kamananui Stream, Oahu
(9) Kahana Stream, Oahu
(10) Waolani Stream, Oahu
(11) Kaawa Stream, Oahu
(12) Makaha Stream, Oahu
(13) Olowalu Stream, Maui
(14) Palai, Four Mile Creek, Hawaii
(15) Kona, Hawaii

(*c*) *Beach erosion control*

(1) Wailua, Kauai
(2) West Hawaii, Kona area, Hawaii
(3) Maunalua Bay, Oahu
(4) Hanauma Bay, Oahu
(5) Kaaawa area, Oahu
(6) Hauula area, Oahu
(7) Mokuleia area, Oahu
(8) Keehi Lagoon area, Oahu
(9) Sandy Beach Park, Oahu
(10) Ewa Beach, Oahu
(11) Maile-Waianae coast area, Oahu

APPENDIXES

Information on projects inspected is set forth elsewhere in this report. However, because of its value as reference material, these appendixes contain details and charts of other water resource projects under jurisdiction of the Corps of Engineers located in the State of Hawaii.

APPENDIX I

OAHU

KEWALO HARBOR

(See p. 58 for project drawing.)

Kewalo Harbor is located on the south coast of Oahu between downtown Honolulu and Waikiki Beach. The harbor is approximately 800 feet wide, 1,000 feet long, and 20 feet deep. The entrance channel which is 200 feet wide and 20 feet deep is situated at the southwest corner of the harbor basin.

Kewalo Harbor has complete dockside facilities including a cargo handling and fueling dock, a boatyard, a marine supply company, motor vehicle parking areas, restrooms, and electric power, ice, and water sources. A tuna packing plant, complete with independent off-loading and storage facilities, is located on the west side of the harbor. The University of Hawaii oceanographic research complex and research vessel docks are located on the existing land fill at the south side of the harbor. The north side of the harbor is devoted to charter fishing and cruise boat slips with their specialized small appurtenances.

During southerly and westerly storms and during periods when deepwater swells generated by distant storms approach the island from a southerly direction, damaging surge conditions are produced in Kewalo Harbor. Crosscurrents generated in the entrance channel during these periods are hazardous to craft negotiating the channel, particularly for the slower and less maneuverable boats.

The Federal project, approved on October 1, 1968, under section 107 of the 1960 River and Harbor Act, as amended, would reduce the crosscurrent at the entrance channel and surge within the harbor basin by constructing three wave absorbers, one beginning at the seaward end and extending shoreward 580 feet along the northwest side of the entrance channel, another extending along the entire length of the southeast side of the channel, and a third, 230-foot-long absorber in the southeast corner of the basin. The wave absorber along the southeast side of the channel would also serve as revetment for the proposed State Magic Island project or other offshore works and the State of Hawaii will share in its cost.

The estimated first cost of the project is $270,000, of which $162,000 would be borne by the Federal Government and $108,000 by the State of Hawaii. The average annual benefits are $13,100, resulting in a benefit-cost ratio of 1.1. In addition to the required cash contribution for the Federal project, the State has also agreed to provide a cash contribution of $95,000, which is the estimated equivalent cost to revet the Magic Island fill along the Kewalo Harbor entrance channel.

Authority and funds to complete reconstruction work have been received from the Chief of Engineers, and the district is proceeding with the preparation of plans and specifications. Initiation of construction will be subject to future appropriation of funds.

ALA WAI HARBOR

(See p. 59 for project drawing.)

Ala Wai Harbor, on the southern coast of Oahu, is situated between the metropolitan area of Honolulu and the Waikiki tourist centers. The harbor was made by the territorial government in 1935 by dredging an entrance channel and small basin in the reef at Mamala Bay. Since that time, the territory, and then the State of Hawaii, has made extensive improvement to the harbor so that now it is an outstanding example of a light-draft harbor. Ala Wai Harbor now has a berthing area of about 31 acres and slips for about 515 vessels. These facilities,

however, are insufficient to meet the demands placed upon them or to meet the future requirements of the tributary area.

The proposed improvements for Ala Wai Harbor were developed as part of the "Coasts of the Hawaiian Islands" survey authorized by the River and Harbor Act of May 17, 1950. The plan provides for an increase in berthing area of about 13 acres (slips for about 425 additional boats) protected by a revetted mole 1,400 feet long, two wave absorbers, one of which to be on the Magic Island side of the entrance channel about 600 feet shoreward of the seaward end of the Magic Island fill and the other at the channel end of the proposed interior mole, and a 60-foot stub breakwater at station 10+50 of the proposed seaward mole. This design was model tested at the Waterways Experiment Station as part of the Magic Island tests.

The project was authorized by Congress in River and Harbor Act of 1968. No funds for advance design or construction have been appropriated.

The estimated costs and economics of the project are as follows:

1st cost	$1,114,000
Federal cost	$579,000
Non-Federal cost	$535,000
Annual benefits	$267,200
Annual costs	$50,100
Benefit-cost ratio	5.3
Additional berthing space provided	425

PALOLO-MANOA VALLEYS

(See p. 60 for survey map.)

The Palolo-Manoa drainage basin which covers an area of 16 square miles, is in the city of Honolulu on the southeastern part of the island of Oahu. This basin, which is a highly developed residential area, includes the Makiki Heights area on the southeastern slopes of Punchbowl Crater, and the Manoa and Palolo Valleys. The drainage system for this basin consists of the Makiki, Manoa, and Palolo Streams, the Palolo-Manoa drainage canal, and the Ala Wai Canal. The Manoa and Palolo Streams flow through their respective valleys and join to form the Palolo-Manoa drainage canal which flows through fairly flat terrain to the Ala Wai Canal, a navigable waterway which enters the ocean at the Ala Wai Small Boat Harbor. Makiki Stream, a tributary of the Ala Wai Canal, enters the canal about 0.4 mile from the ocean.

A survey study for this drainage basin was authorized by the Flood Control Act of 1950. A preliminary plan of improvement has been developed and consists of dredging the Ala Wai Canal, and channel improvements along the lower reaches of Manoa Stream, along the lower half of Makiki Stream, and on the Palolo-Manoa drainage canal. No improvements are planned for Palolo Stream because the flood control improvements constructed by the State of Hawaii are adequate and in good condition. This study is scheduled to be completed in 1970.

WAIALAE-NUI AND KAPAKAHI STREAMS

(See p. 61 for survey map.)

The drainage basin of the Waialae-Nui and Kapakahi Streams is rectangular in shape and extends about 5 miles from Maunalua Bay to the Koolau Mountains, averaging over 1 mile in width. The basin area is bounded on the west by Mauumae Ridge, on the north by the Koolau Mountains, on the east by Kapakahi Ridge, on the south by the Pacific Ocean, and drains the northeast slope of Diamond Head.

The basin is divided into five subareas, each with a definite runoff pattern.

(1) An area of 0.6 square mile drains runoff from the slopes of Diamond Head and a portion of Kaimuki, and concentrates the flow toward the low area along the Waialae-Kahala boundary.

(2) An area of 0.9 square mile drains runoff from Maunalani Heights, Wilhelmina Rise, and a portion of Kaimuki, and concentrates the flow near the Waialae-Kahala boundary on Waialae Avenue.

(3) An area 3.3 square miles is drained by the Waialae-Nui and Kapakahi Streams. Kapakahi Stream extends from the foot of the Koolau Mountains to Maunalua Bay. The Waialae-Nui Stream begins at the Koolaus and enters the Kapakahi Stream in the Waialae golf course on the downstream side of Kalanianaole Highway.

(4) An area of 0.2 square mile drains by overland flow into interior drainage structures along Luawai Street. The flow is conveyed to Waialae major drain which drains into the ocean.

(5) An area of 0.5 square mile is served by a system of interior drainage structures and a pumping station to convey water to various outlet structures. Approximately 0.1 square mile drains by gravity into Kapakahi Stream. The Waialae major drain collects water from approximately 0.1 square mile, and 0.3 square mile is drained by interior drainage structures.

Except for the steep slopes and forest reserve, the entire drainage basin is almost fully developed into residential and commercial use. The portion of Kaimuki which drains into the low-lying Waialae-Kahala area is a densely developed residential area. The only exceptions are the Army installation at Fort Ruger on the foot of Diamond Head, a cemetery, and three secondary schools. Maunalani Heights and Wilhelmina Rise are a combination of old and new homes, fully developed residential, apartment and commercial areas. Below Kalanianaole Highway is the low-lying Waialae-Kahala subdivision, a highly developed residential area with its own shopping center and schools. More than 1,000 homes, some costing in excess of $100,000, are in the area. The Waialae golf course, through which Kapakahi Stream flows to the ocean, is adjacent to the Waialae-Kahala subdivision on the east.

Flooding of the Waialae-Kahala shopping center and residential developments in the subdivisions is the major problem. The existing Waialae major drain and the Kilauea major drain are inadequate to carry flood flows originating in higher elevations.

The contemplated plan of improvement would provide protection from floods with a recurrence interval of 100 years and a range in discharges from 2,000 to 10,000 cubic feet per second with 10,000 cubic feet per second being the design flow for lower Kapakahi Stream.

The plan provides for a system of diversion channels, levees, and stream improvements. The estimated first cost of the contemplated improvement is $1 million, of which $880,000 is Federal.

A detailed project study is currently underway.

WAILUPE STREAM

(See p. 62 for survey map.)

The Wailupe Stream drainage basin lies on the leeward slopes of the Koolau Mountains between the east side of Wiliwilinui Ridge and the west side of Hawaiiloa Ridge. The basin is approximately 3 miles long and 1 mile wide, and drains an area of 3 square miles from elevation 2,600 feet to sea level. The lower one-fourth of the drainage basin contains the Aina Haina residential subdivision which is bisected by Wailupe Stream.

The contemplated plan of improvement consists of enlarging and lining the existing channel with concrete for a distance of approximately 6,100 feet with a proposed channel cross-section of a 30-foot bottom width, a 9-foot depth including a 2-foot freeboard, and a side slope of 1 on 1. The limits of improvement would be from the mouth of Wailupe Stream to the vicinity of Ani Street Bridge. The three existing bridges over the stream are of adequate capacity to pass the design flow with the proposed channel conditions.

The plan of improvement provides for enlarging and lining the existing channel for a distance of approximately 6,100 feet. The estimated first cost of the proposed improvement is $1.2 million of which $1 million is Federal.

A fully funded detailed project study is being conducted under section 205 authority. The completion of the study is scheduled for 1969.

KULIOUOU STREAM FLOOD CONTROL PROJECT

(See p. 63 for survey map.)

Kuliouou Stream is the principal stream draining Kuliouou Valley, an area of 1.6 square miles on the leeward slopes of the Koolau Mountains approximately 11 miles east of Honolulu. The lower 0.77 square mile of the valley is built up into the Kuliouou residential subdivision which includes a flood plain of about 0.11 square mile. The population of the area has increased from 800 in 1950 to 1,700 in 1963. About 42 percent of these people reside in the flood plain area.

This project was authorized for construction under section 205 of the 1948 Flood Control Act. The construction plans and specification include improving the existing stream by excavation, concrete lining a major portion of the existing stream, adding supplemental walls on the banks of the existing improved trapezoidal channel, and construction of a rectangular reinforced concrete lined ditch 7 feet wide to carry interior drainage downstream of Kalanianaole Highway. Local interests are required to replace two bridges and relocate utilities.

The contract for construction of this project was awarded in August 1968. Construction has begun and is scheduled to be completed in March 1970. The contract cost is $1,595,000. This includes the cost for construction of the two bridges and relocation of waterlines which are being performed at the request of local interests and with funds contributed by them.

MAUNALUA BAY HARBOR

(See p. 64 for project drawing.)

Maunalua Bay Harbor for light-draft vessels will be located approximately 11 miles east of downtown Honolulu within the eastern half of Maunalua Bay southeast of the mouth of Kuliouou Stream. This area is in the heart of rapidly expanding residential developments serving Honolulu.

This harbor is one of eight recommended for Federal construction in the "Interim Report on Survey of the Coasts of the Hawaiian Islands Harbors for Light-Draft Vessels" and was authorized by the River and Harbor Act of 1965. Advance engineering funds totaling $32,000 have been appropriated for Maunalua Bay Harbor.

The harbor site is in a wide shallow reef of protected coast. At the site the coral formation extends seaward about 2,800 feet. The authorized plan of improvement provides for a protected harbor basin of approximately 44 acres with a berthing capacity of about 950 small craft. The basin would be enclosed by revetted moles 2,900 and 1,950 feet long. The entrance channel, 870 feet long and 200 feet wide, would extend seaward from a widened channel section of about 370,000 square feet. This channel alinement minimized the distance to deep water.

An architect-engineering firm engaged by the city and county of Honolulu has prepared a master plan for recreational use of Maunalua Bay with the harbor project as a principal feature. The Honolulu engineer district is coordinating a proposed harbor plan, which would ultimately accommodate 1,100 boats, with State and city and county officials. The draft of the design memorandum is scheduled to be completed in the winter of 1969. The estimated costs and harbor capacity are as follows:

1st cost	$1,486,000
Federal cost	$666,000
Non-Federal cost	$820,000
Design capacity (boats)	950

AIEA STREAM

(See p. 65 for survey map.)

The Aiea drainage basin of 1.9 square miles is on the southern coast of the island of Oahu approximately 7 road miles northwest of Honolulu. The basin is 3.8 miles long and averages about 0.5 mile in width. It extends from Pearl Harbor to the leeward slopes of the Koolau Range. The drainage basin is divided into two areas. Area 1 drains 0.5 square mile and area 2, 1.4 square miles and is the principal drainage of Aiea Stream.

A study under the authority of section 205 of the Flood Control Act of 1948, as amended, is underway. The contemplated plan of improvement provides for 1,700 feet of concrete channel beginning 170 feet upstream of Maunalua Road and ending 200 feet downstream of Kamehameha Highway. The planned channel varies in base width from 16 to 24 feet in the upper reach and transitions to a 45-foot width at the Kamehameha Highway Bridge. The channel design capacity is 5,000 cubic feet per second (100-year frequency).

The estimated first cost of the project is $1,760,000 of which $1 million would be Federal.

WAIMALU STREAM

(See p. 66 for survey map.)

The Waimalu drainage basin is on the southern coast of the island of Oahu approximately 11 road miles northwest of Honolulu. The drainage basin is shaped like an elongated triangle with palmate stream characteristics and extends from Pearl Harbor to the Koolau Range, approximately 7 miles in length. The basin rises gently from a flat coastal plain to an elevation of 2,570 feet. The total drainage area is 8.1 square miles.

A detailed project study under the authority of section 205 of the Flood Control Act of 1948, as amended, is underway. The contemplated plan of improvement provides for 6,500 feet of channel improvement extending from Pearl Harbor to approximately 2,700 feet upstream of Moanalua Road. Existing improvements would be modified and integrated into the proposed plan. The trapezoidal channel from Pearl Harbor to Kamehameha Highway Bridge would have an 80-foot bottom width with side slopes of 2½ to 1. The invert and side slopes under the Kamehameha Bridge would be paved with concrete.

The 2,900-foot reach between Kamehameha Highway and Moanalua Road would have a minimum bottom width of 100 feet. An earth levee with riprapped side slopes of 2 to 1 would be constructed only along the right bank fronting the school area. No increase in wall height along the existing 400-foot concrete lined walls or construction of a levee along the remaining right bank are contemplated as future developments of this unimproved area will provide flood protection. The existing concrete lining on the left bank of the channel would be retained and additional wall heights would be provided. The 2,700-foot reach upstream of Moanalua Road would consist of a concrete rectangular section with a minimum width of 50 feet for a 500-foot reach and a trapezoidal, concrete-lined channel with a 30-foot bottom width and 2 to 1 side slopes upstream of the rectangular channel. A minimum 2-foot freeboard would be provided along the entire improvement.

The proposed improvements would contain flows up to 17,000 cubic feet per second in the lower reaches and 14,300 cubic feet per second in the concrete channel above Moanalua Road (both discharges are for 100-year frequency floods). The first cost is estimated at $2,640,000, of which Federal cost is $1 million. The study is scheduled to be completed in 1969.

WAIANAE HARBOR

(See p. 67 for project drawing.)

The town of Waianae is on the lee of the Waianae Mountains on the west coast of the island of Oahu, approximately 30 road-miles from Honolulu. The population of the Waianae area, including adjacent Makaha, was 6,844 in 1960. The Waianae judicial district, the immediate tributary area of the proposed harbor, had a population of 16,452 in 1960, an increase of 9,428 from 1950. The population is expected to increase to 20,000 in 1980.

The present State small boat harbor for about 70 craft is immediately north of Kaneilio Point, a narrow, rocky peninsula which projects seaward about 1,000 yards in front of the town and forms the southern boundary of the waters known as Pokai Bay. Littoral drift from the north is trapped within the boat basin and frequent removal and redistribution of sand are necessary. In addition to high maintenance costs, the harbor conflicts with the recreational use of the adjacent swimming beach. For these reasons, the State of Hawaii desires to develop a small boat harbor at the site on the south side of Kaneilio Point.

This is one of eight harbors recommended for Federal construction in the interim report on the coasts of Hawaiian Islands. The eight harbors were

authorized by the River and Harbor Act of October 27, 1965. No advance engineering funds have been appropriated.

The authorized harbor, subject to model testing, would have a berthing area of 10 acres for 380 boats. The plan provides for a generally rectangular-shaped harbor basin, protected by a rubble-mound breakwater 1,350 feet long, extending in a southeasterly direction from Kaneilio Point. A second rubble-mound structure 175 feet long would be at the southeast end of the harbor basin. The general navigation channels would consist of an entrance channel, 830 feet long by 150 feet wide, dredged to a depth of 17 feet for the seaward 230 feet and with a transition to 15 feet for the remaining distance; and a main access channel 870 feet long to the berthing areas. The access channel would have a transition from a 150-foot width and 15-foot depth in its outer portion to a 100-foot width and 12-foot depth.

The estimated costs and project economics are as follows:

1st cost	$2,370,000
Annual cost	$111,600
Annual benefit	$116,600
Benefit-cost ratio	1.04
Federal cost	$1,195,000
Non-Federal cost	$1,175,000
Design capacity (at year 2015)	380

HALEIWA SMALL BOAT HARBOR

(See p. 68 for project drawing.)

The Haleiwa small boat harbor is the first Federal-State small boat harbor on the island of Oahu. Prior to improvements in the harbor, light-draft vessels used the banks of the lower reaches of the Anahulu River for mooring, and pleasure boats used the launching facilities at the harbor. Boatowners experienced many difficulties under these conditions. The entrance channel frequently silted causing many vessels to run aground during storm wave activity thereby blocking the entrance channel to further navigation. Flash floods tore boats from their moorings and brought debris downriver damaging boats and creating hazards to navigation.

The project was authorized under the authority of section 107 of the River and Harbor Act of 1960. Prior to construction of the project, section 310 of the River and Harbor Act of 1965 increased the Federal limits of participation from $200,000 to $500,000. The Federal portion of the project was completed in 1966.

The Federal project provides an entrance channel 610 feet long, 120 feet wide, and 12 feet deep; a revetted mole 1,200 feet long; a diversion channel for the Anahulu River 520 feet long and 80 feet wide; and a protected harbor area of about 7.4 acres. The project first cost was $490,000, of which 60.2 percent, or $295,000, was Federal cost, with the remaining $195,000 borne by the State of Hawaii.

In September 1967, the State completed the first phase of their development of Haleiwa small boat harbor at a cost of approximately $300,000. This phase provided for the dredging of a berthing area and construction of 20 catwalks to accommodate 40 boats, construction of a marginal wharf adjacent to the launching ramp, paving of the area behind the catwalks and marginal wharf, and installation of utilities services. Through incremental development, the State plans to increase the capacity of Haleiwa small boat harbor to 220 boats by 1980.

HALEIWA BEACH EROSION CONTROL PROJECT

(See p. 69 for project drawing.)

Haleiwa Beach is on the eastern arm of Waialua Bay, 31 miles from the city of Honolulu. Waialua Bay, on the north-central shore of the island of Oahu, is used for recreation by the population of the immediate area, approximately 8,000 people, as well as the residents of the entire island, 500,000 people. The eastern part of the bay contains the Haleiwa small boat harbor, the mouths of the Anahulu River and the Loko Ea Stream, and Haleiwa Beach.

Formerly, Waialua Bay had three large sandy beaches. The beaches of the Hawaiian Islands are constantly changing their composition, structure and volume, because of shifts in the volume of the littoral drift. In the 1940's, a large

beach located at the present Haleiwa Beach Park eroded away to 5,000 square feet of sand above the mean high water mark, because of such a shift in the littoral drift.

Restoration of the beach was completed by the State of Hawaii in 1965. An artificial placement of 1,600 feet of beach, from the north side of the Haleiwa Beach Park pavilion south to the Loko Ea Stream mouth, is protected by a 520-foot groin at the south end of the beach, and a 160-foot breakwater offshore opposite the park pavilion. The beach varies in width from 140 to 265 feet above the mean lower low water line. The beach was formed with 30,000 cubic yards of beach core material overlain by 60,000 cubic yards of beach sand blanket.

The project was completed by the State of Hawaii in 1965 according to plans approved by the Chief of Engineers. The River and Harbor Act of October 27, 1965 authorized the project and allowed Federal participation in the amount of 60 percent of the first cost of improvements for restoration and protection of the shores of Haleiwa Beach. The project cost is $400,000, of which $240,000 is Federal cost and $160,000, non-Federal.

HEEIA-KEA HARBOR

(See p. 70 for project drawing.)

Heeia-Kea is a small community on the northeast coast of Oahu on Kaneohe Bay, approximately 3 miles from the town of Kaneohe and about 15 miles from Metropolitan Honolulu. As an interim measure, the State of Hawaii has recently expanded the existing small boat facility to now accommodate 135 craft. The town of Kaneohe had a population of 14,400 in 1960.

Variable tradewinds are predominant throughout most of the year at this site. The shoreline of the area is bordered by a fringing reef formation varying in width from 500 feet to one-half mile, with depths from 0 to 3 feet within the reef areas. The mean tidal range is 2.1 feet with a maximum range of about 4.5 feet. Littoral drift along the bay shore is negligible, and storm waves in the inner bay higher than 3 feet are infrequent.

This is one of eight harbors recommended for Federal construction in the Interim Report on the Coasts of Hawaiian Islands. The eight harbors were authorized by the River and Harbor Act of October 27, 1965. No advance engineering funds have been appropriated.

The authorized plan provides a tricompartmentalized harbor of approximately 47 acres to accommodate 1,600 boats, which is the projected boat population of the area for the year 2010. The northern compartment would be protected by a revetted mole 1,450 feet long and served by a combination entrance and access channel 570 feet long, 150 feet wide, and 12 feet deep. The large central compartment would be protected by a north mole 1,780 feet long, and a south mole 1,720 feet long, and served by an access channel 150 feet long, varying in width from 150 to 280 feet, and having a depth of 8 feet. A trapezoidal shaped access channel 8 feet deep to the existing mole and basin would also be dredged.

The estimated cost and project economics are as follows:

1st cost	$1,039,000
Benefit-cost ratio	4.8
Federal cost	$508,000
Non-Federal cost	$531,000
Design capacity (boats)	1,600

KANEOHE-KAILUA AREA

(See p. 71 for survey map.)

The authorized study includes several drainage areas located within the geographic districts of Kahaluu, Kaneohe, and Kailua. The current study is concentrated on the drainage basin for the Kamooalii and Kaneohe Streams. This area suffered the worst damages in recent years. Several thousands of dollars in flood damage were sustained and two lives were lost.

The Kamooalii and Kaneohe drainage basin is on the eastern part of the island of Oahu on the windward slopes of the Koolau Mountains. It is ell shaped, having a length of about 5 miles and a width varying from 0.5 to 1.8 miles. The total area of this drainage basin is about 5 square miles.

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The Kapunahala and Keapuka subdivisions, separated by Likelike Highway, are both first-class residential areas in the Kaneohe district. There are 380 and 540 homes in the Kapunahala and Keapuka subdivisions, respectively. There are some homes in the upstream areas of Keapuka subdivision. These homes are old and are located primarily in the undeveloped upper reaches of the drainage basin. A golf course is near the head of the drainage basin. Downstream of the U.S. Geological Survey Gaging Station, Kamooalii Stream enters into Kaneohe Stream. Approximately 40 homes of fairly recent construction are in the low area immediately upstream and 300 yards downstream of Kamehameha Highway Bridge. Bananas and small truck crops are raised in the area further downstream. There are 16 residences on the left bank near the mouth of Kaneohe Stream. These are in the low lying coastal plain. A sewage treatment plant and golf course are on the right bank. Areas adjacent to the stream on the right bank are also used for pasture.

Previous investigation consists of reconnaissance study which was completed in 1965. This study showed that a flood detention dam and channel improvements would provide the desired degree of protection. The cost of this plan was estimated at $4,500,000.

The current study being conducted under the survey authorization is further developing this plan. The work to date includes field surveys, extensive foundation investigations and laboratory analysis, and considerable in-house design work. To date $129,000 have been appropriated. This study is expected to be fully funded in fiscal year 1970 and is also scheduled to be completed in that year.

KAWAINUI SWAMP

(See p. 72 for project drawing.)

Kawainui Swamp on the windward side of the island of Oahu is bounded on the north and west by the Koolau Mountains, on the south by the boundaries of the Maunawili-Olomana-Pohakupu sections of Kailua town and on the east by Kailua town. The swamp occupies 740 acres and drains an area of 11.2 square miles. The swamp is drained to the Pacific Ocean through the Kaelepulu Stream and the Oneawa Channel, which was constructed by the State in 1952.

Rain-laden clouds sweep off the Pacific from the east and are carried by thermal currents over the peaks of the Koolau Mountains, depositing rain on the summits. The annual rainfall on the mountain area is 150 inches. The runoff from these rains is collected in the Kawainui Swamp and then carried on into the sea through the natural drainage of the Kaelepulu Stream into south Kailua Bay and through Oneawa Channel into north Kailua Bay near the Kaneohe Marine Air Station.

The Federal project authorized in the Flood Control Act of 1950 allowed for the widening and deepening of the Oneawa Channel outlet of Kawainui Swamp for a distance of 9,100 feet; the protection of the channel side slopes with crushed stone; the excavation of a silt basin 370 feet long at the entrance to the channel; and the construction of a groin and shore revetment at the channel mouth, protecting it against deposition and wave erosion. The project also provides earth levees, totaling 8,740 feet in length and extending from Kailua Road to the right bank of Oneawa Channel, to protect the town from further overflow of the swamp. The improved Oneawa Channel has an average depth of 7 feet and an average width of 110 feet in the downstream portion and 80 feet in the upstream portion.

In July 1964, the Honolulu Engineer District, Corps of Engineers, awarded the contract ($1.1 million) to W. T. Chang Contractors, Inc., of Honolulu. Work was completed in June 1966, and the project was turned over to the city and county of Honolulu for operation and maintenance.

KAILUA HARBOR

(See p. 73 for project drawing.)

A public hearing was held in 1959 regarding a small craft harbor in Kailua Bay. It was suggested at that time that a protected harbor be constructed in Kailua Bay; however, investigation showed that such a protected harbor would necessitate costly breakwaters and mole construction, as well as constituting an adverse influence upon the excellent bathing beach. Another hindrance was the acquisition of property in the high-class residential area along the shoreline.

Therefore the Corps looked to other areas in which a boat harbor could be constructed. Thus, it appeared that the Kawainui Swamp—after the completion of the flood control project—offered the best promise of several alternate sites. Several sites within the swamp area were considered. The proposed site was selected because of the ready accessibility by both boats and automobiles.

This is one of eight harbors recommended for Federal construction in the "Interim Report on the Coasts of Hawaiian Islands—Harbors for Light-Draft Vessels." The eight harbors were authorized by the River and Harbor Act of October 27, 1965. No advance engineering funds have been appropriated.

The authorized harbor would have a capacity of about 700 boats. These boats would have a maneuvering basin of about 120,000 square feet (2.8 acres) and a main access channel 1,800 feet long which would vary in width from 100 to 150 feet. Floating piers would be effective in the berthing areas at this facility since this type of pier would not interfere with floodwater exit to the ocean. No protective structures such as breakwaters or moles would be necessary because of the project's inland location.

However, because of the restriction at Kalaheo Avenue Bridge, only certain sizes of small boats would be capable of traversing the Oneawa Channel. At high tide the clearance is 5½ feet, while at low tide it is 7½ feet. Thus, the Kailua Harbor project would be restricted to the use of power boats no greater than 20 feet in length with draft not greater than 4, and with hull structures or appurtenances not extending more than 4 or 5 feet. The clearance at the center of the bridge is 7.78 feet MLLW.

The estimated cost and project economics are as follows:

1st cost	$859,000
Annual cost	$42,000
Annual benefit	$68,200
Benefit-cost ratio	1.6
Federal cost	$312,000
Non-Federal cost	$547,000
Design capacity (at year 2015)	680

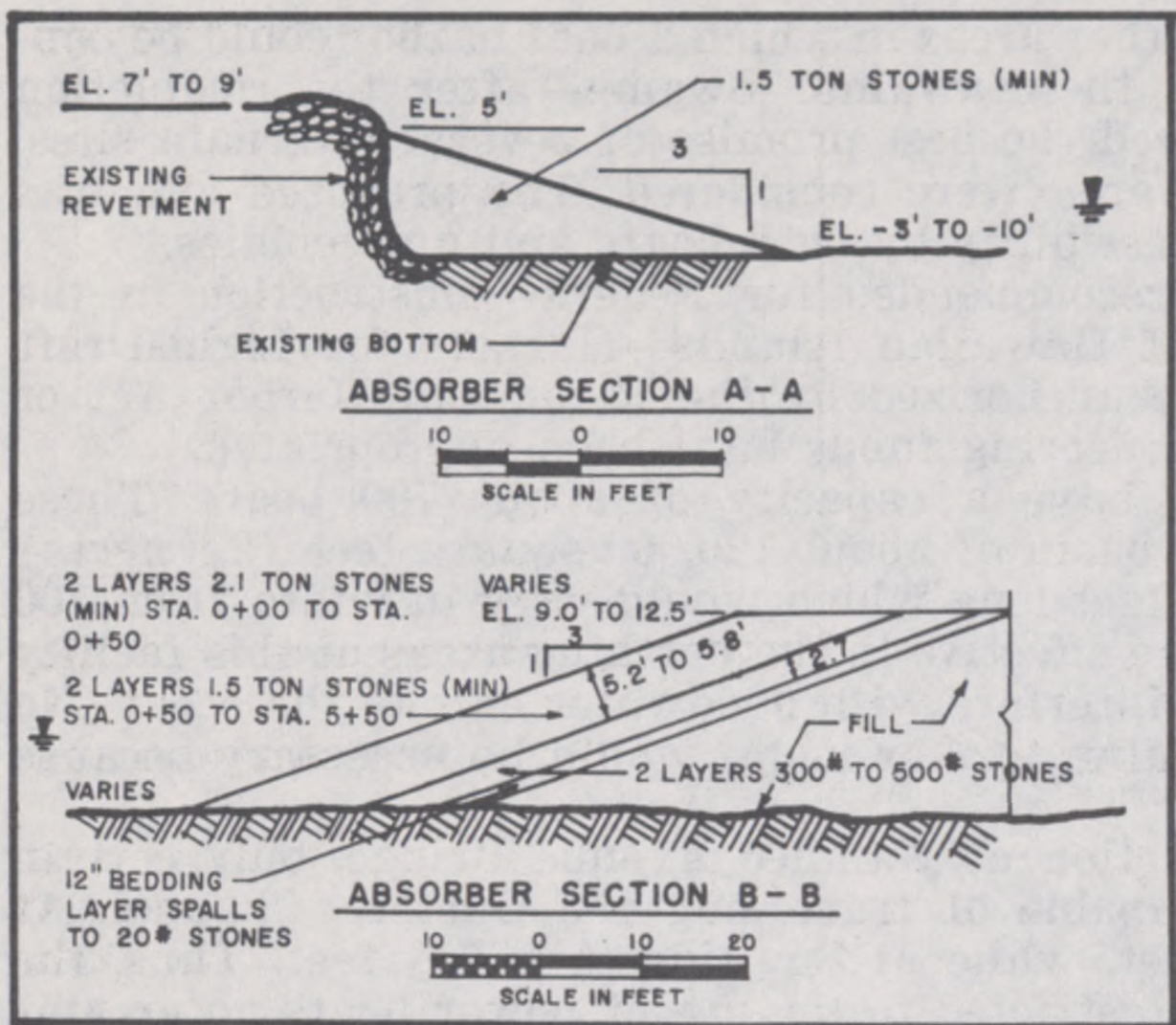
Miscellaneous data: Restricted to use of power boats no greater than 20 feet in length with drafts not greater than 4 feet and with hull structures or appurtenances not extending more than 5.5 feet above the waterline.

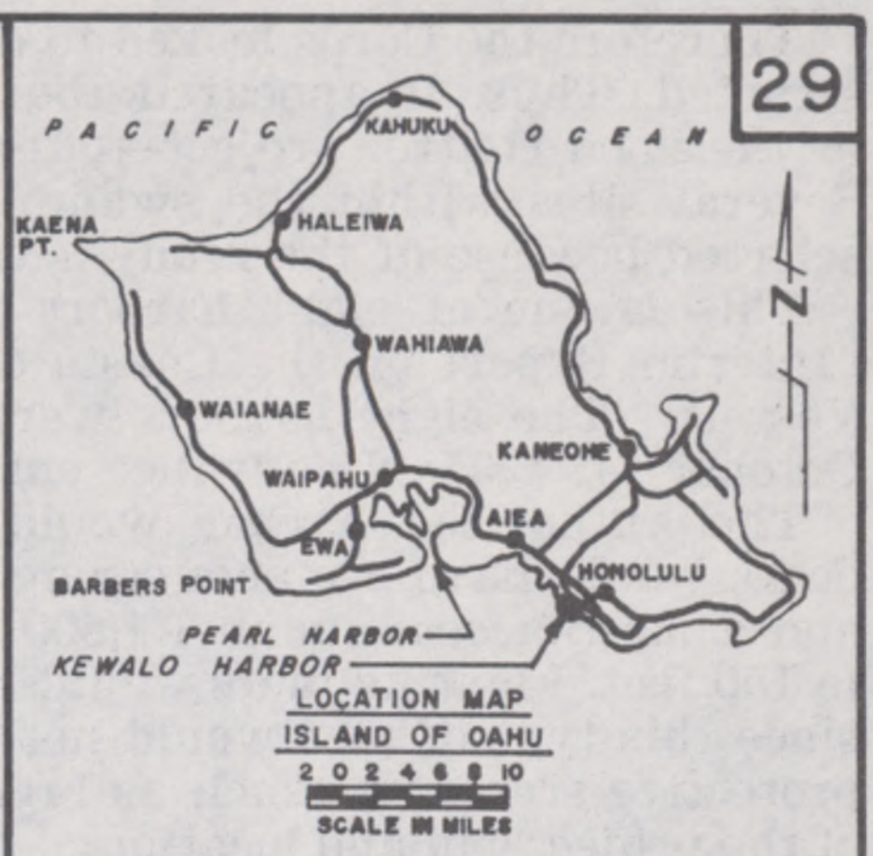
KALIHI STREAM

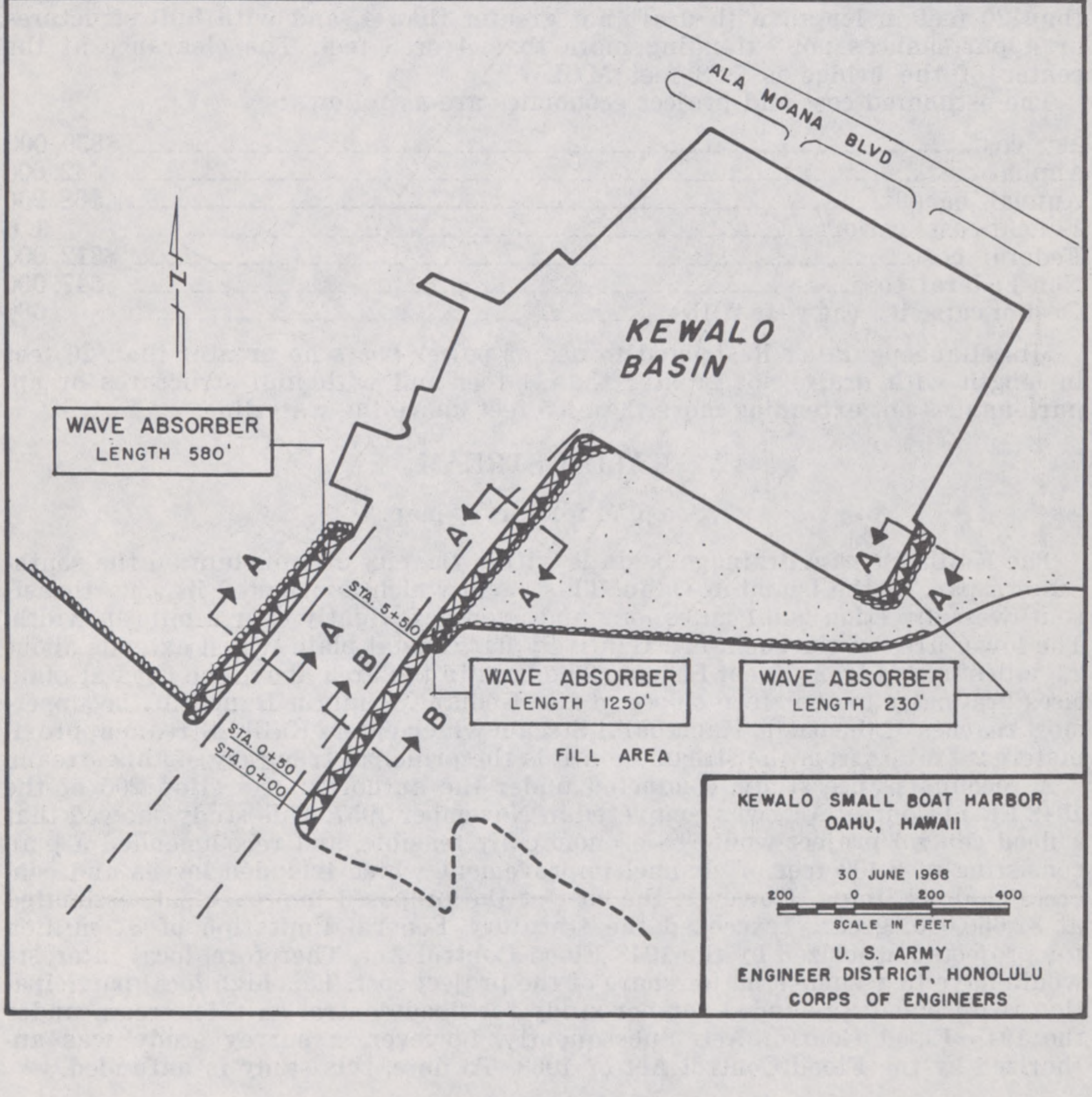
(See p. 74 for survey map.)

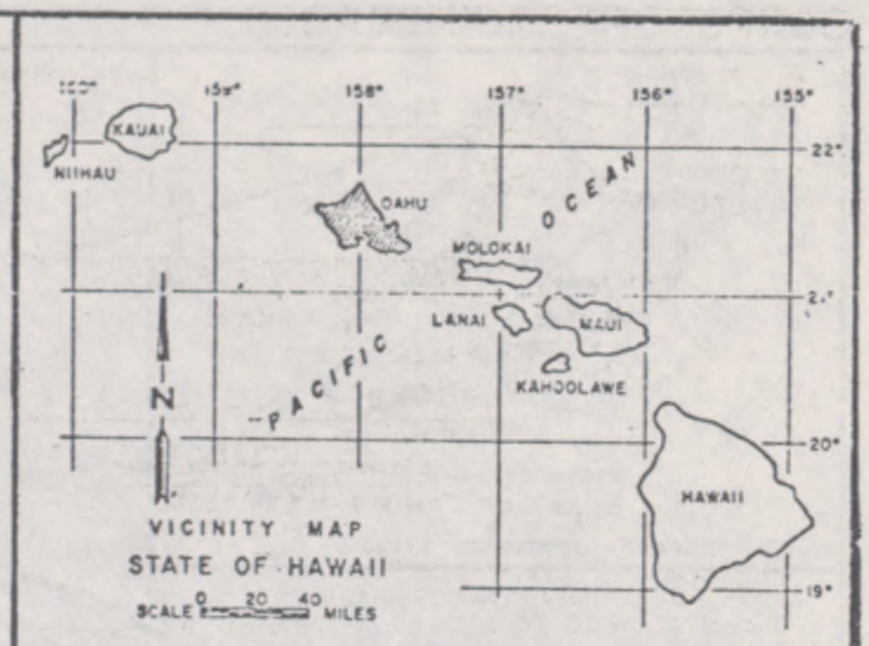
The Kalihi Stream drainage basin is within the city of Honolulu on the southeastern part of the island of Oahu. This basin which is oriented in a northeast-southwest direction is 6.1 miles long and averages slightly over a mile in width. The lower area of the basin is a relatively flat coastal plain which extends about 2.5 miles inland from Keehi Lagoon. The land in the area above the coastal plain rises gradually to the steep slopes of the Koolau Mountain Range in the uppermost reaches of the basin. Kamanaiki Stream which enters Kalihi Stream approximately 2.4 miles from the stream mouth is the principal tributary of this stream.

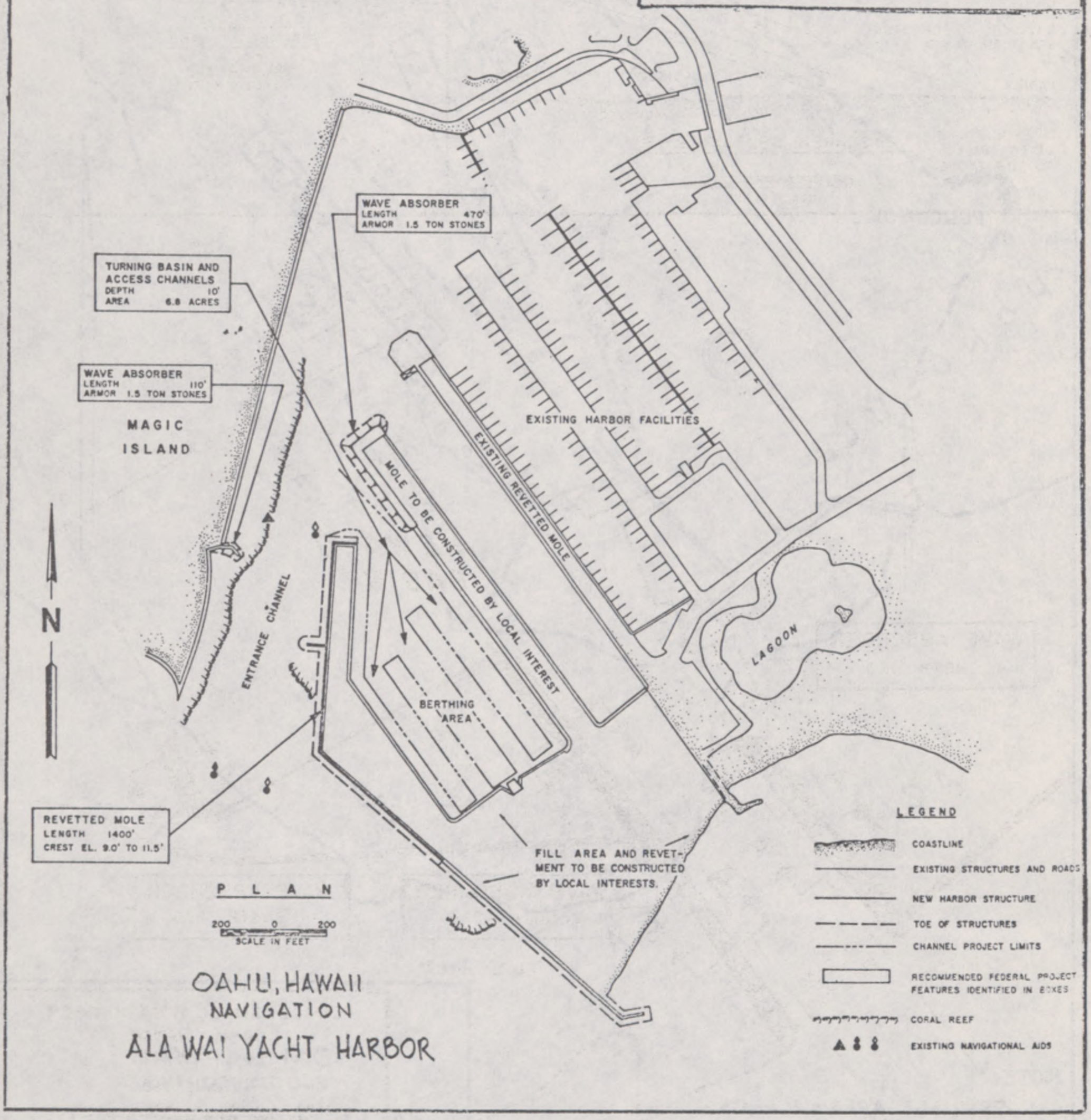
A reconnaissance study, conducted under the authority of section 205 of the 1948 Flood Control Act, was completed in November 1957. This study showed that a flood control project would be economically feasible, and recommended a plan consisting of 8,400 feet of channel improvement which included levees and concrete channel lining. However, the cost of the proposed improvement, estimated at $2,650,000, greatly exceeded the statutory Federal limitation of $1 million for projects authorized by the 1948 Flood Control Act. Therefore, local interests would have to assume a major share of the project cost. This high local participation requirement precluded further study for flood control on this stream under the 1948 Flood Control Act. Subsequently, however, a survey study was authorized by the Flood Control Act of 1968. To date, this study is unfunded.


EL. 7' TO 9'
EL. 5'
1.5 TON STONES (MIN)
3
1
EXISTING REVETMENT
EL. -3' TO -10'
EXISTING BOTTOM
ABSORBER SECTION A-A
10 0 10
SCALE IN FEET
2 LAYERS 2.1 TON STONES (MIN) STA. 0+00 TO STA. 0+50
VARIES EL. 9.0' TO 12.5'
5.2' TO 5.8'
2.7
2 LAYERS 1.5 TON STONES (MIN) STA. 0+50 TO STA. 5+50
FILL
2 LAYERS 300# TO 500# STONES
VARIES
12" BEDDING LAYER SPALLS TO 20# STONES
ABSORBER SECTION B-B
10 0 10 20
SCALE IN FEET


29
PACIFIC OCEAN
KAHUKU
KAENA PT.
HALEIWA
WAHIAWA
WAIANAE
KANEOHE
WAIPAHU
AIEA
EWA
HONOLULU
BARBERS POINT
PEARL HARBOR
KEWALO HARBOR
LOCATION MAP
ISLAND OF OAHU
2 0 2 4 6 8 10
SCALE IN MILES

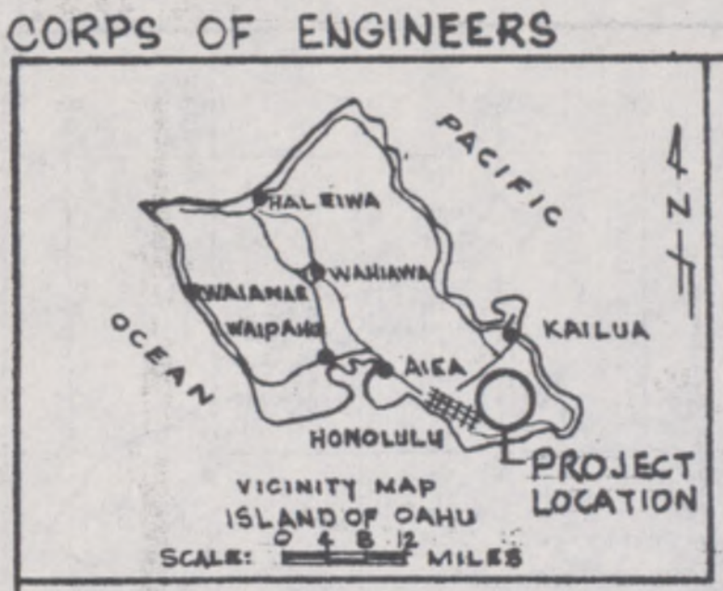

ALA MOANA BLVD
KEWALO BASIN
WAVE ABSORBER
LENGTH 580'
WAVE ABSORBER
LENGTH 1250'
WAVE ABSORBER
LENGTH 230'
FILL AREA
A
B
STA. 5+50
STA. 0+50
STA. 0+00
KEWALO SMALL BOAT HARBOR
OAHU, HAWAII
30 JUNE 1968
200 0 200 400
SCALE IN FEET
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS





OAHU, HAWAII
NAVIGATION
ALA WAI YACHT HARBOR

CORPS OF ENGINEERS U.S. ARMY



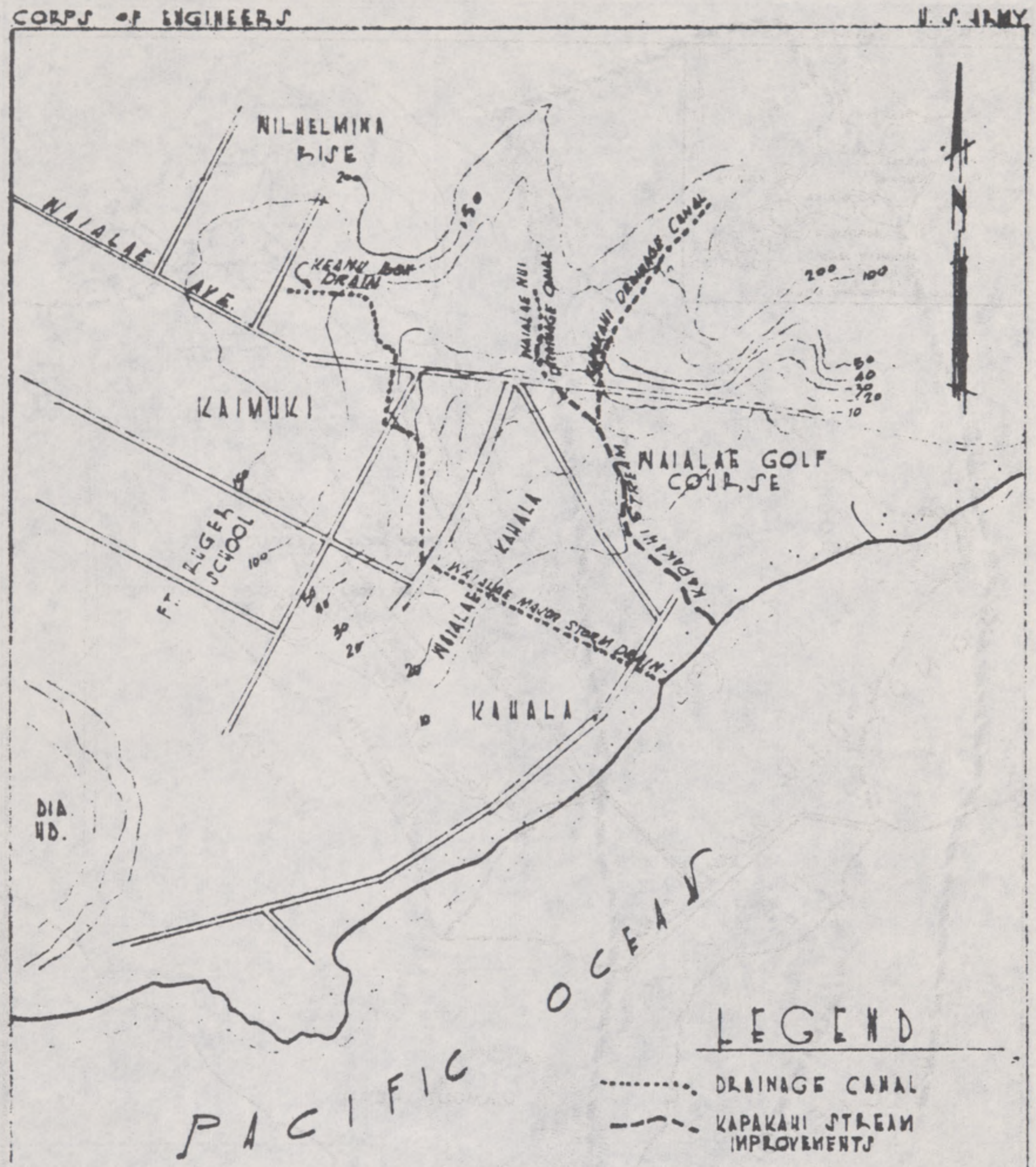
NOTE:

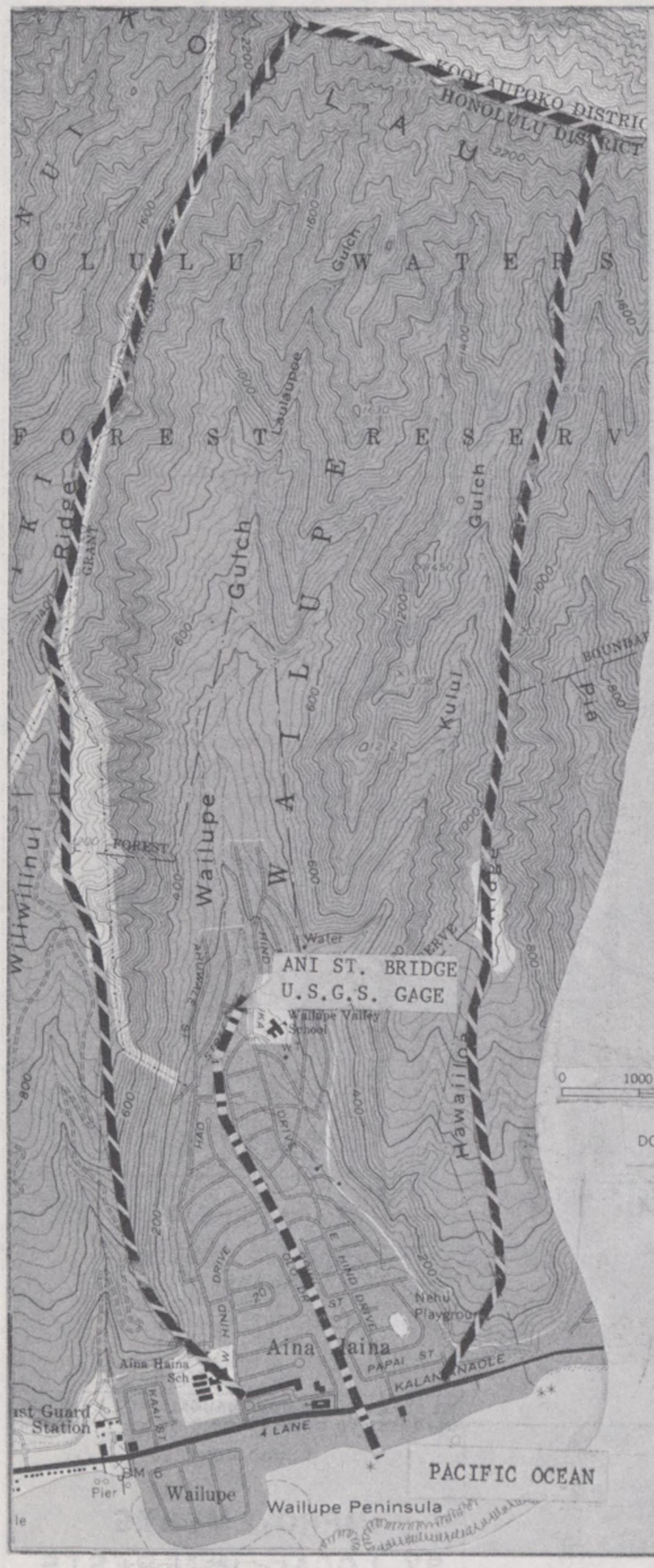
1. DRAINAGE AREA - MANOA
2. DRAINAGE AREA - PALOLO
1,2&3. DRAINAGE AREA - ALA WAI CANAL

OAHU, HAWAII
FLOOD CONTROL

PALOLO AND MANOA VALLEYS

U.S. ARMY ENGINEER DISTRICT, HONOLULU

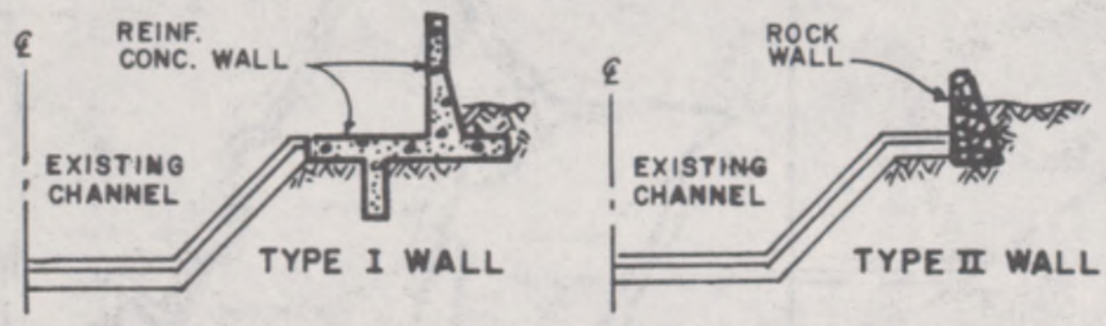

CORPS OF ENGINEERS
U. S. ARMY
WILHELMINA RISE
NAIALAE AVE.
KEANU BOY DRAIN
NAIALAE NUI DRAINAGE CANAL
KEANU DRAINAGE CANAL
KAIMUKI
NAIALAE GOLF COURSE
KAPAKAHI STREAM IMPROVEMENTS
KAHALA
NAIALAE MAJOR STORM DRAIN
KAHALA
DIA. HD.
PACIFIC OCEAN
200
100
50
40
30
20
10
LEGEND
DRAINAGE CANAL
KAPAKAHI STREAM IMPROVEMENTS
CONTOURS
SCALE 1000 0 1000 2000 FEET
WAIALAE-NUI, KAIMUKI, MAUNALANI HEIGHTS AND WILHELMINA RISE
OAHU HAWAII
FLOOD CONTROL
IMPROVEMENTS BY LOCAL INTERESTS
U.S. ARMY ENGINEER DISTRICT HONOLULU
FILE NO RH 20/1



WAILUPE STREAM
OAHU, HAWAII

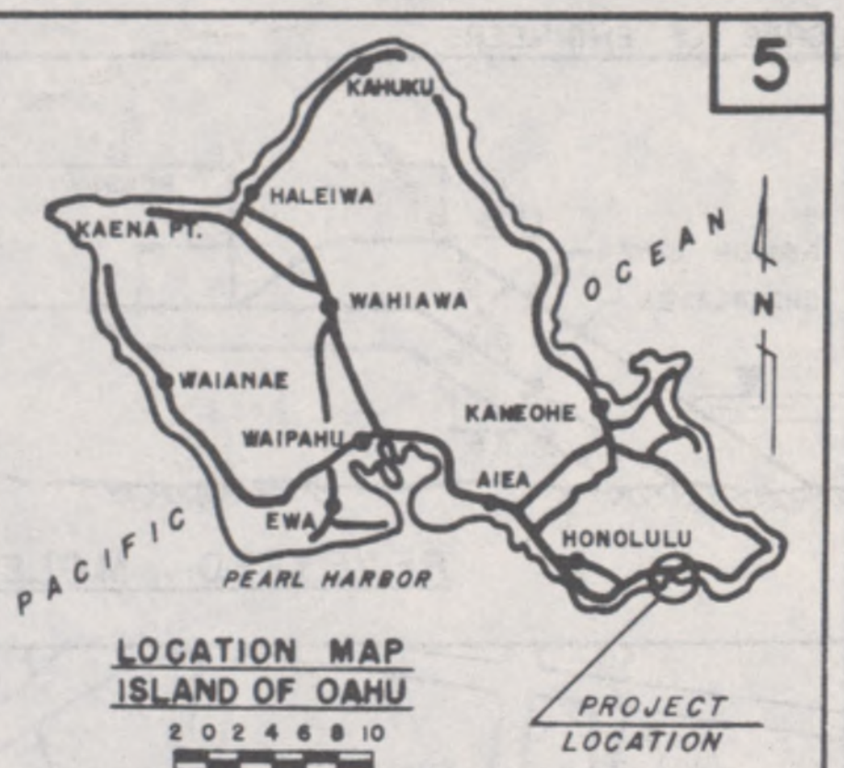
GENERAL PLAN

USArmy Engr Dist, Honolulu

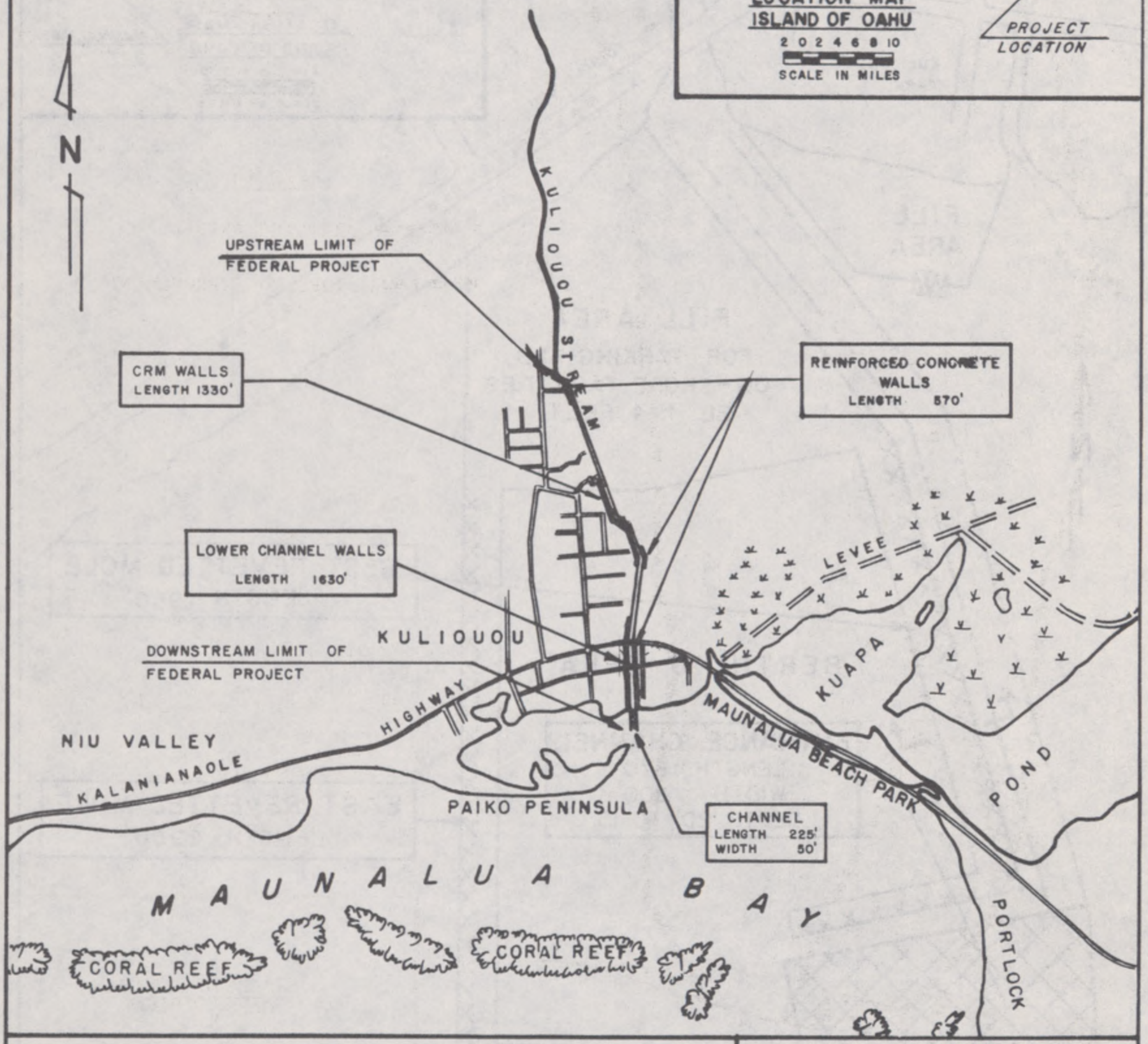


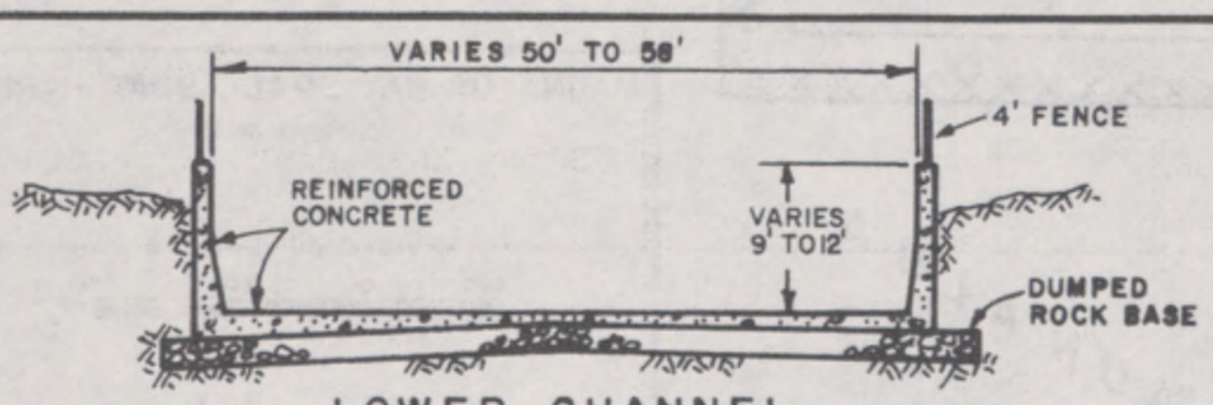
MODIFIED UPPER EXISTING CHANNEL

5



LOCATION MAP
ISLAND OF OAHU
2 0 2 4 6 8 10
SCALE IN MILES





LOWER CHANNEL

FLOOD CONTROL
KULIOUOU STREAM
OAHU, HAWAII

REVISED 30 JUNE 1967

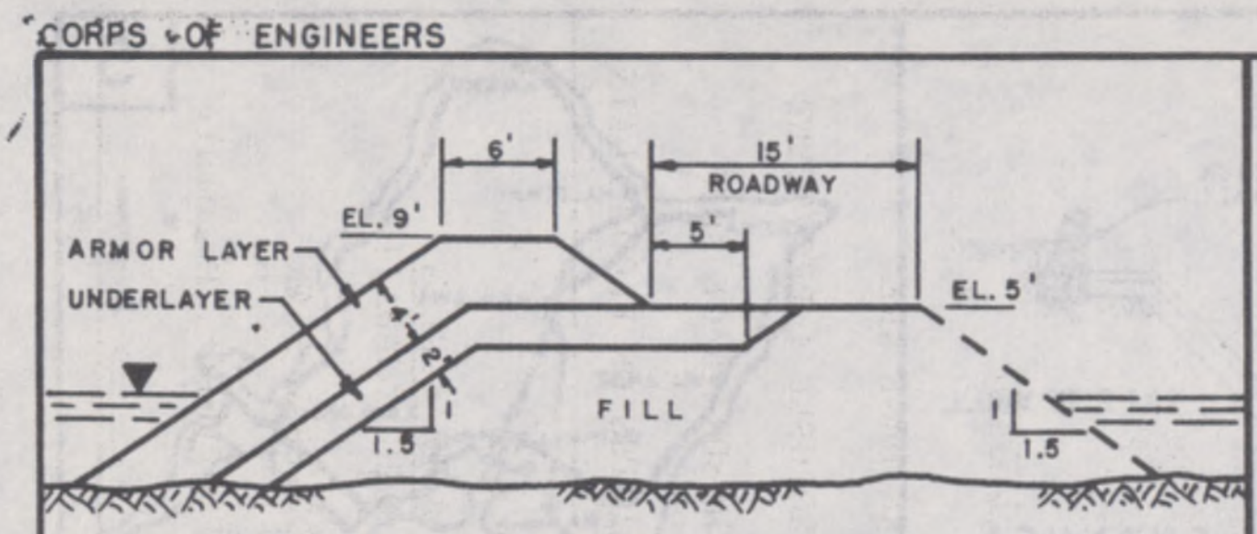
1000 0 1000
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

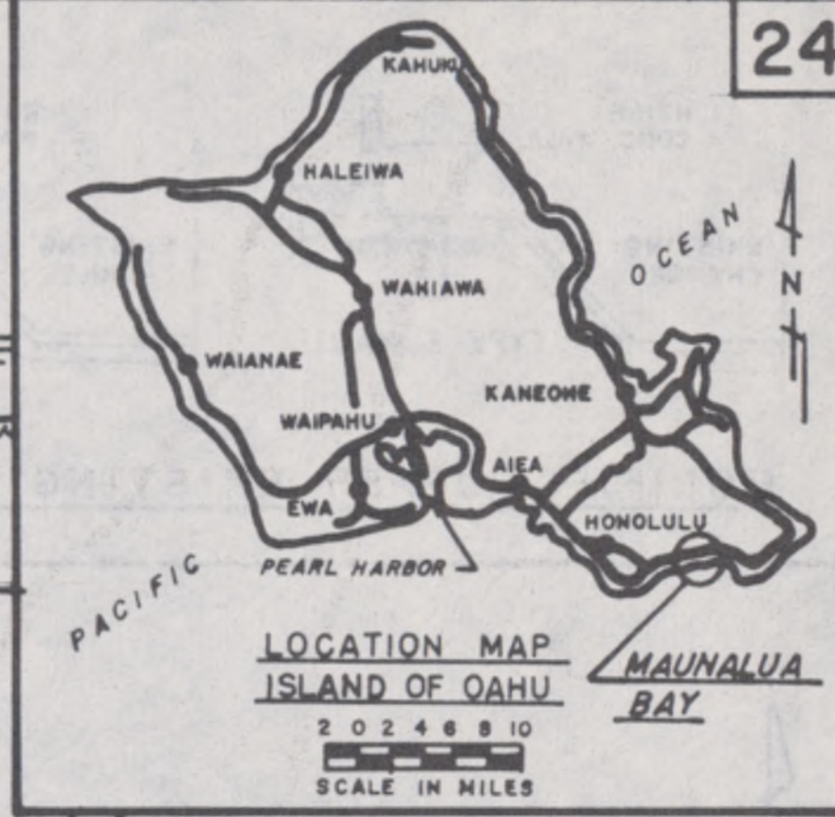
CORPS OF ENGINEERS

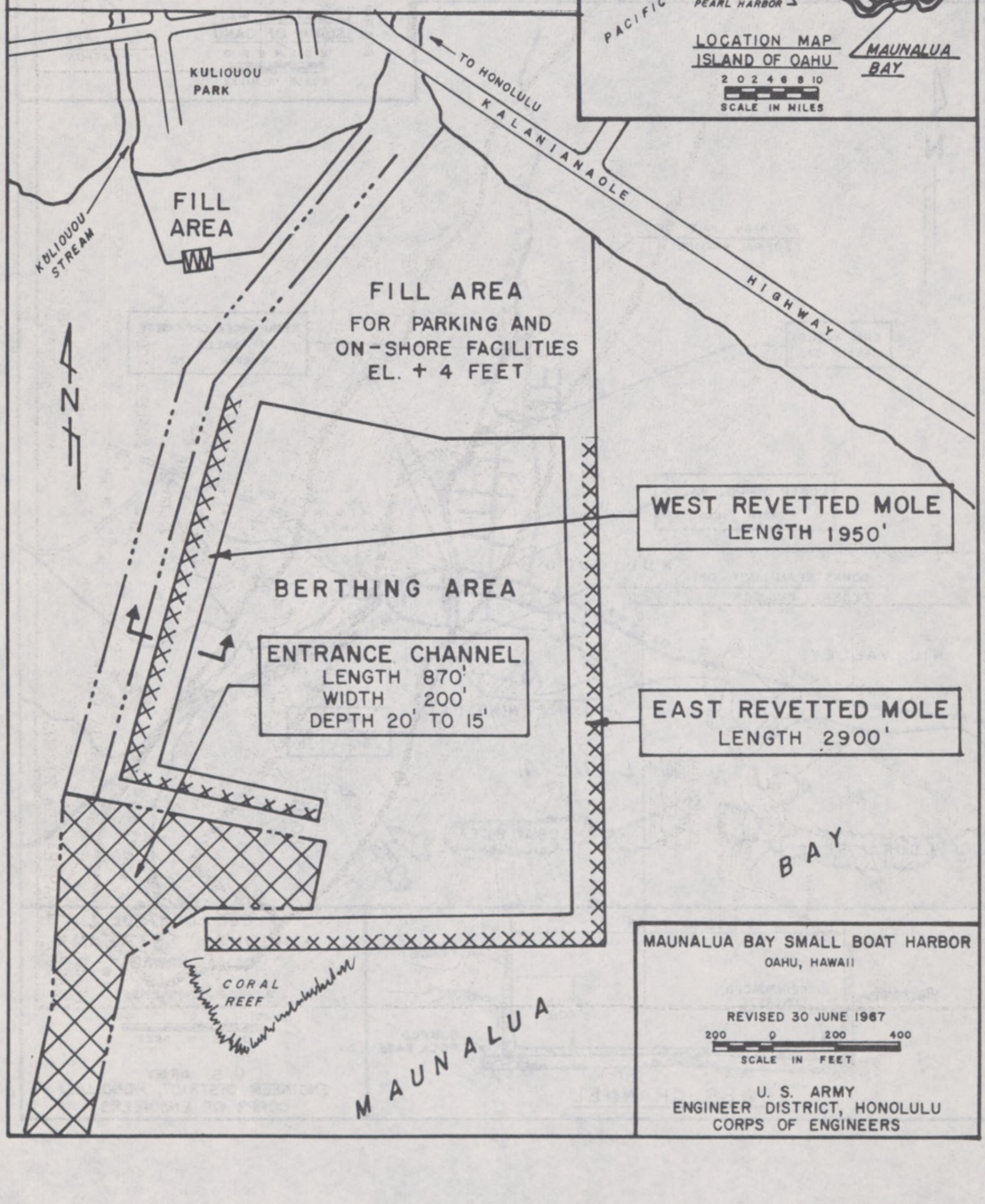
U.S. ARMY

24



REVETTED MOLE



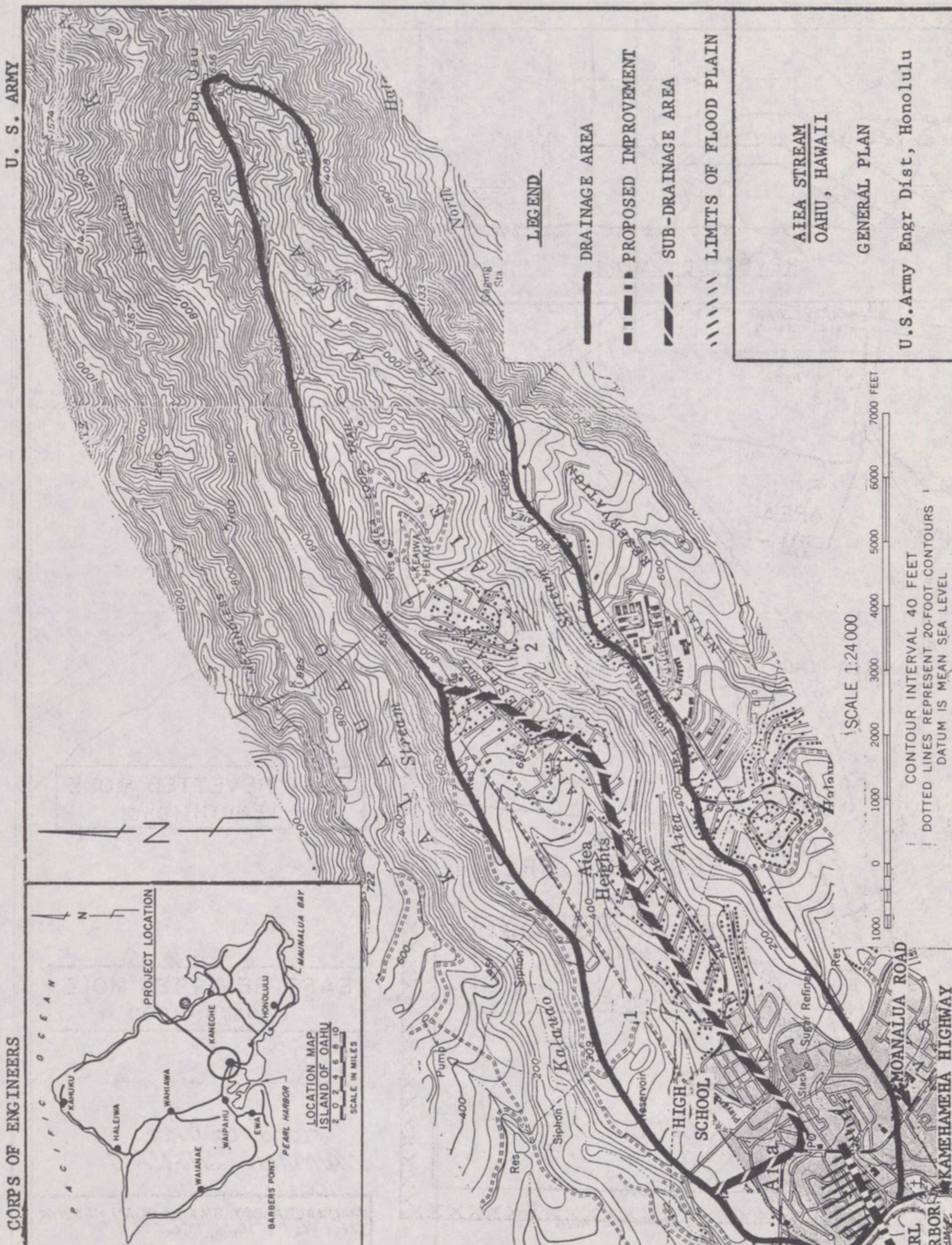


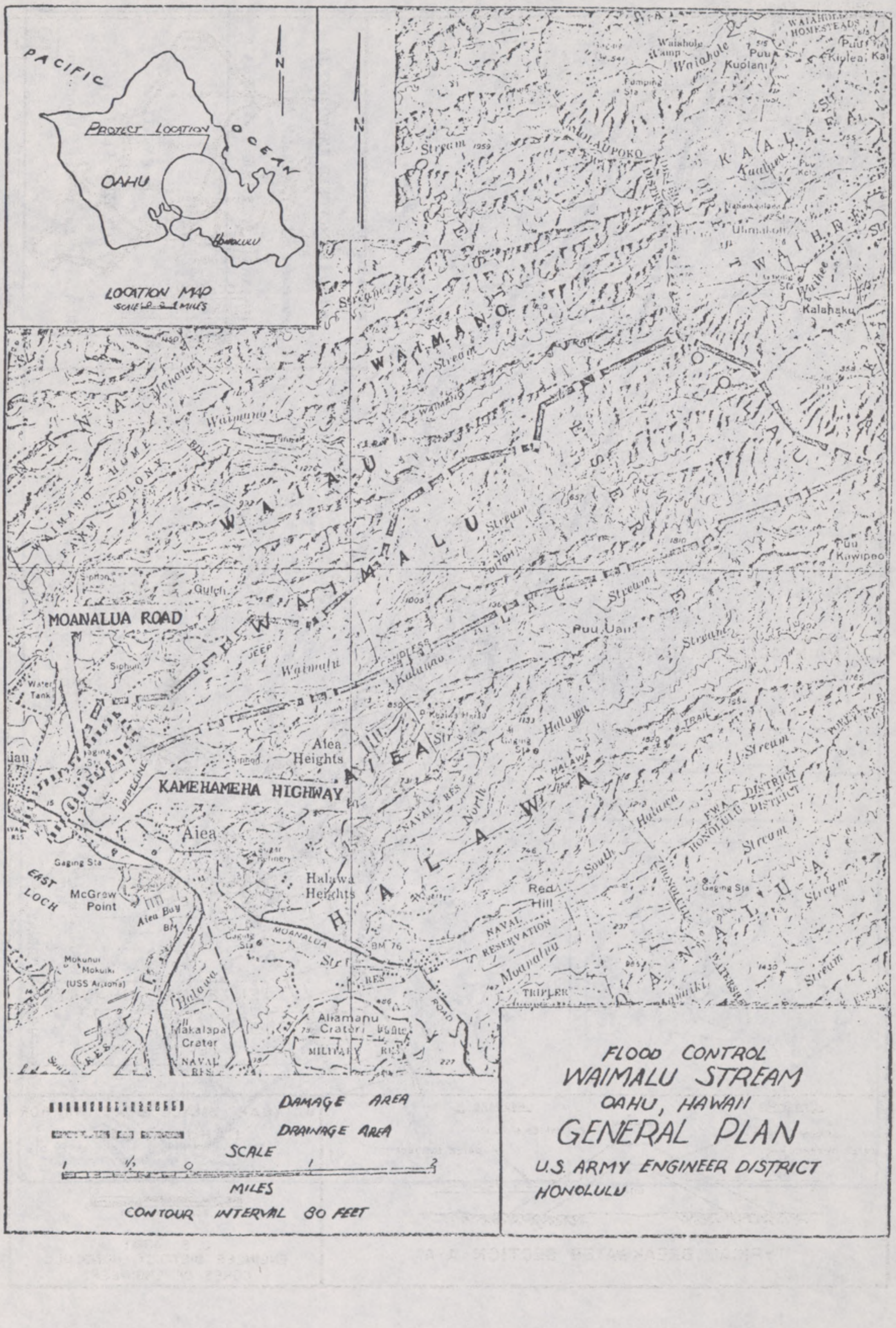
MAUNALUA BAY SMALL BOAT HARBOR
OAHU, HAWAII

REVISED 30 JUNE 1967

200 0 200 400
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS


CORPS OF ENGINEERS
U. S. ARMY
LEGEND
DRAINAGE AREA
PROPOSED IMPROVEMENT
SUB-DRAINAGE AREA
LIMITS OF FLOOD PLAIN
AIEA STREAM
OAHU, HAWAII
GENERAL PLAN
U.S.Army Engr Dist, Honolulu
SCALE 1:24 000
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
PROJECT LOCATION
PACIFIC OCEAN
KAHUKU
HALEIWA
WAHIAWA
WAIANAE
WAIPAHU
EWA
KANEOHE
HONOLULU
MAUNALUA BAY
PEARL HARBOR
BARBERS POINT
KAENA POINT
LOCATION MAP
ISLAND OF OAHU
2 0 2 4 6 8 10
SCALE IN MILES
N
Puu Uau
Kalauao
North
Aiea
Stream
KALAUAO
AIEA
Aiea Heights
HIGH SCHOOL
NAVAL RESERVATION
MOANALUA ROAD
KAMEHAMEHA HIGHWAY
PEARL HARBOR
Sugar Refinery
Reservoir
Siphon
Pump
Res
1
2


PACIFIC
OCEAN
PROJECT LOCATION
OAHU
LOCATION MAP
SCALE 0 2 MILES
N
WAIAHOLE HOMESTEADS
Waiahole Camp
Waiahole
Puu Kuolani
Kipilea
Pumping Sta
Stream
KULAUPOKO
KALALAU
Kualpua
Ulumahoi
WAIHEE
Waihee
Kalahaku
WAIMANO
Stream
Waimano
Waimano Home
WAIMANO FARM COLONY
WAIALUALU
Stream
Gulch
Puu Kawipoo
MOANALUA ROAD
Siphon
Water Tank
JEEP
Waimalu
CANDLESS
Kalauao
Puu Uaini
Stream
Halawa
Aiea Heights
KAMEHAMEHA HIGHWAY
PIPELINE
Aiea
Gaging Sta
EAST LOCH
McGrew Point
Aiea Bay
Halawa Heights
MOANALUA
Mokuauli
Mokuiki
(USS Arizona)
Halawa
Makalapa Crater
NAVAL RES
Aliamanu Crater
MILITARY RES
HALAWA
Stream
North
South
Red Hill
NAVAL RESERVATION
Moanalua
TRIPLER
FWA HONOLULU DISTRICT
DAMAGE AREA
DRAINAGE AREA
SCALE
1 1/2 0 1 2
MILES
CONTOUR INTERVAL 80 FEET
FLOOD CONTROL
WAIMALU STREAM
OAHU, HAWAII
GENERAL PLAN
U.S. ARMY ENGINEER DISTRICT
HONOLULU

CORPS OF ENGINEERS U. S. ARMY

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POKAI BAY

EXISTING BREAKWATER

KANEILIO POINT

BERTHING AREA

PARKING AND ON-SHORE FACILITIES

POKAI STREET

N

MAIN ACCESS CHANNEL
LENGTH 870'
WIDTH 100' TO 150'
DEPTH 12' TO 15'

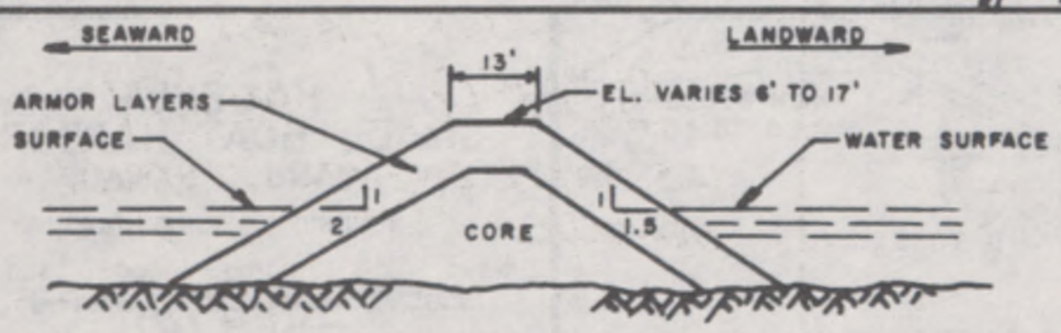
BREAKWATER
LENGTH 1350'

GROIN
LENGTH 175'

ENTRANCE CHANNEL
LENGTH 830'
WIDTH 150'
DEPTH 15' TO 17'

KAHUKU
HALEIWA
WAHIAWA
WAIANAE
WAIPAHU
EWA
KANEOHE
AIEA
HONOLULU
PEARL HARBOR
WAIANAE HARBOR
OCEAN
PACIFIC

LOCATION MAP
ISLAND OF OAHU
2 0 2 4 6 8 10
SCALE IN MILES



TYPICAL BREAKWATER SECTION A-A

WAIANAE SMALL BOAT HARBOR
OAHU, HAWAII

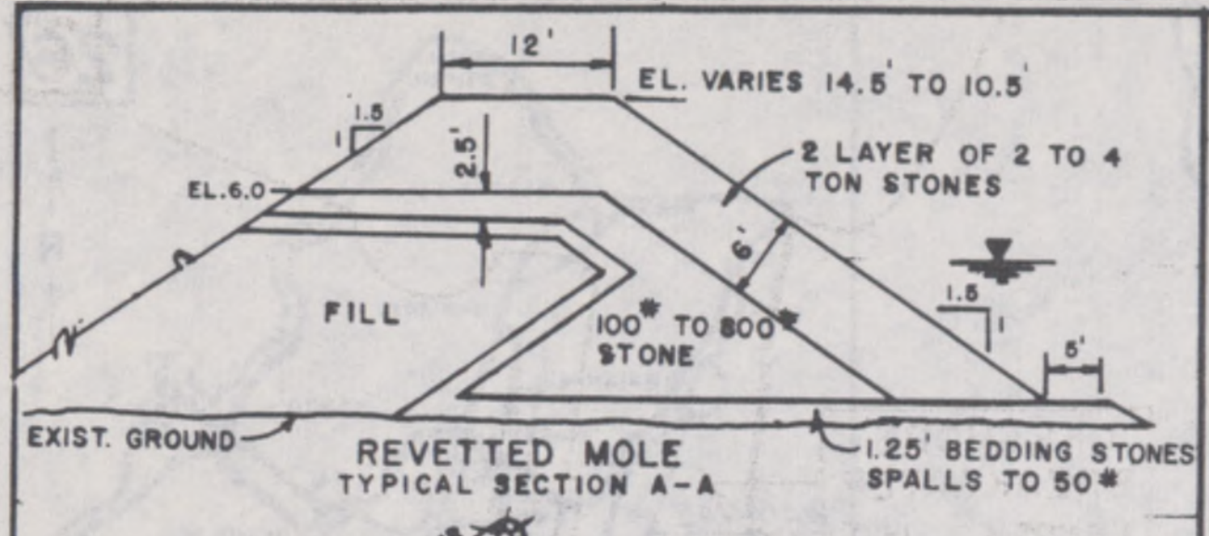
REVISED 30 JUNE 1967
100 0 100 200
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY

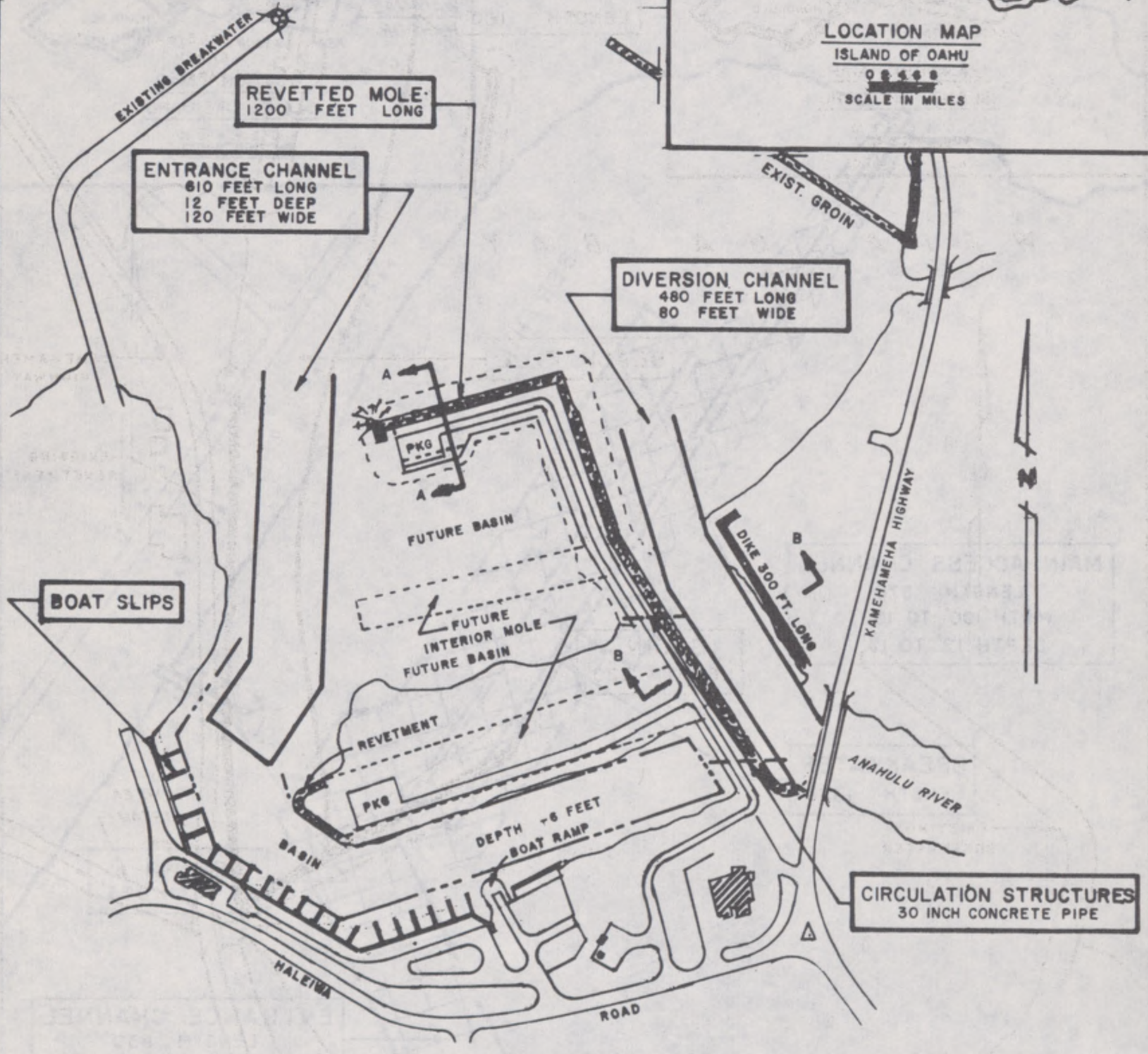
15

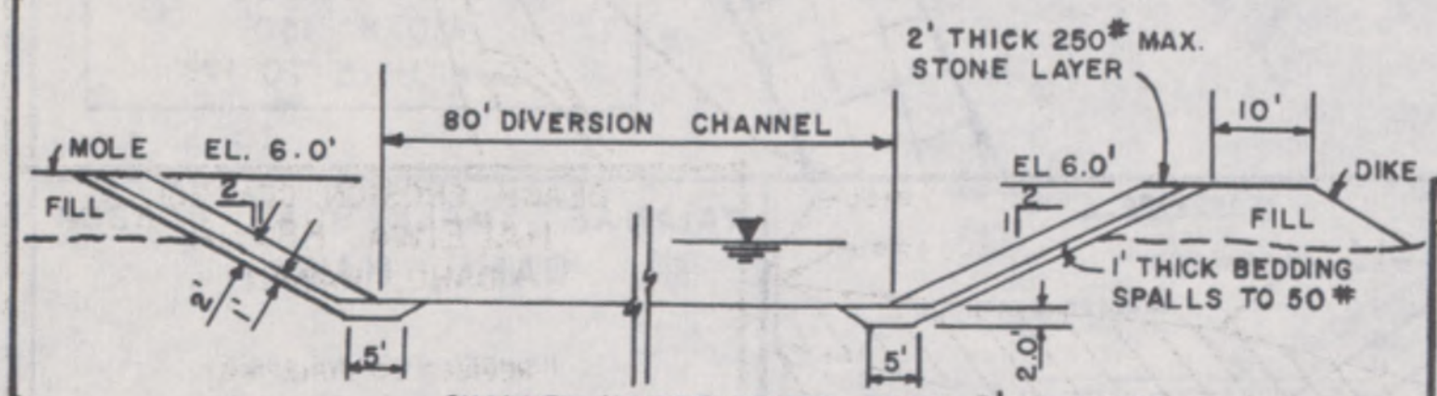


REVETTED MOLE
TYPICAL SECTION A-A



LOCATION MAP
ISLAND OF OAHU
0 2 4 6 8
SCALE IN MILES





DIVERSION CHANNEL
TYPICAL SECTION B-B

HALEIWA
SMALL BOAT HARBOR
OAHU, HAWAII

REVISED 30 JUNE 1968

100 0 100 200 300
SCALE IN FEET

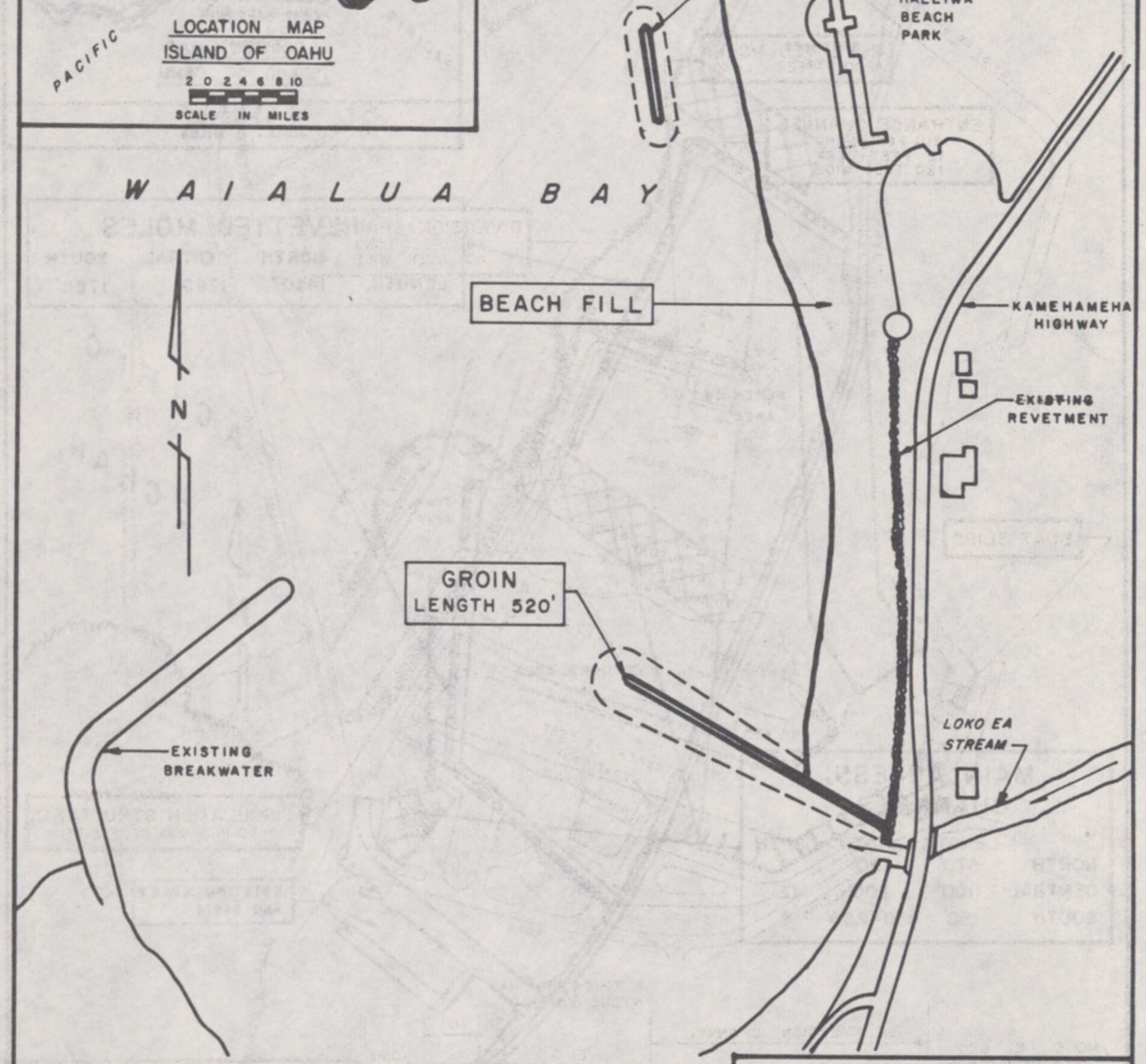
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

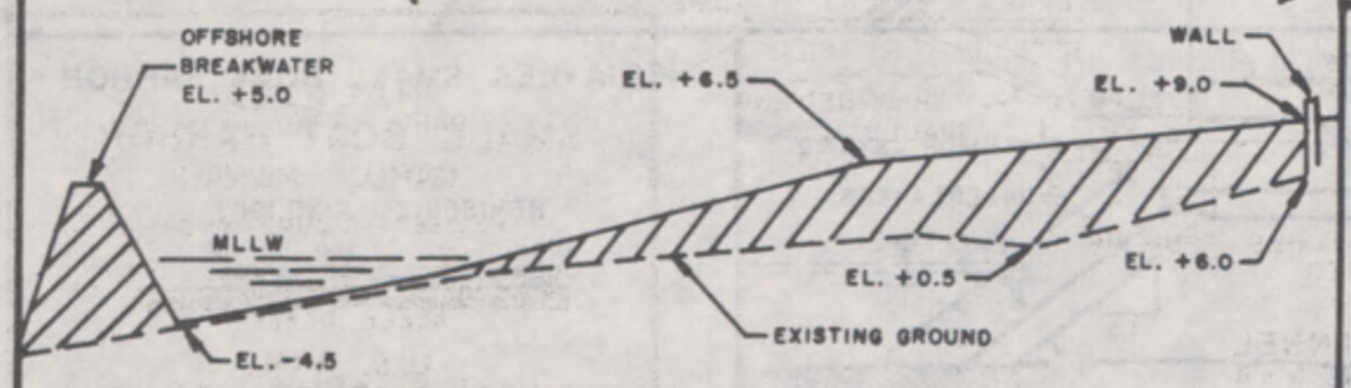
CORPS OF ENGINEERS

U. S. ARMY

27







TYPICAL BREAKWATER AND BEACH SECTION

BEACH EROSION CONTROL
HALEIWA BEACH
OAHU, HAWAII

REVISED 30 JUNE 1967

100 0 100 200
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U. S. ARMY

20

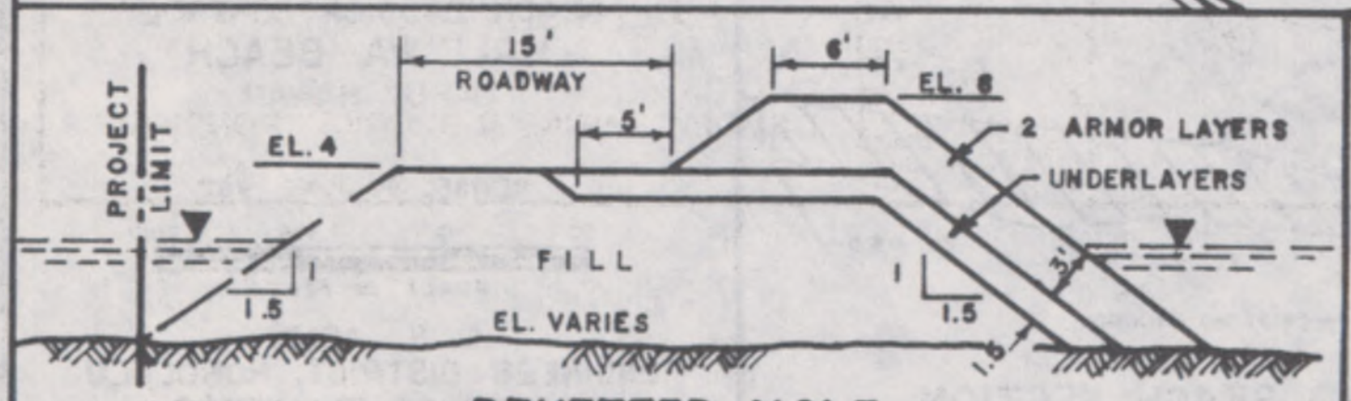


REVETTED MOLES

	NORTH	CENTRAL	SOUTH
LENGTH	1450'	1780'	1720'

MAIN ACCESS CHANNELS

	LENGTH	WIDTH	DEPTH
NORTH	570'	150'	12'
CENTRAL	1100'	200'	12'
SOUTH	150'	150'-280'	8'



REVETTED MOLE

HEEIA-KEA SMALL BOAT HARBOR

OAHU, HAWAII

REVISED 30 JUNE 1967

200 0 200 400

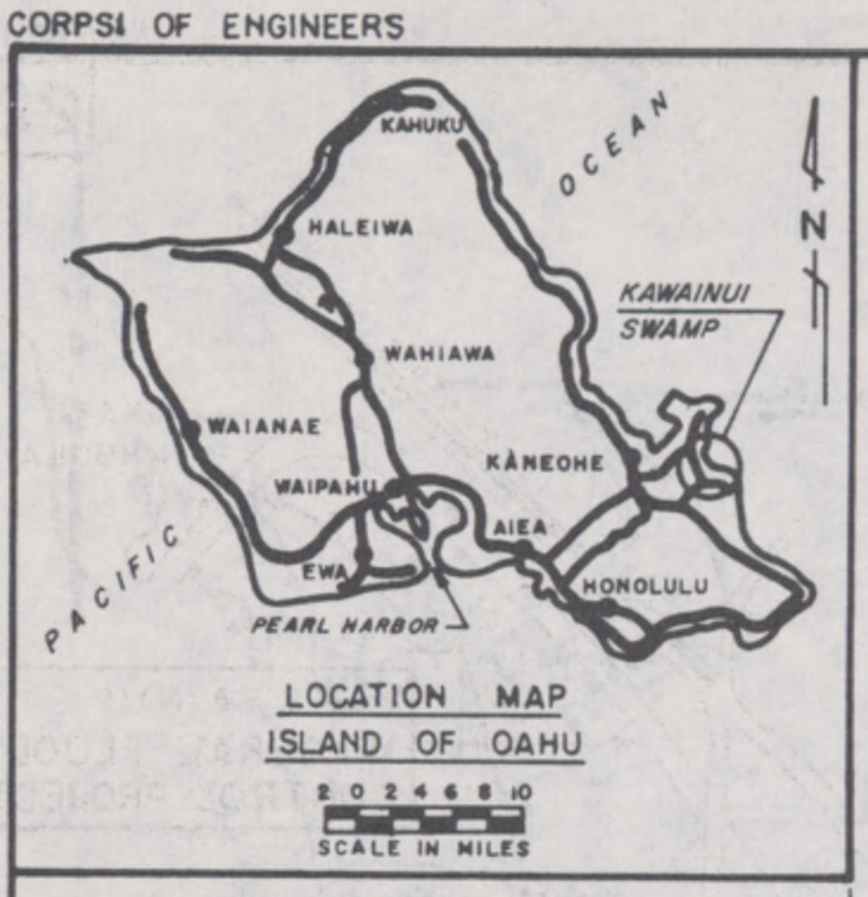
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS


US ARMY
KANEOHE BAY
KAWAINUI SWAMP
FLOOD CONTROL
KAILUA BAY
AREA 1
AREA 2
AREA 3
SCALE 1:62500
CONTOUR INTERVAL 80 FEET
OAHU
STUDY AREA
PACIFIC
LOCATION MAP
KANEOHE - KAILUA AREA
OAHU, HAWAII
GENERAL PLAN
US ARMY ENGINEER DISTRICT HONOLULU

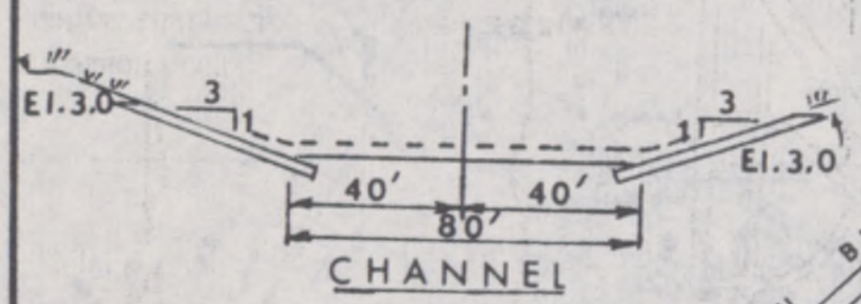
CORPS OF ENGINEERS

U.S. ARMY

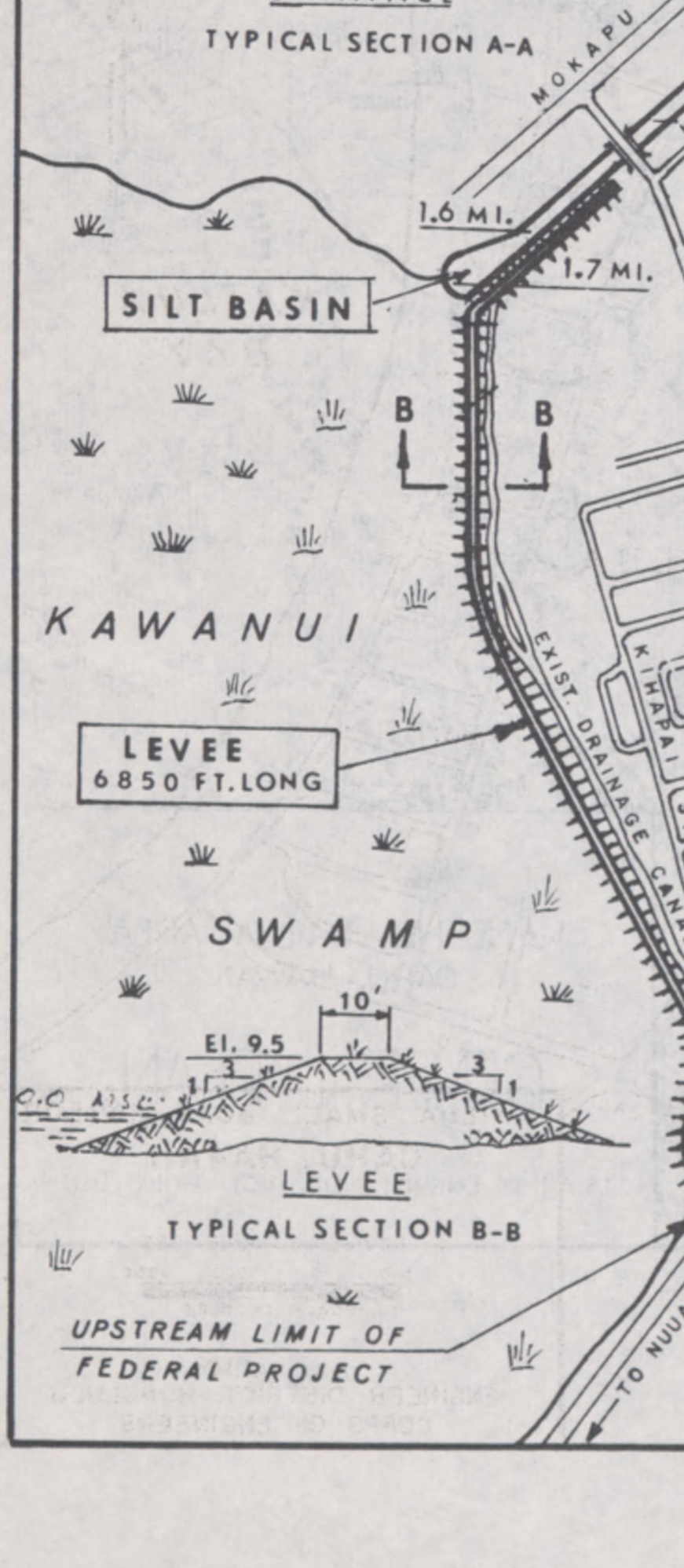


LOCATION MAP
ISLAND OF OAHU

2 0 2 4 6 8 10
SCALE IN MILES



CHANNEL
TYPICAL SECTION A-A



LEVEE
TYPICAL SECTION B-B

2

TO KANEOHE MCAS
0.2 MI.
MOKAPU PENINSULA
0.4 MI.
0.0 MI.
REVETMENT AND GROIN
0.6 MI.
DOWNSTREAM LIMIT OF FEDERAL PROJECT
0.8 MI.
KALAHEO AVE. BRIDGE
1.0 MI.
1.2 MI.
MOKAPU BLVD
KAINUI DR.
ONEAWA CHANNEL
9,470 FT. LONG
1.4 MI.
1.6 MI.
1.7 MI.
SILT BASIN
B
B
LEVEE
6850 FT. LONG
KAWANUI
SWAMP
EXIST. DRAINAGE CANAL
ONEAWA ST.
KIHAPAI ST.
KAINALU DR.
KALAHEO AVE
KAILUA
KAILUA BAY
KAILUA ROAD
TO NUUANU PALI
UPSTREAM LIMIT OF FEDERAL PROJECT

N

INFLOW DESIGN FLOOD = 18,100 CFS
OUTFLOW CHANNEL CAPACITY = 6,700 CFS
CHANNEL FREEBOARD = 2 FT.

FLOOD CONTROL
KAWAINUI SWAMP
OAHU, HAWAII
REVISED 30 JUNE 1968

500 0 500 1000
SCALE IN FEET

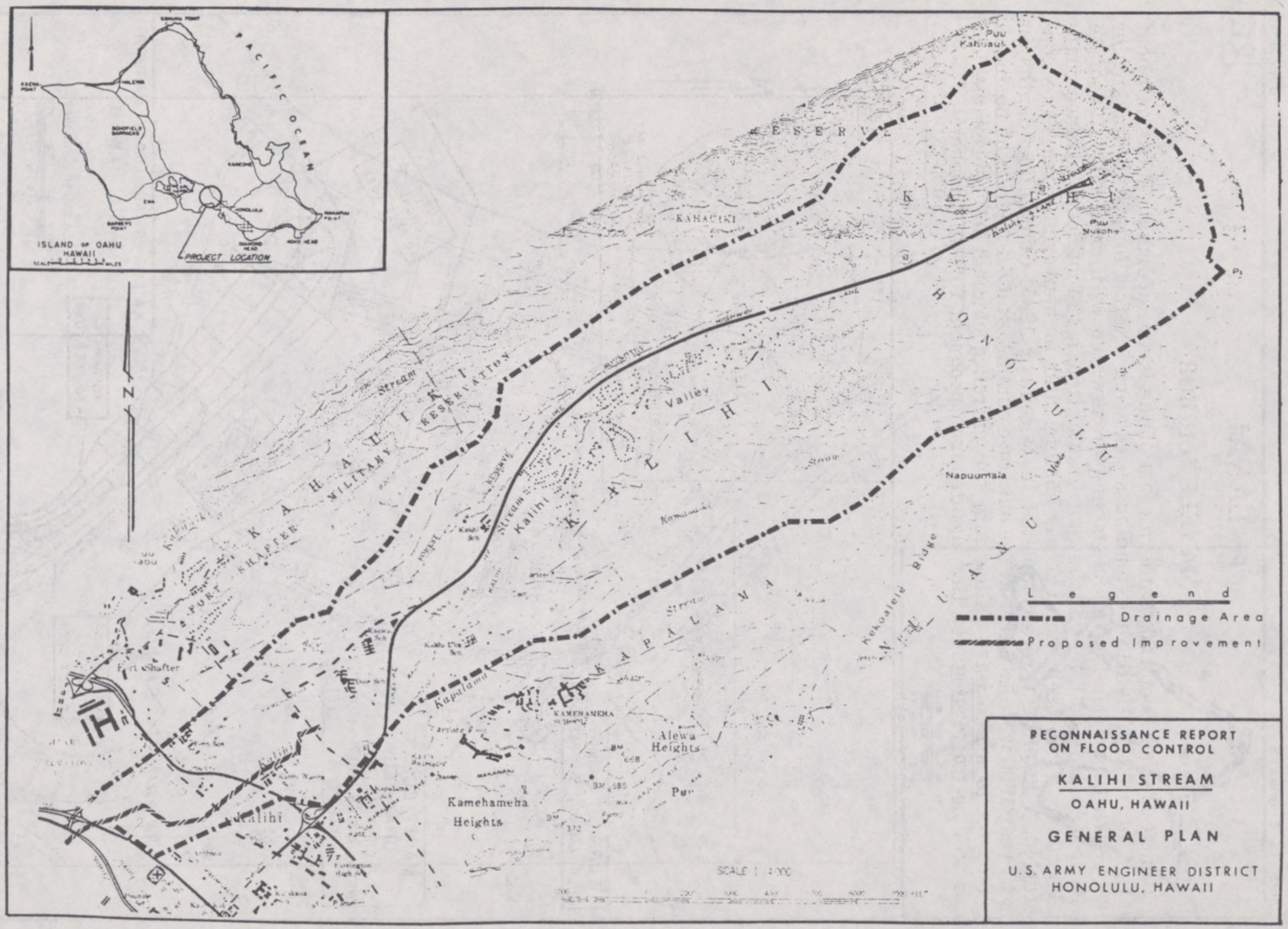
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS

U.S. ARMY

22




PACIFIC OCEAN
KAENA POINT
MAKAPUU POINT
DIAMOND HEAD
HONOLULU
PROJECT LOCATION
ISLAND OF OAHU
HAWAII
N
KAHAUKI
KALIHI
RESERVATION
KAHAU
MILITARY
RESERVE
Stream
Kalihi
Valley
Aiea
Puu
Kahiauli
Puu
Nukoha
Napuumaia
Kekoaleia Ridge
KAPALAMA
Kapalama
Stream
Fort Shafter
FORT SHAFTER
MILITARY
RESERVATION
KAMEHAMEHA
SCHOOL
Alewa
Heights
Kamehameha
Heights
Kalihi
SCALE 1 : 4800
Legend
Drainage Area
Proposed Improvement
RECONNAISSANCE REPORT
ON FLOOD CONTROL
KALIHI STREAM
OAHU, HAWAII
GENERAL PLAN
U.S. ARMY ENGINEER DISTRICT
HONOLULU, HAWAII

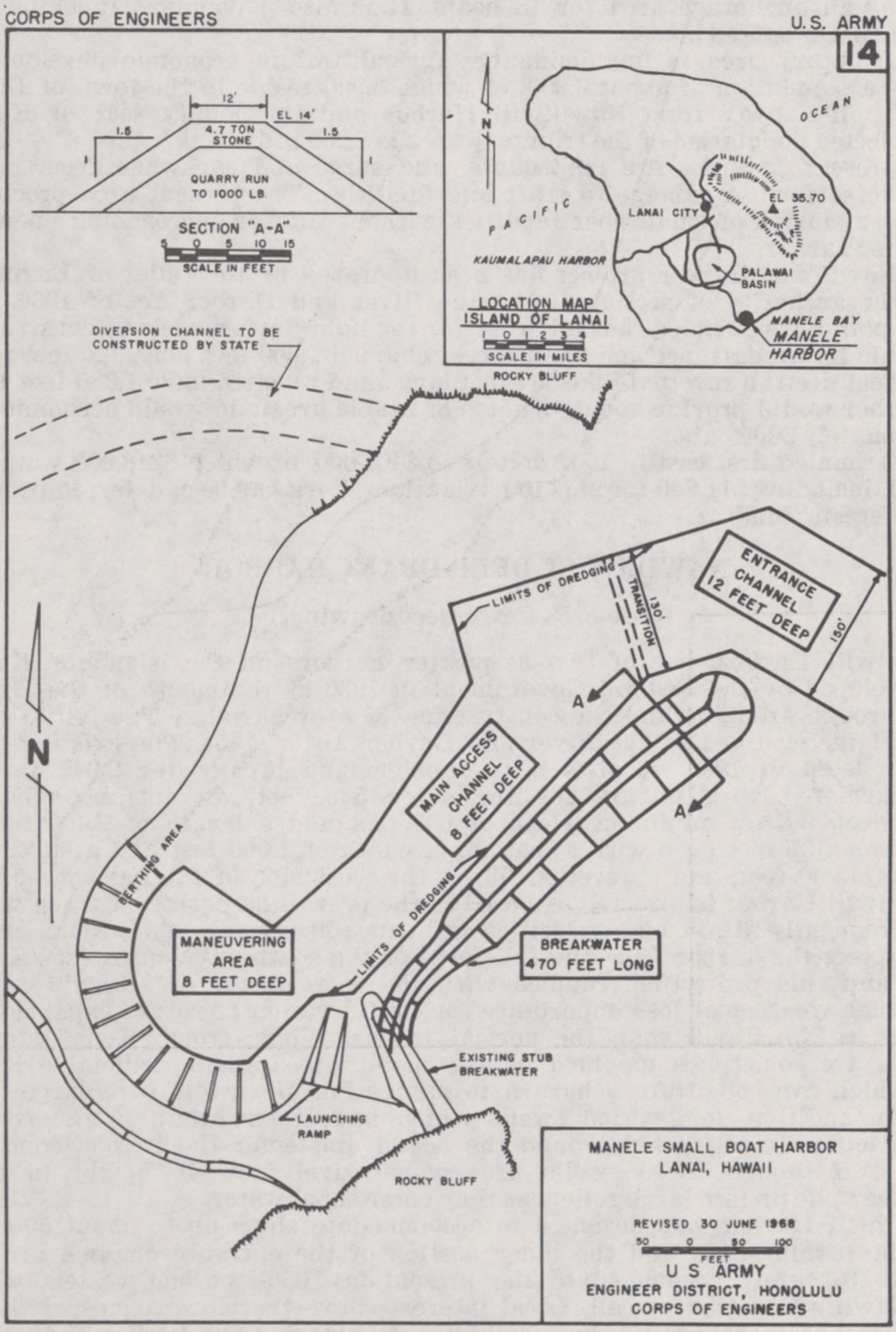
74

LANAI

MANELE HARBOR

Manele Harbor is on the southern coast of the island of Lanai. This small boat harbor project consisted of extending an existing 100-foot-long stub breakwater by constructing a 470-foot rubble-mound breakwater with crest elevation of 14 feet at the head and 6 feet at the root. In addition, a 12-foot-deep entrance channel and an 8-foot-deep main access channel and maneuvering area were constructed. The project was completed in December 1965. Controlling depths in fiscal year 1966 were 10.5 feet in the entrance channel and 5.4 feet in the basin.

Two rocks which have fallen into the entrance channel have been marked and will be removed under the maintenance program for this harbor.



KAUAI

NAWILIWILI SMALL BOAT HARBOR

(See p. 82 for project drawing.)

The proposed small boat harbor is in the westernmost portion of the bay and would be protected from storm waves by the adjacent existing coral fill area and the Nawiliwili Harbor breakwater. Nawiliwili deepwater harbor presently serves as an anchorage area for 18 boats. It is also a popular launching site for 45 trailer-mounted boats.

The tributary area is predominantly agricultural in economic development and has a population of about 6,300, of which 3,900 reside in the town of Lihue, about 2 miles away from Nawiliwili Harbor and the county seat of Kauai. The projected population of the tributary area is 8,200 in 1980.

The present facilities are inadequate, and surge and backwash from trans-pacific vessels cause damage to craft and facilities. The present area precludes further expansion of small boat facilities without further encroaching upon the deepwater harbor.

The Nawiliwili Harbor project has been approved by the Chief of Engineers under the authority of section 107 of the River and Harbor Act of 1960. The project plan recommended that a harbor for the light-draft vessels be constructed to provide for an entrance and main access channel 1,600 feet long, 120 feet wide, and 12 feet deep; a revetted dike 954 feet long; and revetted mole 1,380 feet long. The harbor would provide about 15 acres of usable area and would accommodate approximately 200 boats.

The estimated first cost in 1967 dollars is $401,000, of which $218,000 would be Federal, including $11,000 for aids to navigation. Work has been deferred pending local interests' funding.

NAWILIWILI DEEP-DRAFT HARBOR

(See p. 83 for project drawing.)

Nawiliwili Harbor, one of two deepwater harbors on the island of Kauai, was developed by the Federal Government in 1930 at the mouth of the Huleia River through dredging and the construction of a breakwater. The initial project was later modified by the River and Harbor Act of 1954. The existing project, completed in 1960, consists of a rubblemound breakwater 2,045 feet in length armored with tribars for the outer 545 feet, an entrance channel 40 feet deep with a minimum width of 600 feet and a length of 2,400 feet, a harbor basin 35 feet deep with a maximum width of 1,600 feet and a maximum length of 1,950 feet, and a revetted fill on the west side of the harbor.

Nawiliwili Harbor is directely exposed to the prevailing northeast trade winds which frequently attain high velocities and cause heavy seas and swells. Mountains protect the harbor from the full force of the south and southwest "Kona" storms and this protection, coupled with the infrequency of "Kona" storms, makes such weather of less importance for consideration of future expansion of facilities at Nawiliwili than the normal trades. Winds from "Kona" storms, however, are sometimes modified by the mountains into unpredictable heavy gusts which can constitute a hazard to navigation of vessels with large "sail area." In addition, long-period swells which have their origin in the remote South Pacific are diffracted around the island and enter the harbor from the southeast. Although these swells are comparatively low in height in open water, they pile up into large rollers as they enter shoal water.

Nawiliwili Harbor was designed to accommodate ships up to about 500 feet long. The turning area and the inner portion of the entrance channel are not adequate to safely accommodate the present-day 650-foot-long vessels which make Nawiliwili a port of call. Local interests have therefore requested that a study be made to determine the feasibility of enlarging the harbor and easing

the bend in the entrance channel. A study was authorized by a U.S. House Public Works Committee resolution adopted October 5, 1966, and a U.S. Senate Committee on Public Works Committee resolution adopted September 9, 1966, to investigate the navigation problem. The study, combined with a similar study for Port Allen, Kauai, in November 1966, is partially funded with $71,500 appropriated through fiscal year 1969. Phase I of the combined study has been completed and a status report was forwarded to higher authorities in September 1968. After the review, phase II studies will be scheduled as required. About 242,000 cubic yards of shoal material were dredged in March 1968 under our maintenance program.

PORT ALLEN HARBOR

(See p. 84 for project drawing)

Port Allen Harbor is in Hanapepe Bay on the south coast of the island of Kauai. Hanapepe Bay is a coastal inlet 3,000 feet wide and 1,800 feet long. Port Allen Harbor is one of the two deepwater ports on Kauai, the other being Nawiliwili Harbor, 21 nautical miles away. The harbor is naturally sheltered from the prevailing trade winds; however, heavy swells from the open sea at times cause adverse surge conditions in the harbor basin.

The initial project, completed in 1935, provides for a rubblemound breakwater 1,200 feet long on the east side of the bay, for a dredged harbor basin 1,000 feet wide, 1,500 feet long, and 35 feet deep, and for an entrance channel 500 feet wide and 35 feet deep. The project was later modified by the River and Harbor Act of 1945 which provided for additional dredging of an area at the northern side of the existing project, 200 feet wide, 1,200 feet long, and 35 feet deep. The expansion of the basin was completed in 1948. The cost of the project as of June 1965 was $952,645 for new work, $221,374 for maintenance, or a total of $1,174,019. Local interests contributed $200,000 toward the $952,645 for the construction of the project.

Maintenance dredging by Federal hopper dredge was completed in March 1963 with the removal of 103,500 cubic yards of material. The April 1963 flood shoaled a portion of the harbor to a depth of 30 feet. The shoal area restricts the movement of ships with a draft in excess of 27 feet. About 166,000 cubic yards of the 326,000 cubic yards of material scheduled to be removed were dredged in March 1968 under the maintenance program. About 16,000 cubic yards of the 40,000 cubic yards in the State berthing area were also dredged by the Corps of Engineers. The dredge *Harding* operation schedule did not allow for completion of all necessary maintenance work.

Local interests desire construction of a second breakwater from the west side of Hanapepe Bay to alleviate the surge problem and to reduce the surge problem and to reduce erosion of the beach. House resolution, dated June 3, 1959, authorized the review of reports on Port Allen, Hawaii, published in House Document 453, 83d Congress, second session, and other pertinent reports, with a view to determining whether it is advisable at this time to modify the existing project in any way. The study, combined with a similar study for Nawiliwili, Kauai, in November 1966, is partially funded with $71,500 appropriated through fiscal year 1969. Phase I of the combined study was completed in September 1968 and a status report was forwarded to higher authority. The project will be reviewed and phase II studies scheduled as required.

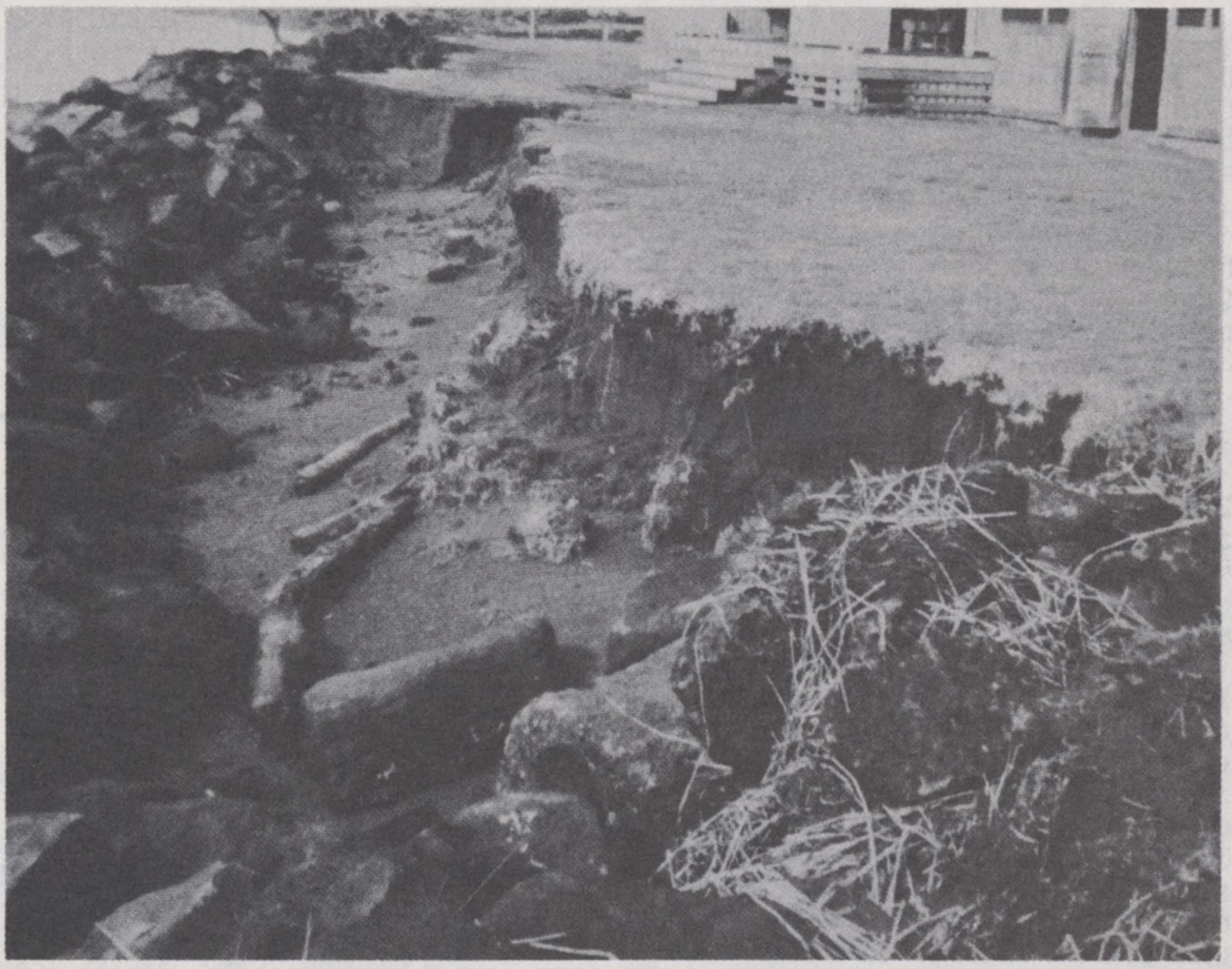
The State of Hawaii in 1962 constructed a 60-boat-capacity small boat harbor at a cost of about $400,000 on the east shores of Hanapepe Bay. The present boat population is about 30.

HANAPEPE BEACH EROSION

(See p. 85 for project drawing.)

The project, authorized by the River and Harbor Act of July 3, 1958, is described in House Document 432, 84th Congress, second session.

The project provides for Federal participation by the contribution of Federal funds in the amount of one-half of the first cost applicable to protection of the publicly owned portions of the shores at Hanapepe Bay by construction of a rubblemound seawall 1,900 feet long. The western and northern shores of the bay are publicly owned. A park whch abuts the beach has a pavilion for recreational purposes.



View of beach erosion at Hanapepe Beach

The State legislature had appropriated a total of $90,000 for the construction of this project in 1965. The State department of transportation, the cooperating agency, transferred $9,500 to the Corps of Engineers for preparation of final design, plans and specifications, and contract estimate. Plans and specifications were completed and furnished the State June 18, 1964. The cost was estimated at $134,000 with the Federal share being $65,000. The State advertised this project and opened bids on August 19, 1965. Two bids were received, the lowest being $208,000. The State by letter dated September 1, 1965, to the Honolulu district recommended rejection of all bids and readvertising later when additional funds can be made available from both the State legislature and the Federal Government. No additional funds were appropriated by the 1966 State legislature. The Honolulu district will request their portion of the cost when State funds are made available.

HANAPEPE RIVER FLOOD CONTROL

(See p. 86 for project drawing.)

The Hanapepe River and its tributaries drain an area of about 30 square miles located in the south-central portion of the island of Kauai at Port Allen. Mount Waialeale, located near the headwaters of the drainage basin, is the wettest known spot on earth with an average of over 465 inches of rainfall annually.

The authorized project provides for a 2,200-foot-long levee (including a 182-foot floodwall) and appurtenant structures along the left bank of the river, and a 4,465-foot-long levee and appurtenant structures along the right bank, both starting about one-half mile above its mouth. The left bank levee and floodwall protects 27 acres of business and residential area against floods of the Hanapepe River and the right bank levee protects 80 acres of residences and farms. The left bank levee was completed in December 1959. All construction work on the right bank was completed August 12, 1963.

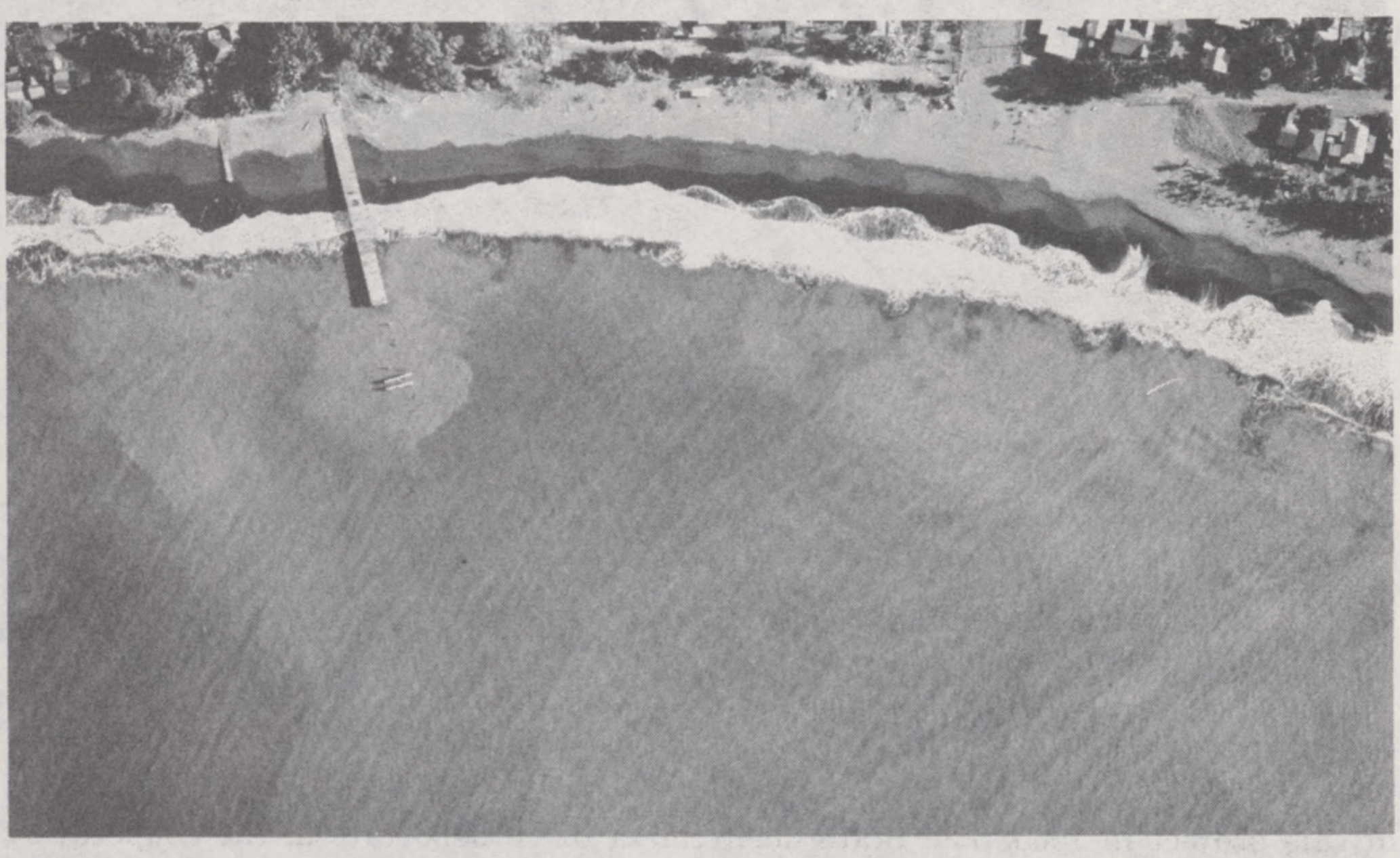
On April 15, 1963, the Hanapepe River had a discharge of approximately 44,000 cubic feet per second. This discharge exceeded the project design flood of 25,600 cubic feet per second by 75 percent, with the stage within a few inches of the completed left bank. The Chief of Engineers authorized additional construction work on this project. Both levees were increased in height an additional 3 feet

to provide additional protection against a similar occurrence of the April 1963 flood. Construction was completed in November 1966 with a total construction cost of $587,786.

WAIMEA BEACH

(See p. 87 for project drawing.)

Waimea Beach is on the southwest coast of the island of Kauai about 7 miles from Hanapepe Bay. This beach extends about a mile westward from the Waimea River along the entire ocean front of the town of Waimea. The beach is owned largely by private interests, although the public has unrestricted access to the beach through streets and a public park.



The project, authorized by the River and Harbor Act of July 3, 1958, provides for Federal participation in one-half of the first cost of, that portion of a rubble-mound seawall 1,240 feet long to protect public shores of Waimea Bay.

The project has been authorized for construction by the State of Hawaii; however, no work has been initiated.

KIKIAOLA HARBOR

(See p. 88 for project drawing.)

A study of this harbor was made under section 110 of the River and Harbor Act of May 17, 1950, which authorized the survey of the coasts of the Hawaiian Islands for light-draft vessels. This harbor is one of the three recommended in the final report which was submitted in June 1967. Kikiaola is on the southwestern coast of Kauai near the Barking Sands area and the Bonham Air Force Base. The State through the years has improved the harbor. Today about 13 small craft are moored in the basin; however, many craft are pulled up on shore near the owners' homes because of the insufficient safe and adequate harbor facilities. The best fishing grounds near Kauai are located at Barking Sands and the nearest adequate harbor is Port Allen. However, Kikiaola, if improved, would attract many boat owners.

The existing facilities consist of a rubblemound west breakwater 600 feet long, a rubblemound east breakwater 1,170 feet long, a concrete launching ramp and a groin 200 feet long within the basin. The basin area is about 5.8 acres, all at a depth ranging from 1 to 5 feet. The proposed modification would provide for removal of 130 feet of the east breakwater that extends into the proposed channel. The crest elevation of the east breakwater for a distance of 770 feet would be raised from elevation 8 feet to elevation 11 feet. A wave absorber 270 feet long with 1 on 3 side slope would be constructed between the west breakwater and groin in front of the division channel. The entrance channel would be 1,050 feet



long and vary from 120 feet wide at the seaward end to 140 feet wide inside the breakwater. The entrance channel depth would be 12 feet. The main access channel would be 630 feet long. The first 50 feet would be a transition from a 12-foot depth to a 10-foot depth. The second transition would be about 200 feet eastward. The width would be reduced from 120 feet to 80 feet and the depths from 10 to 6 feet. The 80-foot width and the 6-foot depth section would extend 330 feet in an easterly direction.

The project first cost is estimated at $517,000, of which $260,000 is Federal cost. The benefit-cost ratio is 1.8.

When the harbor is fully developed it will have a berthing capacity for 130 boats.

WAILUA RIVER

(See p. 89 for project drawing.)

The Wailua River basin of 53 square miles is on the eastern side of the island of Kauai. The basin is bounded on the west by the principal mountain divide of the island, including the summits of Waialeale and Kawaikini, and on the north and south by irregular arrangements of mountains and ridges sloping generally eastward to the Pacific Ocean. The principal tributaries of Wailua River are Opaekaa Stream, South Fork and North Fork.

A resolution adopted by the Committee on Public Works on August 16, 1950, authorized the review of reports on Waimea, Hanapepe, and Wailua Rivers and tributaries, Kauai, with a view to determine whether the recommendation should be modified in any way at the present time. Authority to study this project under

section 205 of the River and Harbor Act of 1948, as amended, was granted by the Chief of Engineers on September 24, 1958. An unfavorable report under section 205 was submitted in June 1961, since some local interests opposed the construction of a Wailua River levee. The views of the State and county were requested as to their desire to cancel the review report authorization or to place the study in a deferred category. State officials preferred to defer the survey. The county also desired deferment of the project; however, they requested that the plan of improvement include the Opaekaa levee and a jetty at the mouth of Wailua River. The Chief of Engineers in his letter dated April 16, 1962, to Senator Fong stated that the jetty would not reduce large, long-duration floods and therefore no further studies would be made until the Wailua River levee is accepted by local authorities.

At that time, the studies indicated a possible feasible project. The first cost was estimated at $562,000, of which $400,000 was Federal.

The proposed plan of improvement essentially consisted of the Opaekaa levee and channel 2,370 feet and 1,000 feet in length, respectively; an earth levee and flood wall on the right bank of Wailua River, 1,940 feet long, and a major drainage outlet to the ocean, 1,275 feet long.

A letter request for reinitiation of the study under section 205, as amended, was received from the State on July 23, 1965. Reasons furnished for the restudy were (1) that many changes and improvements have been made or are contemplated in the Wailua River area; and (2) that past local opposition to the project can be overcome in view of this. This study is scheduled to be completed in 1969.

HANALEI SMALL BOAT HARBOR

(See p. 90 for project drawing.)

Hanalei Bay is on the north coast of the island of Kauai, about 35 road miles from Lihue, the county seat of Kauai. The nearest light-draft harbor is 40 nautical miles away at Nawiliwili. The village of Hanalei, at the head of the bay, had a 1960 population of nearly 400, while the Hanalei judicial district, comprising the north coastal area of Kauai and the immediate tributary area of the proposed project, had a total population of 1,312. A major resort hotel was newly opened on the east side of the bay in 1961. The area is served by the Kauai Belt Highway which connects the major towns on the island. Hanalei Bay, semicircular in shape, is situated between two headlands and the entrance is about 1¼ miles wide. Depths in excess of 5 fathoms prevail at approximately 1,000 feet offshore. The Hanalei River, which has a tributary area of approximately 23 square miles, drains the valley inland from the bay on the east and south. The river enters the east side of the bay through a narrow, winding estuary. A sandy beach extends along most of the bay shoreline. Prevailing winds are from the north to the northeast and the area is subject to frequent northerly storms.

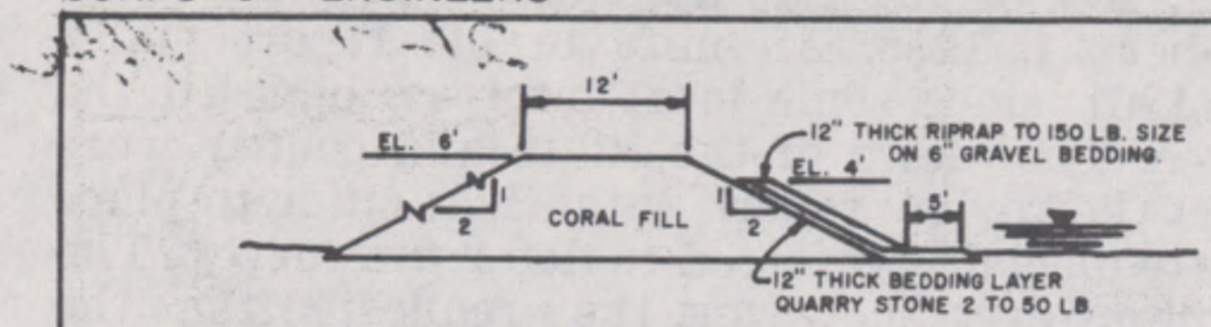
The recommended plan of improvement provides for harbor basin to be constructed by dredging entirely within the land area comprising the north end of the peninsula between the bayshore and the river estuary. A combination entrance and main access channel would extend from Hanalei Bay into the middle portion of the peninsula to serve a berthing area of approximately 5.5 acres which would accommodate about 180 boats. The total length of the channel would be 1,800 feet. The 950-foot channel inside the existing shoreline would be 100 feet wide and dredged to a depth of 12 feet. The entrance channel would extend 850 feet offshore to the existing 15-foot depth contour of the bay floor. The shoreward 200 feet of this outer channel would be 120 feet wide and 12 feet deep, while the seaward 650-foot portion would be the same width but have a depth of 15 feet. A jetty would be necessary on the south side of the entrance channel to prevent littoral drift from shoaling the channel.

The estimated total first cost of the project in 1968 dollars is $1,066,000 of which $447,000 would be borne by the Federal Government and $619,000 by local interests. The benefit-cost ratio is 1.3. The Interim Report on the Coasts of Hawaiian Islands, Harbors for Light-Draft Vessels, containing the recommendation for Hanalei small boat harbor, was published as House Document No. 353 88th Congress, second session. The project is currently unfunded.

CORPS OF ENGINEERS

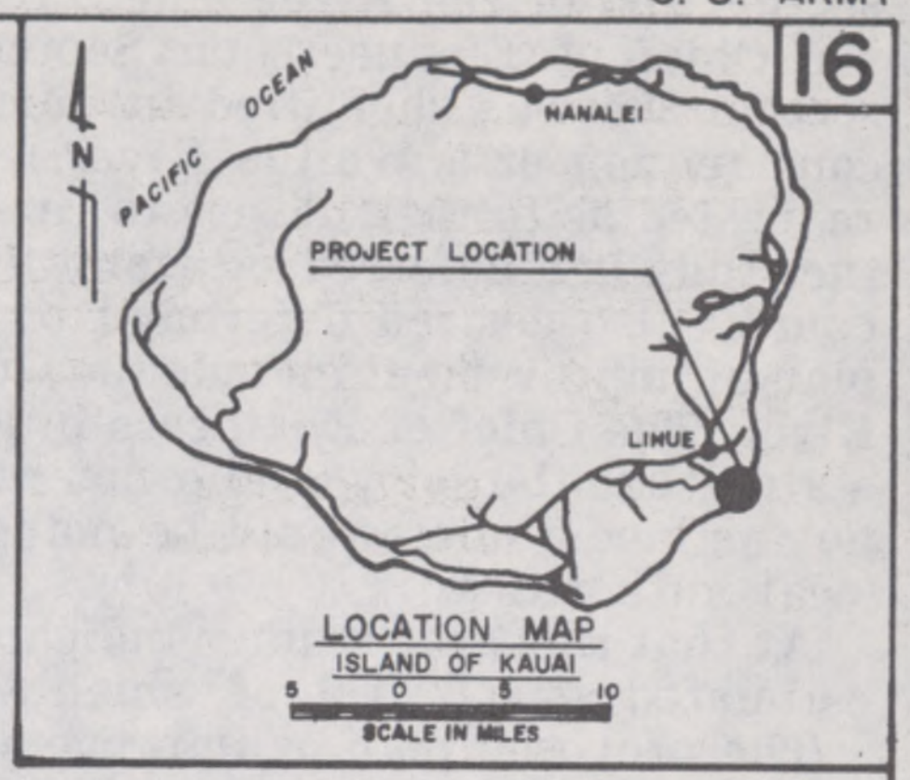
U. S. ARMY

16

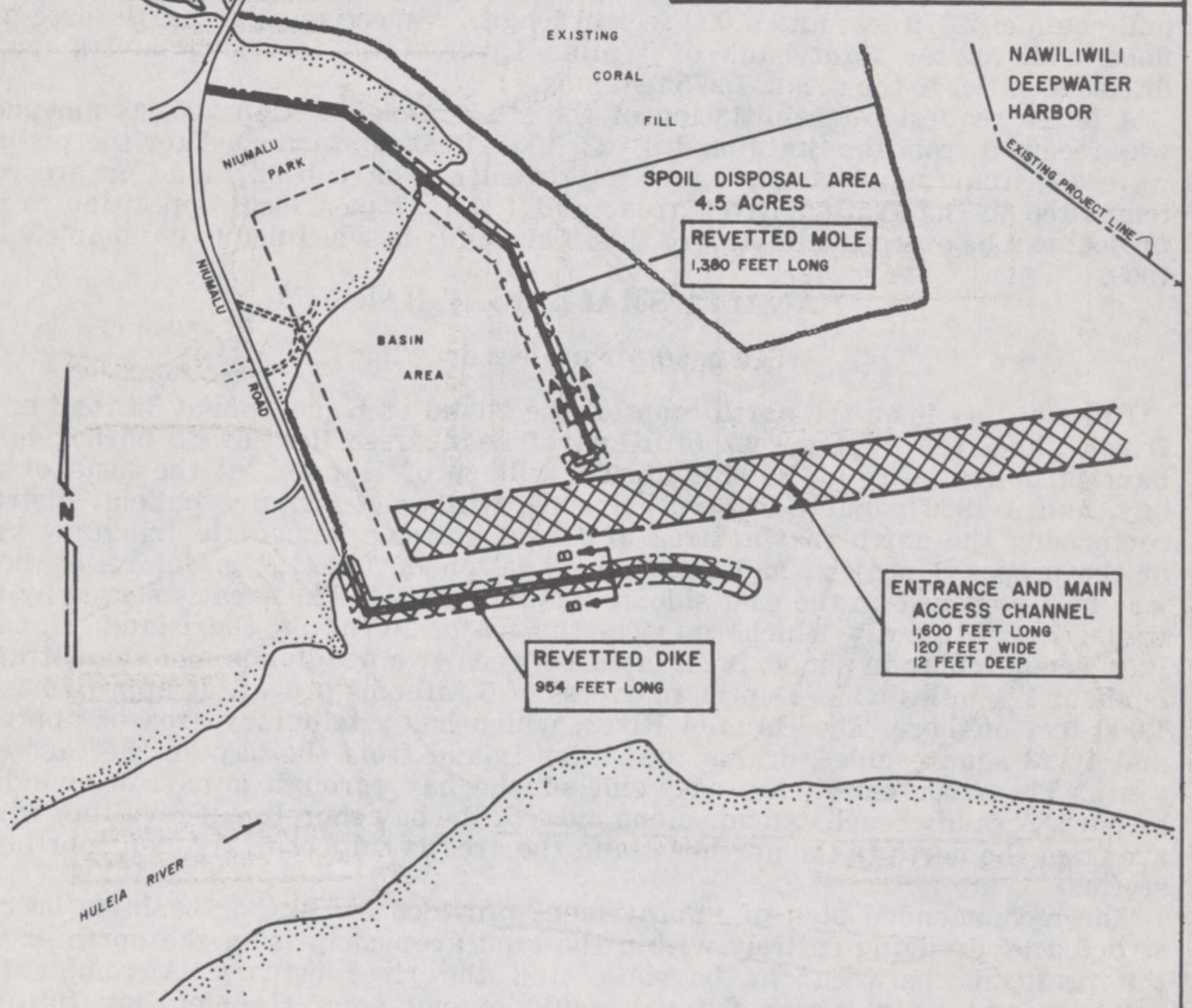


A-A TYPICAL MOLE SECTION - TRUNK

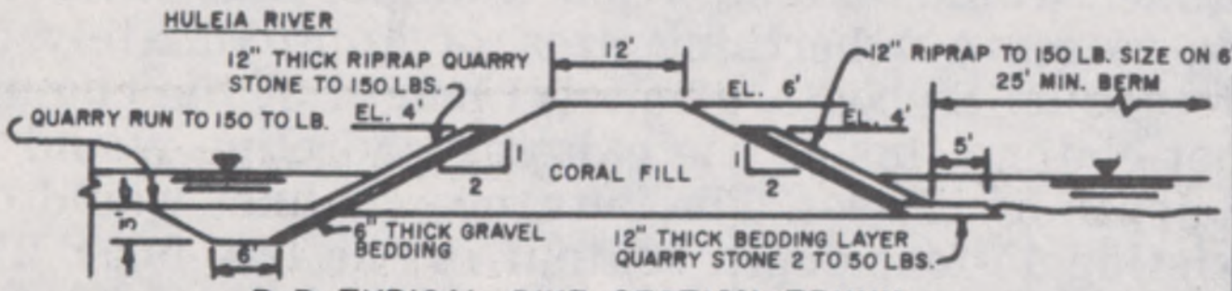
100 0 100 200
SCALE IN FEET



LOCATION MAP
ISLAND OF KAUAI
5 0 5 10
SCALE IN MILES



HULEIA RIVER



B-B TYPICAL DIKE SECTION - TRUNK

100 0 100 200
SCALE IN FEET

ELEVATIONS AND DEPTHS BASED ON MLLW

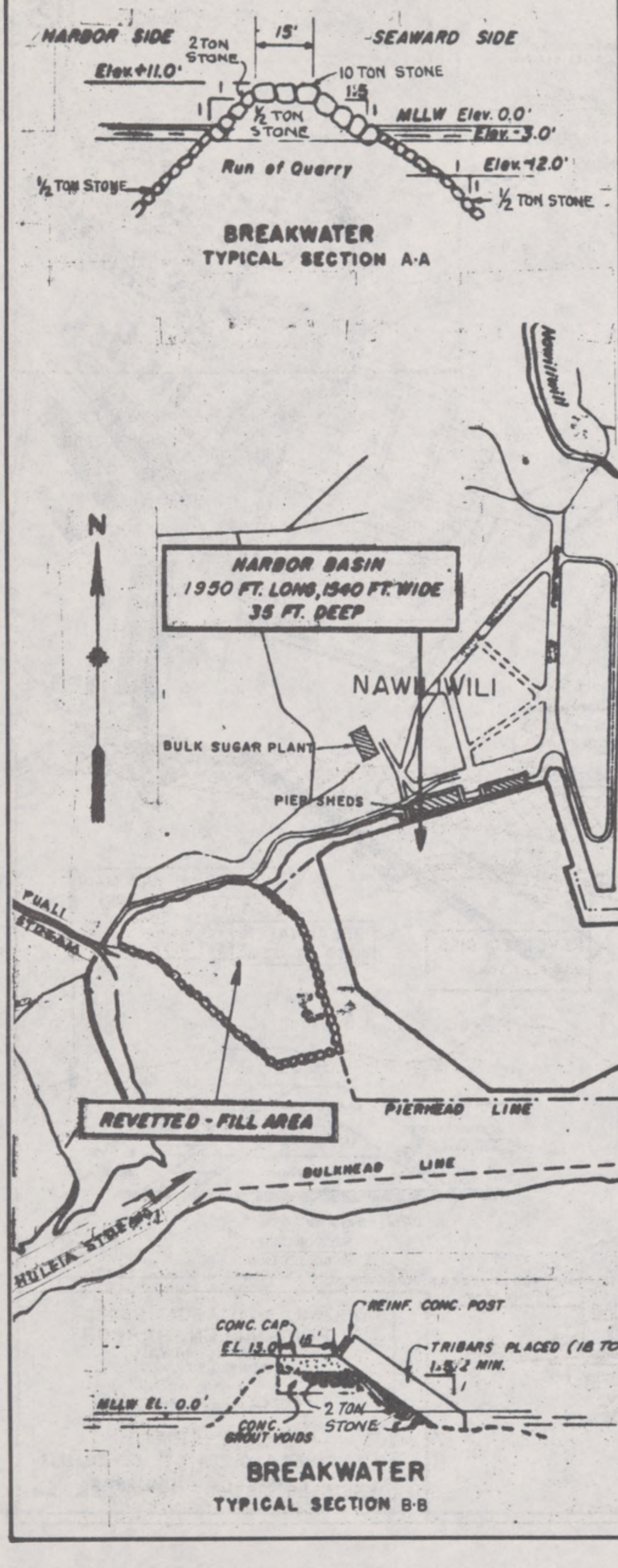
NAWILIWILI SMALL BOAT HARBOR
KAUAI, HAWAII

REVISED 30 JUNE 1967

100 0 100 200
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

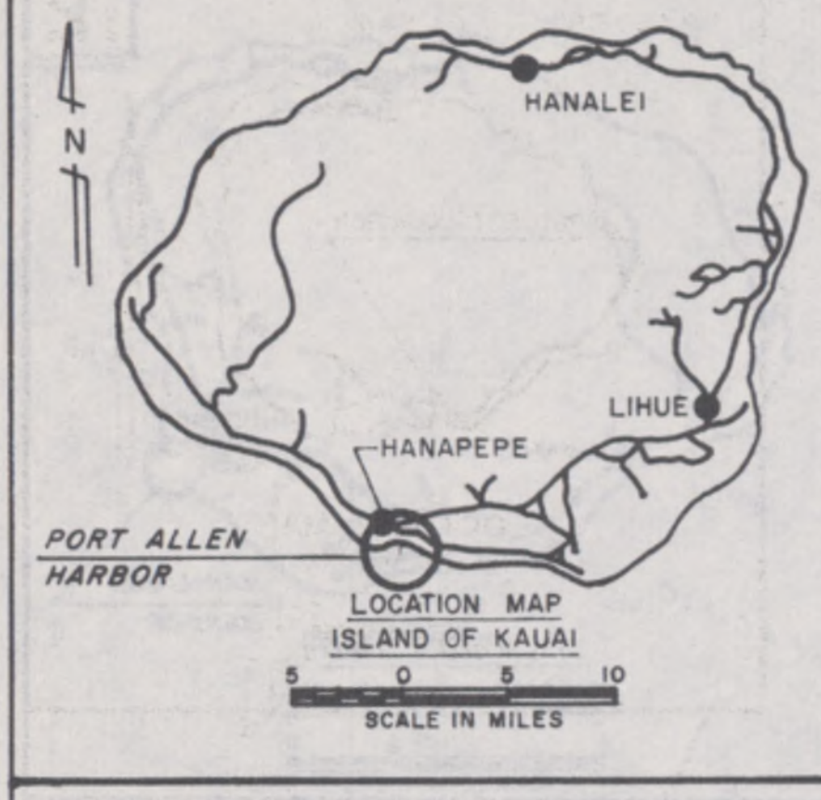
CORPS OF ENGINEERS U.S. ARMY



CORPS OF ENGINEERS

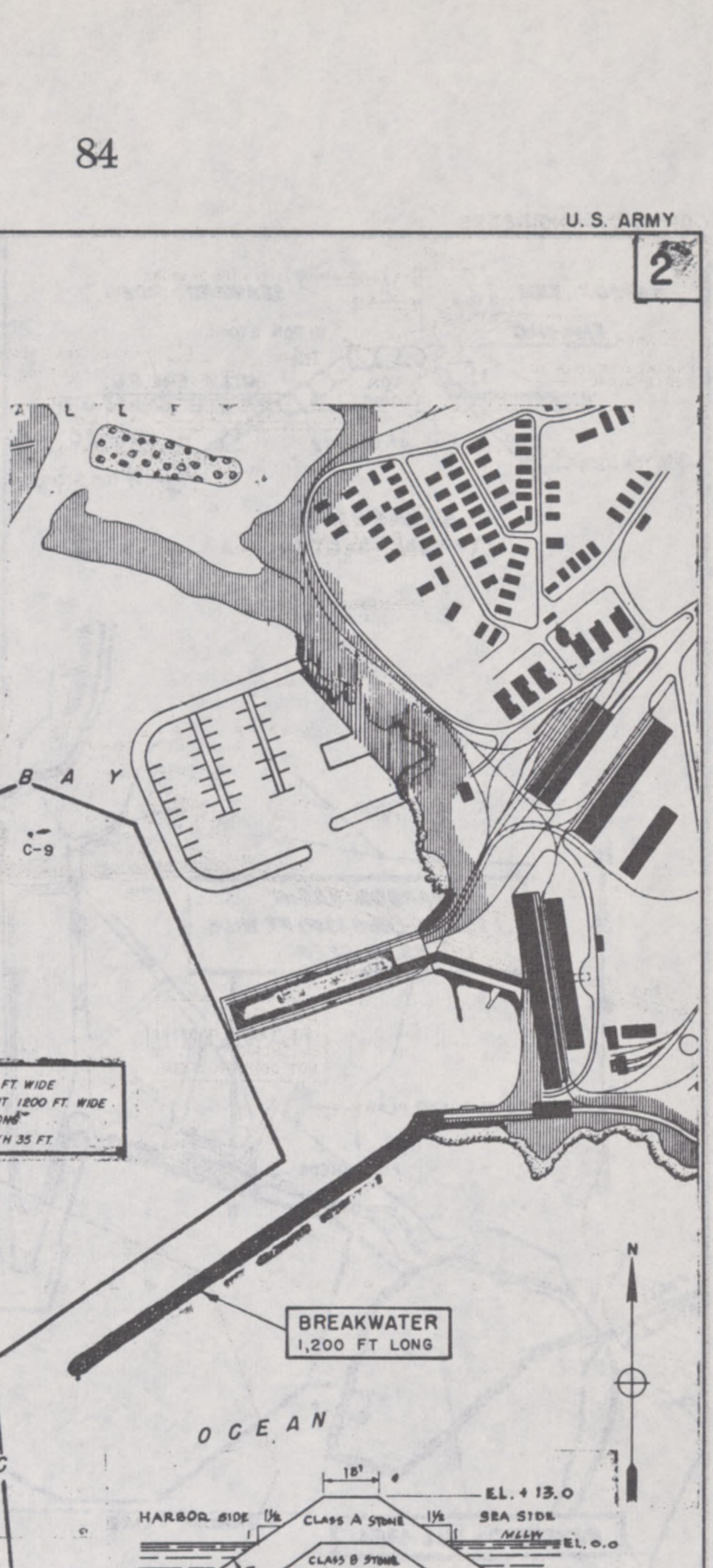
U. S. ARMY

2

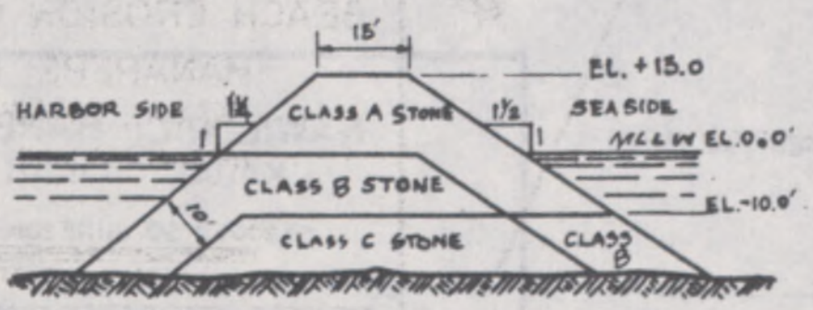


LOCATION MAP
ISLAND OF KAUAI

5 0 5 10
SCALE IN MILES



STA. 10+50 TO STA. 12+00
BREAKWATER
TYPICAL SECTION



STA. 0+00 TO STA. 10+50
BREAKWATER
TYPICAL SECTION

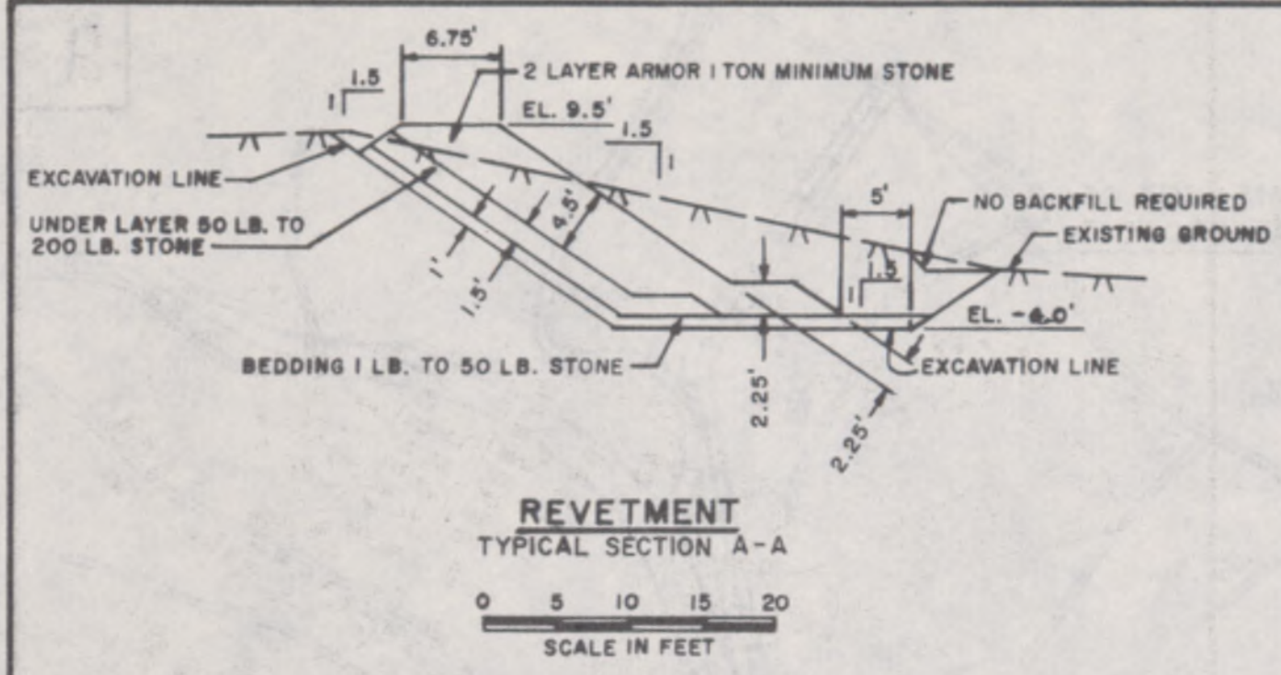
PORT ALLEN HARBOR
KAUAI, HAWAII
REVISED 30 JUN 67

SCALE IN FEET
100 0 100 200 300 400 500

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

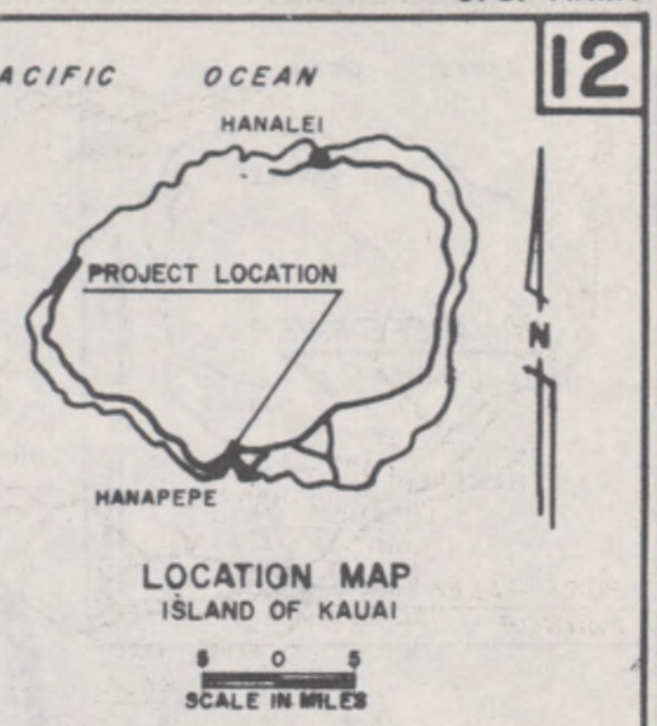
CORPS OF ENGINEERS

U.S. ARMY



REVETMENT
TYPICAL SECTION A-A

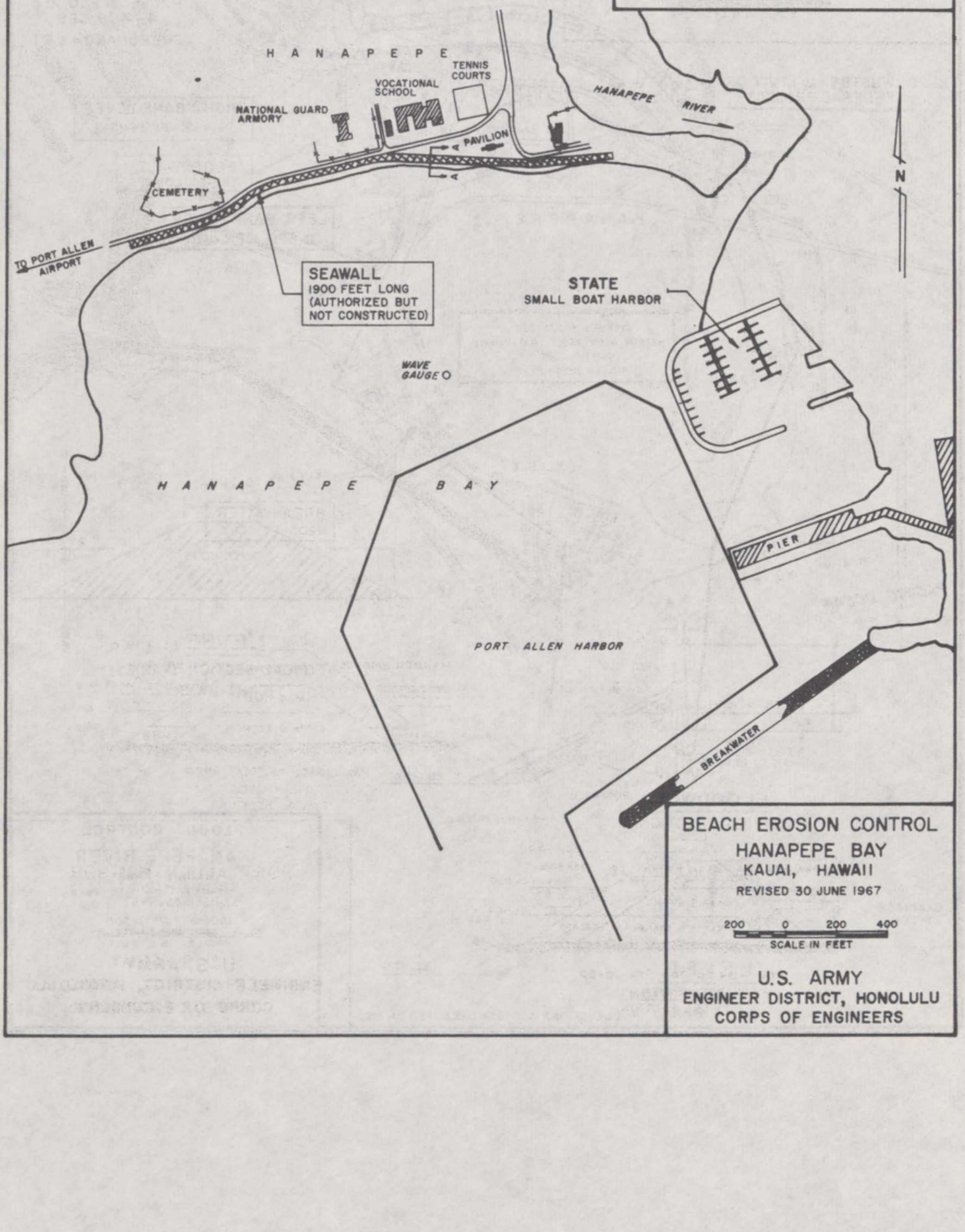
0 5 10 15 20
SCALE IN FEET



LOCATION MAP
ISLAND OF KAUAI

5 0 5
SCALE IN MILES

12



BEACH EROSION CONTROL
HANAPEPE BAY
KAUAI, HAWAII
REVISED 30 JUNE 1967

200 0 200 400
SCALE IN FEET

U.S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS U. S. ARMY

1

PACIFIC OCEAN

HANALEI

HANAPEPE RIVER

WAIMEA

LIHUE

HANAPEPE

LOCATION MAP
ISLAND OF KAUAI

5 0 5
SCALE IN MILES

N

UPSTREAM LIMIT OF FEDERAL PROJECT

1.2 MI.

1.0 MI.

0.8 MI.

PROJECT FLOOD = 44,400 CFS
FREEBOARD = 3 FT

0.6 MI.

DOWNSTREAM LIMIT OF FEDERAL PROJECT

RIVER

RIGHT BANK LEVEE
4,465 FT. LONG

FLOODWALL
185 FT. LONG

LEFT BANK LEVEE
2,200 FT LONG

HANAPEPE

0.4 MI.

HANAPEPE HARBOR

0.2 MI.

ELEELE

BELT HWY TO LIHUE

10'

2

1

IMPERVIOUS FILL

0.0 MI.

HANAPEPE BAY

PACIFIC OCEAN

TO PORT ALLEN

12"

EL. 10.0'

2'-6"

6" DRAIN TILE

12'-6"

2'-6"

IMPERVIOUS FILL

3'-0"

12"

RIPRAP

18"

GRADED FILL

STEEL PILING
16.0 FT LONG

2'-0"

EXISTING ROCKWALL

EL. -3.0'

GRANULAR FILL

FLOODWALL
TYPICAL SECTION

LEVEE
TYPICAL SECTION (VARIES)
RIGHT BANK

9'

CAST-IN-PLACE WALL

2'

1.5

DRAINAGE DITCH

IMPERVIOUS FILL

GRANULAR FILL

12"

RIPRAP

18"

EL.-3.0'

LEVEE
TYPICAL SECTION
LEFT BANK

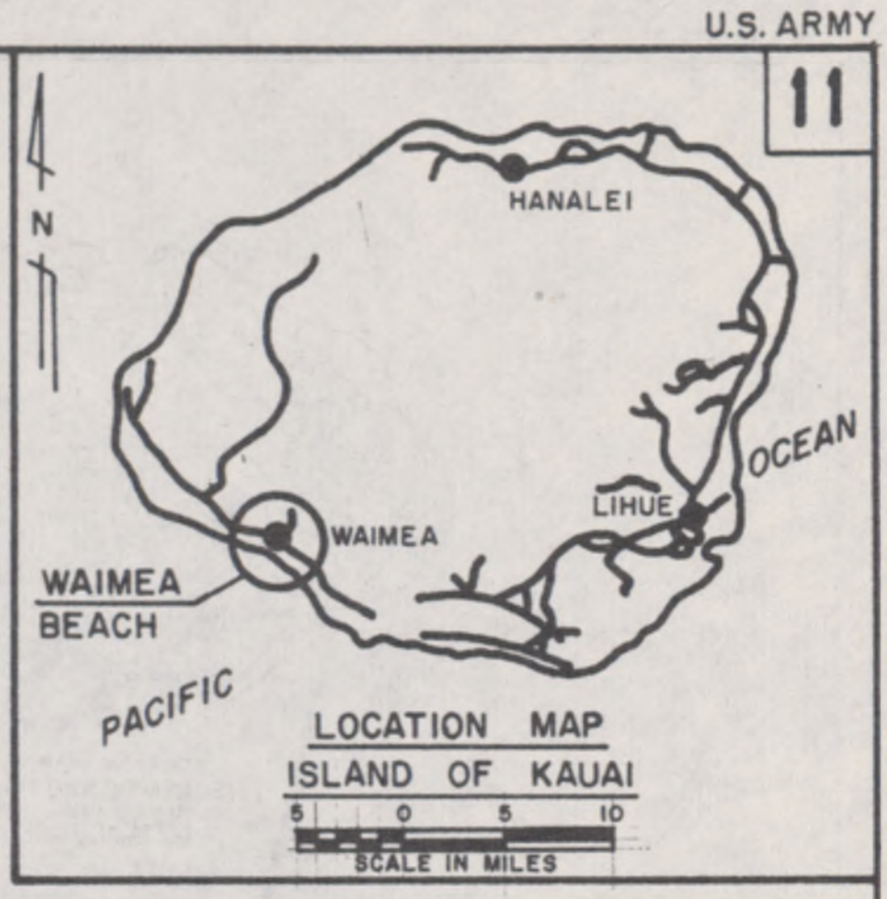
ELEVATIONS AND DEPTHS BASED ON MSL

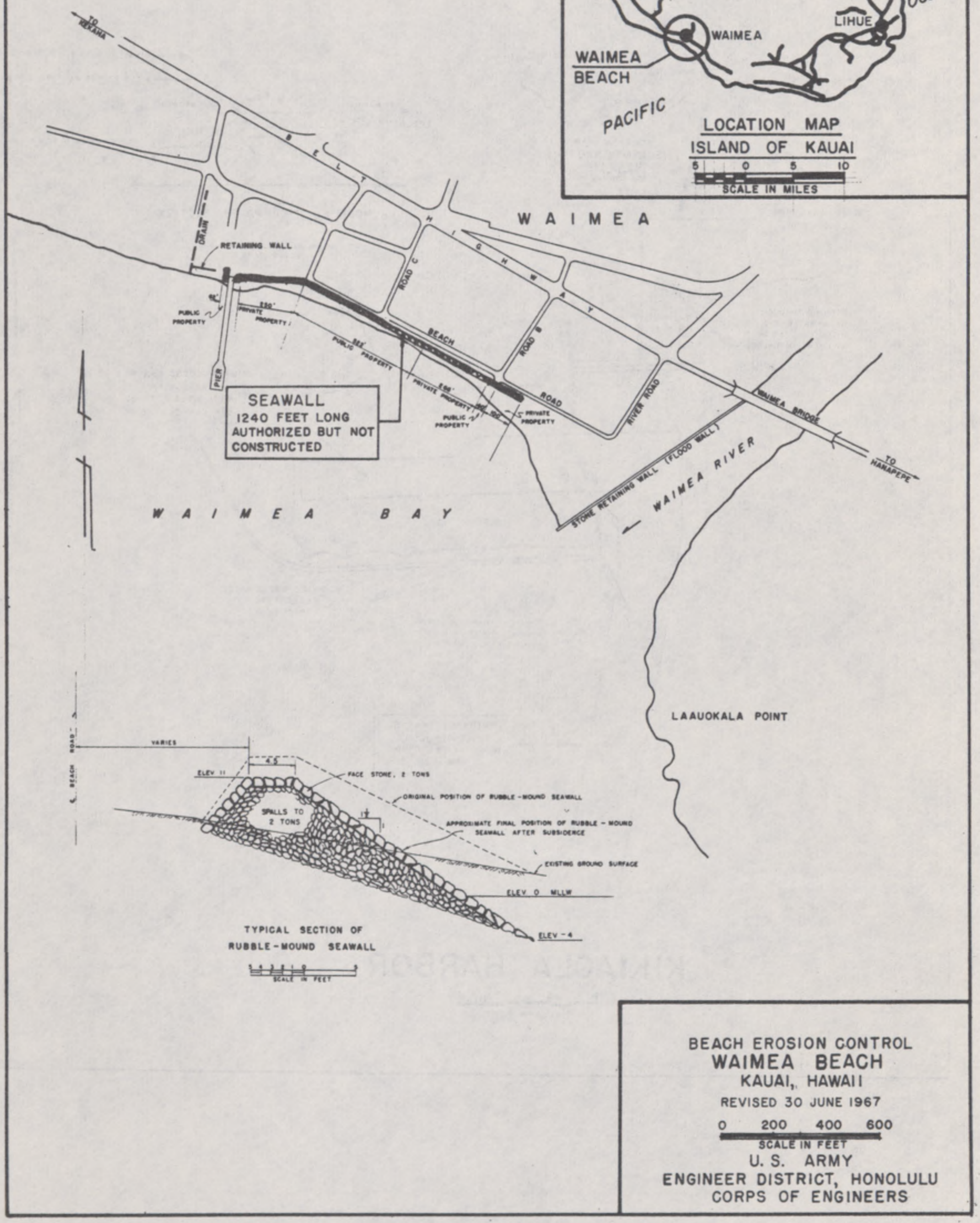
FLOOD CONTROL
HANAPEPE RIVER
KAUAI, HAWAII
REVISED 30 JUNE 1968

100 0 500
SCALE IN FEET

U S ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

CORPS OF ENGINEERS U.S. ARMY





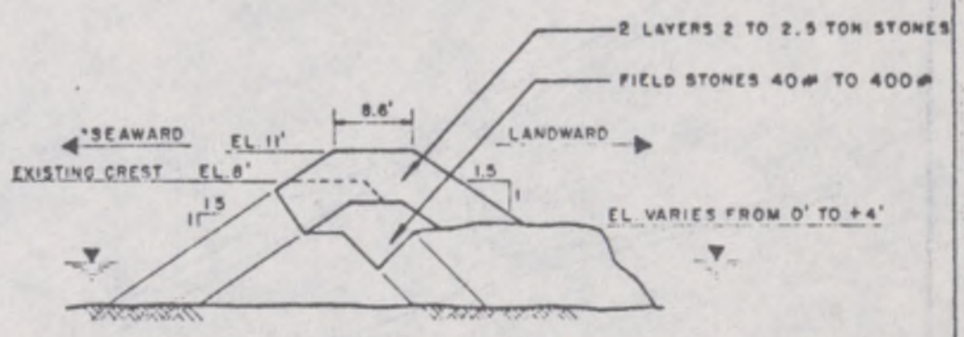
BEACH EROSION CONTROL
WAIMEA BEACH
KAUAI, HAWAII
REVISED 30 JUNE 1967
0 200 400 600
SCALE IN FEET
U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

21-793 O—69——7

CORPS OF ENGINEERS

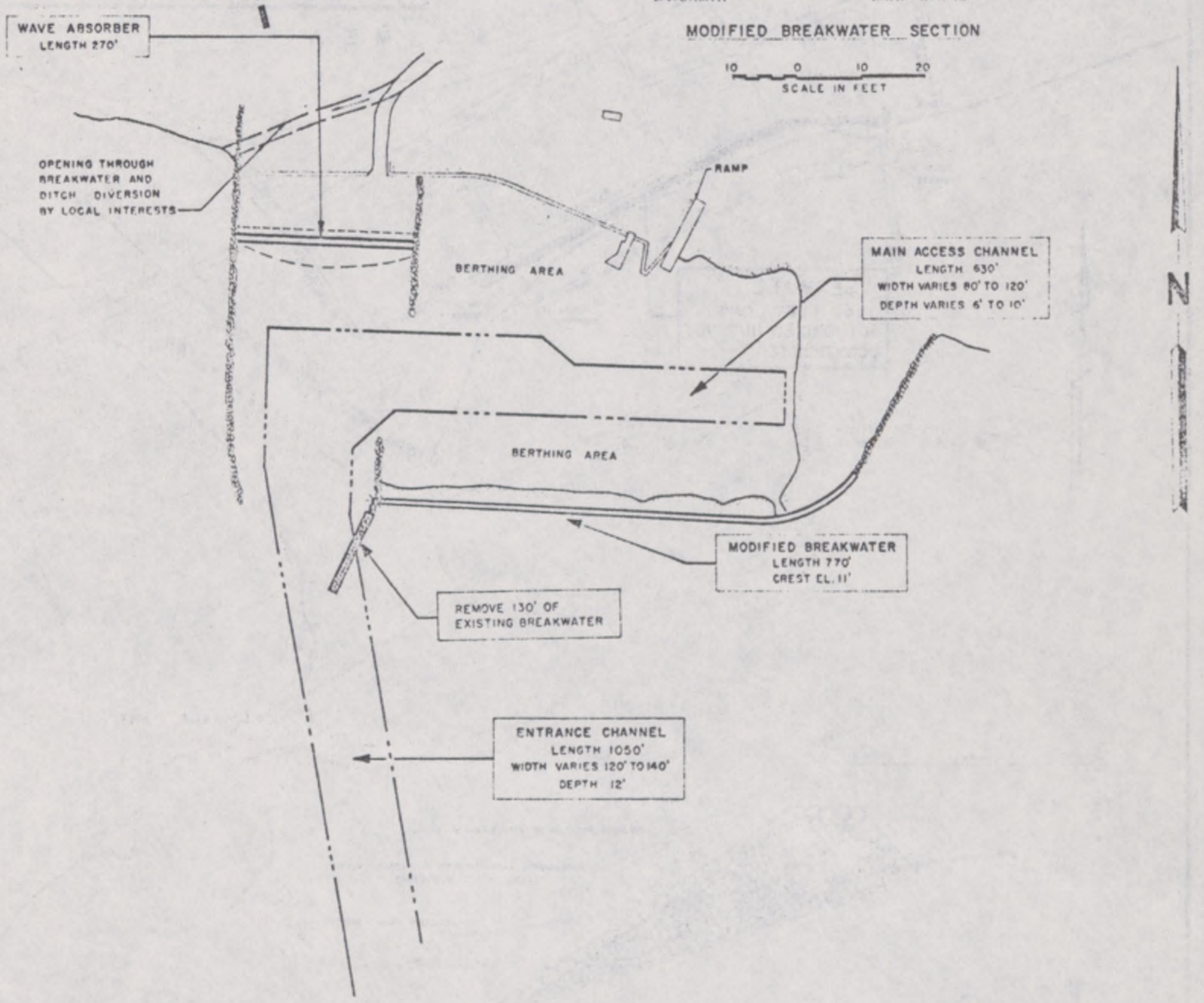


LOCATION MAP
ISLAND OF KAUAI
0 1 2 3 4 5
SCALE IN MILES



MODIFIED BREAKWATER SECTION

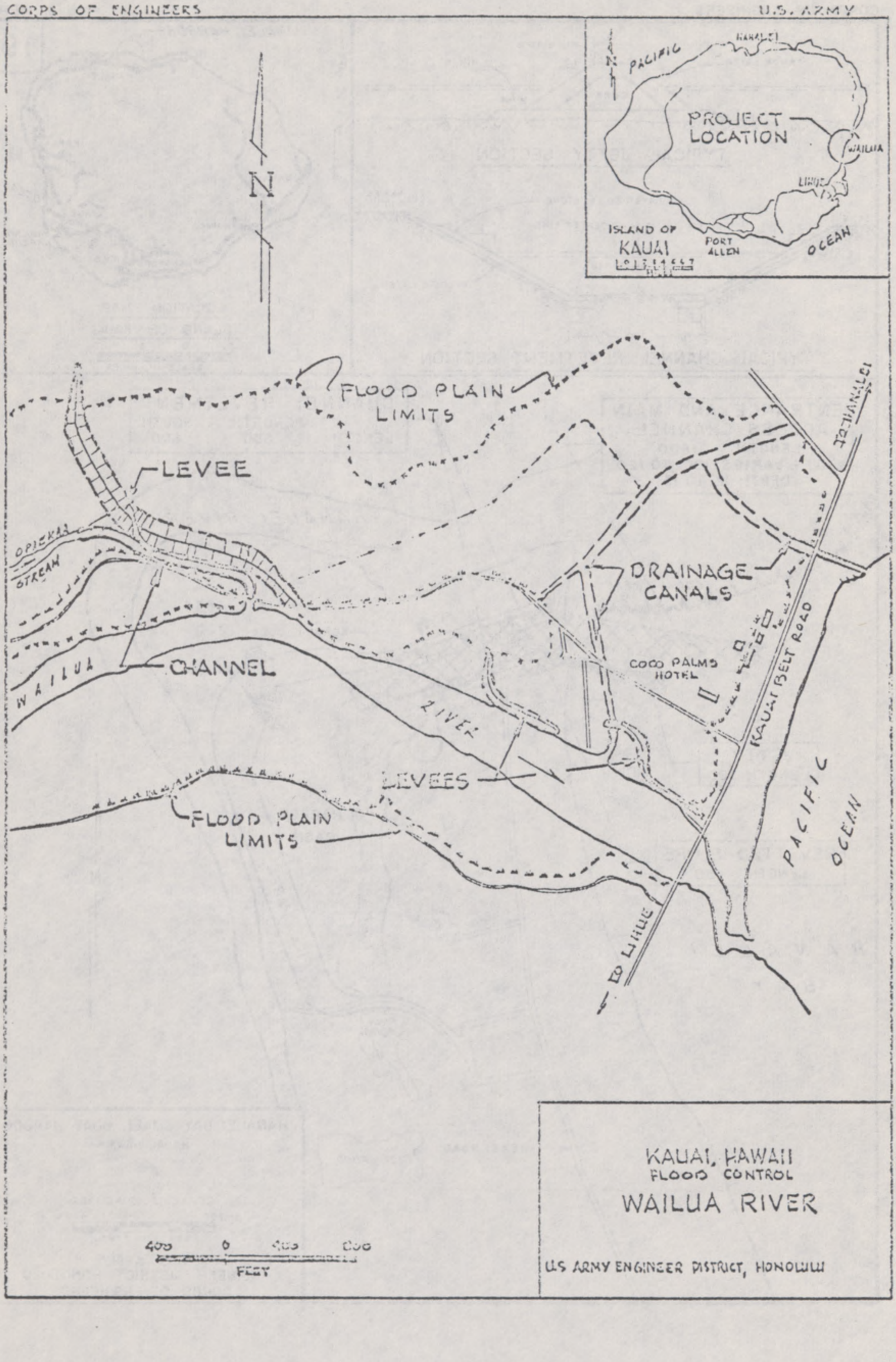
10 0 10 20
SCALE IN FEET



KIKIAOLA HARBOR

100 0 100 200
SCALE IN FEET

CORPS OF ENGINEERS U.S. ARMY

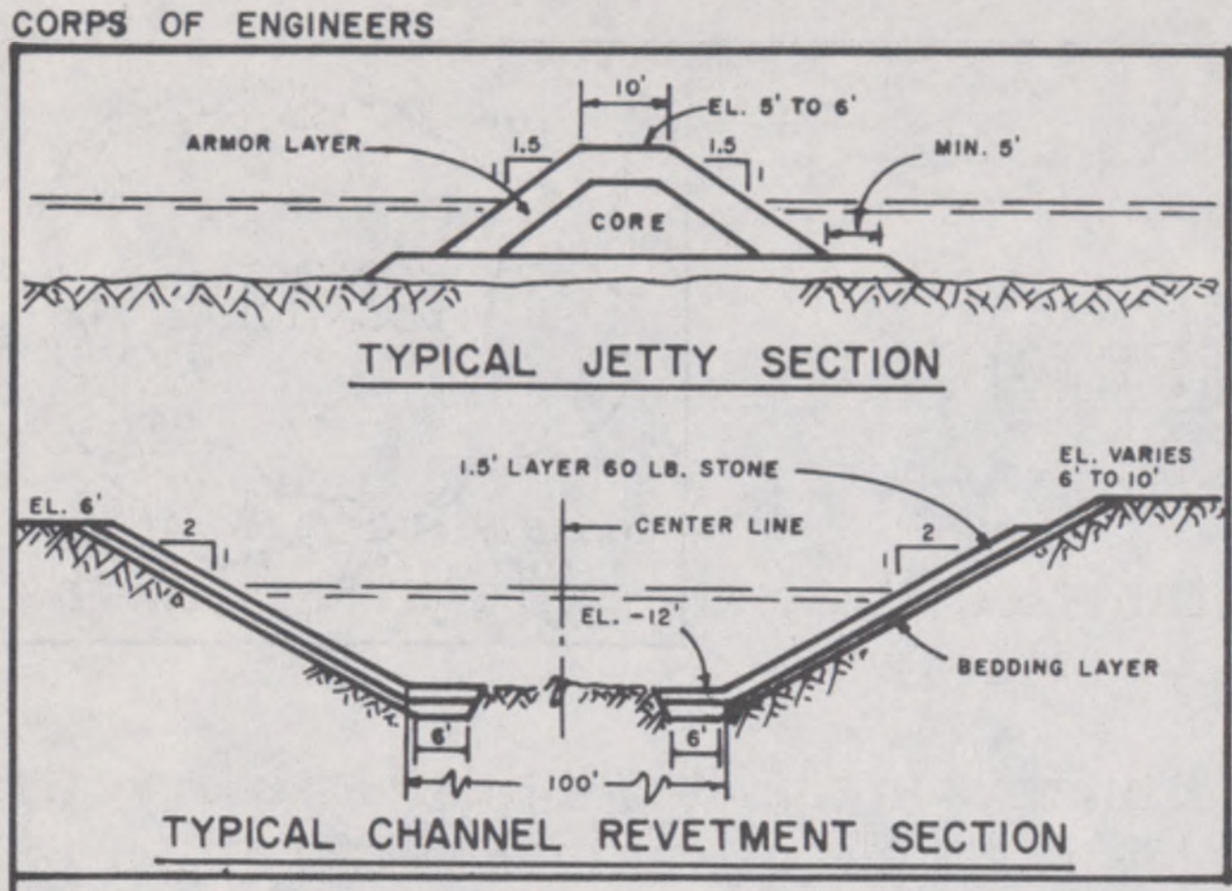


KAUAI, HAWAII
FLOOD CONTROL
WAILUA RIVER

U.S ARMY ENGINEER DISTRICT, HONOLULU

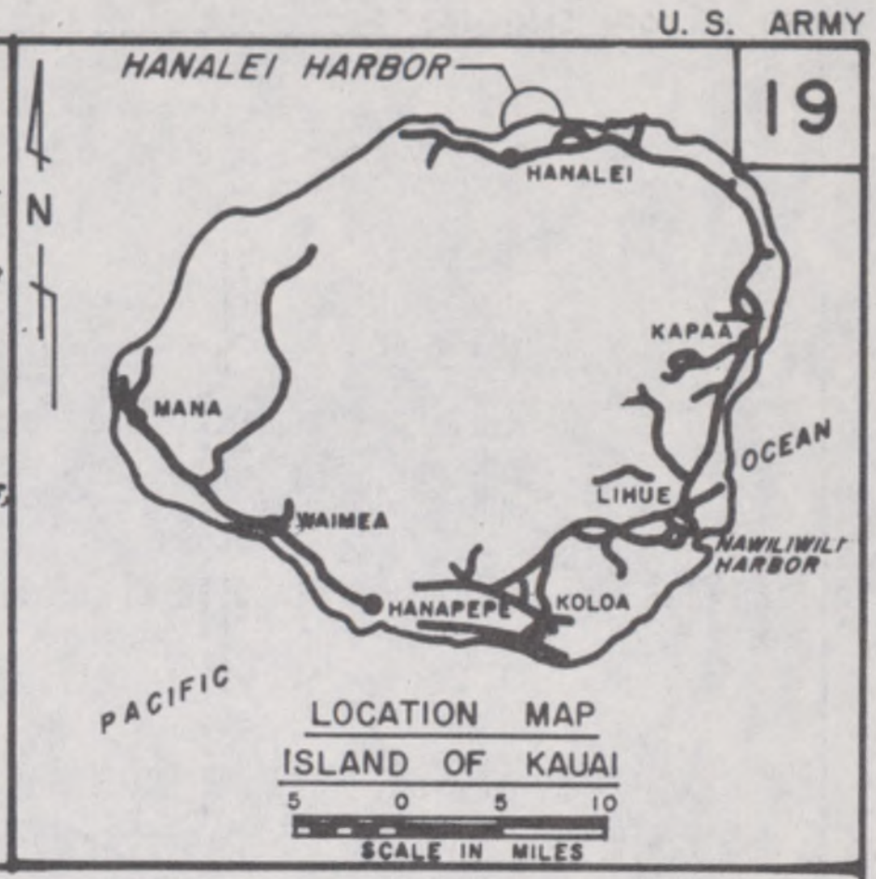
CORPS OF ENGINEERS

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TYPICAL JETTY SECTION

TYPICAL CHANNEL REVETMENT SECTION

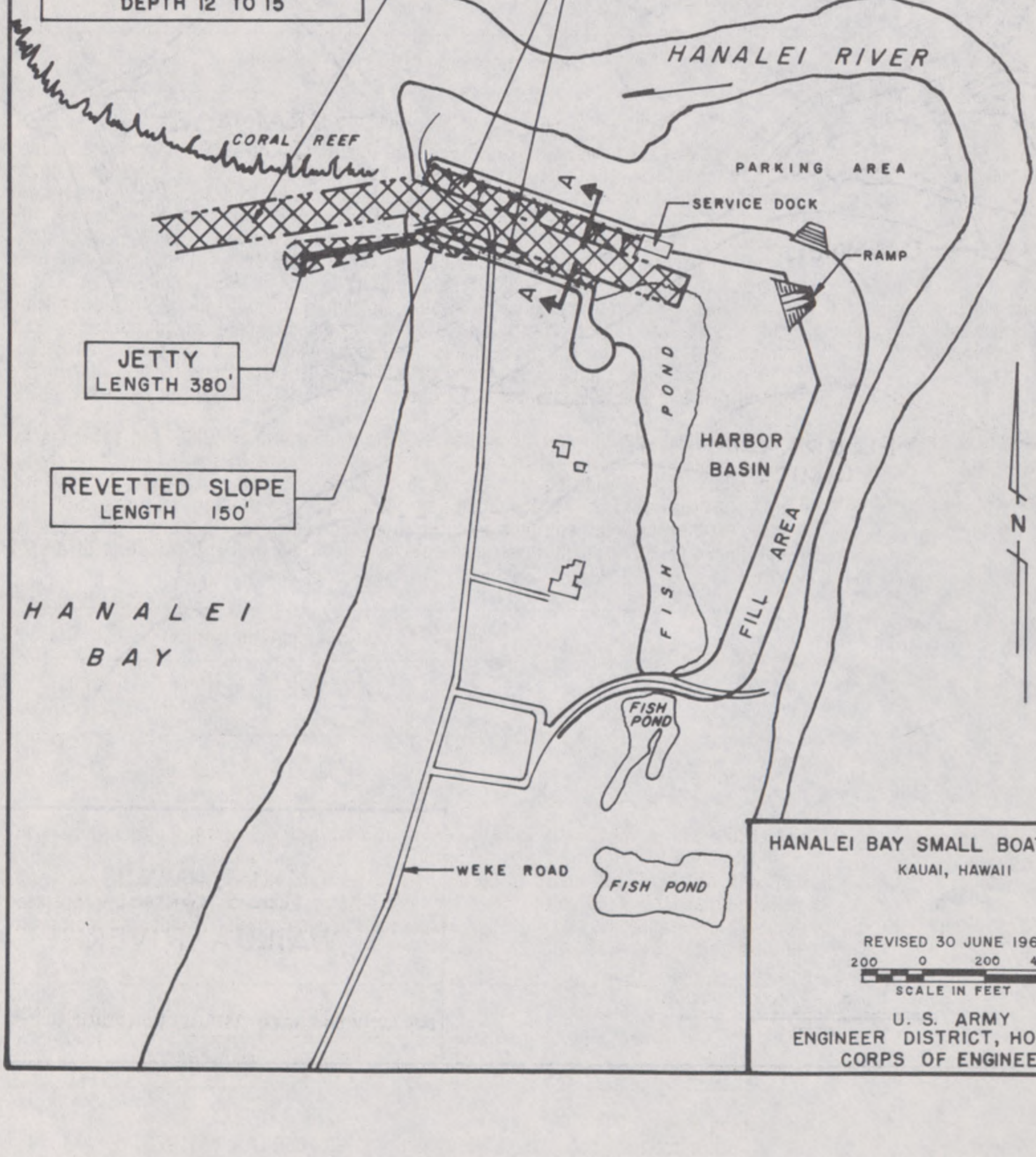


LOCATION MAP
ISLAND OF KAUAI
5 0 5 10
SCALE IN MILES

ENTRANCE AND MAIN ACCESS CHANNEL
LENGTH 1800'
WIDTH VARIES 100' TO 120'
DEPTH 12' TO 15'

CHANNEL REVETMENT

	NORTH	SOUTH
LENGTH	850'	600'



HANALEI BAY SMALL BOAT HARBOR
KAUAI, HAWAII

REVISED 30 JUNE 1967
200 0 200 400
SCALE IN FEET

U. S. ARMY
ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS

APPENDIX II

Status of Uncompleted Authorized Projects and Surveys in the State of Hawaii

A review of the projects and surveys in the Honolulu district reveals that the following have not been completed. A brief description of each project and survey and the status as of October 1, 1968, follows:

HONOLULU ENGINEER DISTRICT CIVIL WORKS PROGRAM

UNCOMPLETED AUTHORIZED PROJECTS

Item	Description and status, Oct. 1, 1968
A. Navigation:	
1. Kaunakakai Harbor, Molokai.	This project was authorized by the River and Harbor Act of 1962. Plans for a deep-draft harbor are indefinite since construction of this project is contingent upon construction of industrial facilities (pineapple cannery). The authorizing document is published as H. Doc. 484, 87th Cong., 2d sess. A design memorandum for the associated small-boat harbor was completed and approved July 30, 1965. Construction of the small-boat harbor cannot be scheduled until the State is in a position to furnish the necessary local funds.
2. Hilo Harbor Tsunami and navigation project, Hawaii.	The Hilo Harbor Tsunami project has been postponed indefinitely or until such time as the State of Hawaii is willing to provide firm assurances of cooperation. As a remedial measure, the breakwater has been repaired. On Apr. 22, 1968, a construction contract was awarded to the firm of Healy Tibbitts Construction Co. in the amount of $99,410 for repair of the breakwater. Work was completed on July 22, 1968.
3. Honolulu Harbor, Oahu.	This project was authorized by the River and Harbor Act of 1965 and provides for deepening of Honolulu Harbor and widening Kapalama Channel. The authorizing document is published as H. Doc. 93, 89th Cong., 1st sess. To date, $75,000 has been appropriated for preconstruction planning. The design memorandum has been rescheduled for completion later in fiscal year 1969 to permit the State to complete project coordination on the sewer relocation and the selection of a spoil area.

Site	1st costs (thousands)			
	Total	Federal	Non-Federal	Benefit-cost ratio
Honolulu Harbor	$5,330	$2,710	$2,620	5.9

4. Barbers Point Harbor, Oahu.	This project was authorized under the River and Harbor Act of 1965 and provides for construction of a new deep-draft harbor and adjacent small-boat harbor with a capacity of about 300 boats to be located at Barbers Point, Oahu. The report was published as H. Doc. 93, 89th Cong., 1st sess. To date, $268,000 has been appropriated for advance engineering and design. Model testing is complete. The design memorandum is under preparation.

Site	1st costs (thousands)			Benefit-cost ratio
	Total	Federal	Non-Federal	
Barbers Point:				
Deep draft	$17,580	$15,660	$1,920	1.5
Small boat	295	115	180	8.6

HONOLULU ENGINEER DISTRICT CIVIL WORKS PROGRAM—Continued

Item	Description and status, Oct. 1, 1968

5. Kawaihae Harbor, Hawaii.

This project was authorized under the River and Harbor Act of 1965. It provides for modification to the existing Kawaihae Harbor by widening the entrance channel, enlarging the deep-draft harbor an additional 18 acres, and constructing a small-boat harbor with a capacity of about 300 boats. The report was published as H. Doc. 75, 89th Cong., 1st sess. Model testing at the waterways experiment station was completed in December 1966. The design memorandum was published in March 1968 and approved by OCE in June 1968. In September, the State requested that the small-boat harbor be relocated outside the deep-draft basin. Additional design studies will now be required.

Site	1st costs (thousands)			Benefit-cost ratio
	Total	Federal	Non-Federal	
Kawaihae:				
Deep draft	$2,040	$2,018	$22	2.0
Small boat	180	96	84	8.8

6. Honokahau Harbor, Hawaii

This project was authorized under the River and Harbor Act of 1965 which provides for construction of a light-draft vessel harbor at Honokahau Bay on the Kailua-Kona coast of the island of Hawaii. The authorizing document is published as H. Doc. 68, 89th Cong., 1st sess. The design memorandum was approved by OCE in March 1968. In June 1968, a construction contract was awarded to Stewart-Pacific in the amount of $1,988,974.33 for the authorized Federal project and portions of the State berthing area. The total Federal cost is $808,068. Construction is proceeding on schedule.

7. Maunalua Harbor, Oahu

This project was authorized by the River and Harbor Act of 1965 and provides for construction of a protected harbor basin of approximately 44 acres with a berthing capacity for about 950 craft. The project report was published in H. Doc. 353, 88th Cong., 2d sess. To date, $32,000 has been appropriated for advance engineering and design studies. Preparation of the design memorandum draft is awaiting coordination with the State on their recent master plan of this area.

Site	1st costs (thousands)			Benefit-cost ratio
	Total	Federal	Non-Federal	
Maunalua Harbor	$1,486	$666	$820	3.8

8. Lahaina Harbor, Maui

This project was authorized by the River and Harbor Act of 1965 and provides for construction of a new small-boat harbor with an interior basin of about 5.3 acres and a berthing capacity of about 160 craft. The project report was published in H. Doc. 353, 88th Cong., 2d sess. To date, $34,000 has been appropriated for advance engineering and design studies. Preparation of the general design memorandum has been postponed until such time as local interests reach agreement on the selection of a harbor site.

Site	1st costs (thousands)			Benefit-cost ratio
	Total	Federal	Non-Federal	
Lahaina Harbor	$901	$474	$427	1.3

9. Small-boat harbors

8 separate projects were authorized by the River and Harbor Act of 1965. The interim report on the coasts of Hawaiian Islands, harbors for light-draft vessels was published as H. Doc. 353, 88th Cong., 2d sess. An additional project at Honokahau was also authorized by the River and Harbor Act of 1965, with a report published as H. Doc. 68, 89th Cong., 1st sess. Except for Honokahau, Maunalua, and Lahaina Harbors, all projects are currently unfunded. Estimated project costs follow:

Site	1st costs (thousands)			Benefit-cost ratio	Boat capacity
	Total	Federal	Non-Federal		
Island of Kauai:					
Hanalei Bay	$1,066	$447	$619	1.3	180
Island of Oahu:					
Waianae	2,370	1,195	1,175	1.04	380
Heeia-Kea	1,039	508	531	4.8	1,600
Kailua	859	312	547	1.6	680
Island of Maui: Hana	2,361	2,127	234	1.03	70
Island of Hawaii:					
Reeds Bay (Hilo)	656	320	336	1.9	270

3 additional separate projects were authorized by the River and Harbor Act of 1968: Kikiaola Harbor, island of Kauai; Ala Wai Harbor, island of Oahu; and Maalaea Harbor, island of Maui. The final report "Coast of the Hawaiian Islands, Harbors for Light-Draft Vessels" was published as H. Doc. 353, 90th Cong., 2d sess. These projects are currently unfunded.

HONOLULU ENGINEER DISTRICT CIVIL WORKS PROGRAM—Continued

Item	Description and status, Oct..1, 1968				
	1st costs (thousands)				
Site	Total	Federal	Non-Federal	Benefit-cost ratio	Boat capacity
Island of Kauai:					
Kikiaola	$517	$260	$257	1.8	117
Island of Oahu:					
Ala Wai	1,114	579	535	5.3	[1] 425
Island of Maui:					
Maalaea	724	475	249	2.3	[1] 200

[1] Number of additional berths provided by this authorization.

10. Nawiliwili small-boat harbor, Kauai. This project was authorized in May of 1964 under the sec. 107 authority. The plan of improvement consists of an entrance channel, dike, and mole to provide a usable area of 15 acres and accommodations for 200 boats. The estimated cost in 1967 dollars is $401,000 of which $218,000 is Federal, including $11,000 for aids to navigation. Local interests will provide $183,000. The benefit-cost ratio is 2.8. Construction is pending local interests' funding.

11. Kewalo Harbor, Oahu.. This project, authorized in September 1968 under the sec. 107 authority, would reduce cross currents at the entrance channel and surge within the harbor basin by providing for construction of 3 wave absorbers, 1 beginning at the seaward end and extending shoreward along the northwest side of the entrance channel, another extending along the entire length of the southeast side of the channel, and a 3d, 230-ft. long absorber in the southeast corner of the basin. The estimated 1st cost of the project is $270,000 of which $162,000 would be borne by the Federal Government and $108,000 by the State. The average annual benefits are $13,000 and the average annual charges are $12,000, resulting in a benefit-cost ratio of 1.1. Plans and specifications are scheduled to be completed in 1969.

B. Beach erosion:

1. Waikiki Beach, Oahu... This project was authorized by the River and Harbor Act of 1965 and provides for beach widening and groin construction in the reach between the Elks Club and Duke Kahanamoku Beach in lieu of the previously authorized project. The report was published as H. Doc. 104, 89th Cong., 1st sess. The estimated net Federal cost in 1968 dollars is $3,050,000 and the non-Federal cost is $1,610,000. The benefit-cost ratio is 14.6. The State is authorized to construct the Kuhio Beach segment and receive credit therefor toward the non-Federal cost. Federal funds for advance engineering and design have not been provided for the remaining portions of the beach; however, authority has been granted to accept State funds on a reimbursable basis to begin advance design and plans and specifications. The State is continuing with the design of the Kuhio Beach segment and they plan to award a construction contract scheduled for late 1968.

2. Waimea Beach, Kauai. This project was authorized under the River and Harbor Act approved on July 3, 1930, as amended, and supplemented. It provides for Federal participation in ½ of the cost of that portion of a seawall to protect public shores. The report was published as H. Doc. 432, 84th Cong., 2d sess. The project has been authorized for construction by the State; however, no work has been initiated.

3. Hanapepe Beach, Kauai. This project was authorized by the River and Harbor Act approved July 3, 1958, and provides for Federal participation in about ½ of the estimated total cost of $310,000 of a seawall to protect public shores. The report was published as H. Doc. 432, 84th Cong., 2d sess. The Honolulu district completed plans and specifications in June 1964 with funds advanced by the State. Construction by the State has been deferred indefinitely because bids openedi n August 1965 exceeded the total State and Federal funds available.

4. Kihei area, Maui..... This project, authorized in September 1968 under sec. 103 of the 1962 River and Harbor Act, as amended, would protect the beach at Kalama Park by providing for construction of a 25-ft.-wide berm the length of the park, protected by a stone revetment approximately 3,000 ft. long, armored with 1,500-lb. stone placed on a 1 on 2 side slope. The estimated 1st cost of the project is $474,000, of which $237,000 would be borne by the Federal Government and $237,000 by the State of Hawaii and county of Maui. The average annual benefits are $23,400 and the benefit-cost ratio is 1.1. Preparation of plans and specifications is underway.

C. Flood control:

1. Kuliouou Stream, Oahu. This project was authorized for construction under sec. 205 of the 1948 Flood Control Act and provides for improving the existing stream by underwater excavation, concrete lining a major portion of the existing stream, adding supplemental walls on the banks of the existing improved trapezoidal channel, and construction of a rectangular reinforced concrete lined ditch 7 ft. wide to separately convey interior drainage downstream of Kalanianaole Highway. Local interests are required to replace 2 bridges and relocate utilities. The project was readvertised for construction on June 7, 1968, and bids were opened on July 11, 1968. There was 1 responsive bid by James W. Glover, Ltd., in the amount of $1,595,000. This bid was accepted and a contract was awarded on Aug. 28, 1968. Local interests requested that the contract include construction of bridges and relocation of utilities. Construction is underway and proceeding as scheduled.

HONOLULU ENGINEER DISTRICT CIVIL WORKS PROGRAM—Continued

Item	Description and status, Oct. 1, 1968
2. Iao Stream, Maui	This project, authorized by the Flood Control Act of 1968, provides for a debris basin located approximately 3 miles upstream from the mouth of Iao Stream and channel improvements (consisting of levees, slope protection, channel lining and realinement) through the town of Wailuku to the ocean. The final report "Iao Stream, Maui, Hawaii" was published as H. Doc. 151, 90th Cong. 1st sess. The total estimated 1st cost of the project is $1,923,000 of which $240,000 will be non-Federal. The annual maintenance of the project is to be borne by local interests and is estimated to be $14,500. This project is currently unfunded.

GENERAL INVESTIGATIONS—SURVEY REPORTS

A. Navigation:	
1. Kahaluu deep-draft harbor, Oahu.	This study was authorized by the River and Harbor Act of 1960 to determine the feasibility of a deep-draft harbor at Kahaluu, Oahu. This study has not been funded.
2. Maalaea area deep-draft harbor, Maui.	This study is to determine the feasibility of a deep-draft harbor for either Lahaina, Maalaea, or Kalepolepo areas of Maui under the combined authorities of the River and Harbor Act of 1960 and House resolution of 1960 and 1951. The study is fully funded with $100,000 appropriated through fiscal year 1969. The study was initiated in December 1965 and a public hearing was held on Feb. 24, 1966. This study is scheduled for completion in mid-fiscal year 1970.
3. Hilo Harbor, Hawaii	This study was authorized by House resolution of May 9, 1957, to determine the feasibility of the harbor modification, especially in regard to enlargement and surge reduction. A 1-year wave gaging study has been contracted with the University of Hawaii at a cost of $23,400. The study is partially funded with $35,000 appropriated through fiscal year 1969.
4. Port Allen and Nawiliwili Harbors, Kauai.	The study of Port Allen Harbor was authorized by House resolution of June 3, 1959, and Nawiliwili Harbor by House resolution of Oct. 5, 1966, and Senate resolution of Sept. 9, 1966. These studies were combined in November 1966. The study was initiated in February 1966 and a public hearing was held on Apr. 14, 1966, for Port Allen. The study is partially funded with $71,500 appropriated through fiscal year 1969. Phase I of this study is complete and a status report has been submitted to higher authority for approval.
B. Flood control:	
1. Waipio River, Hawaii	This study was authorized under the Flood Control Act of 1962 and provides for a multipurpose feasibility study to determine the need for improvement and development of the stream and basins of the Waipio River, Hamakua coast area. The study is partially funded with $55,500 appropriated through fiscal year 1969. The 1st phase studies indicate a project for the Waipio Valley is economically unjustified. However, a study of the upper basin and other areas of the Hamakua coast is continuing.
2. Waimea River, Kauai	This study was authorized under the Flood Control Act of 1962 to study all aspects of development and improvement of the stream. In addition, a House resolution adopted July 6, 1949, provides for review of previous reports on Waimea River. The study has been deferred pending action on construction of the Kokee water project by the State under a Federal loan and grant.
3. Palolo and Manoa Valleys, Oahu.	This study was authorized by the Flood Control Act of 1950 and provides for a detailed analysis limited to the lower reaches of Palolo and Manoa Streams with emphasis on the Palolo-Manoa drainage canal and the Ala Wai Canal. To date $91,700 has been appropriated toward completion of this study.
4. Kaneohe-Kailua area, Oahu.	This study, authorized by the Flood Control Act of 1965, provides for determining the feasibility of providing flood protection in the Windward Oahu area. An earlier reconnaissance study was completed under the sec. 205 authority and indicated flood protection was economically feasible in the Kaneohe area. The current study was initiated in December 1965 with a public hearing held on Jan. 24, 1966. Contract work for aerial photo contour mapping and for subsurface investigations has been completed. The study is partially funded with $129,000 through fiscal year 1969.
5. Kahoma Stream, Maui	This study was authorized by the Flood Control Act of 1960. A study of this project was completed under the sec. 205 authority; however, because of cost sharing requirements, local interests formally indicated an unwillingness to provide the necessary local assurances and requested that further study be pursued under the outstanding survey authority. This study is partially funded with $8,000 through fiscal year 1969.
6. Kalihi Stream, Oahu	This study was authorized by the Flood Control Act of 1968 to determine the feasibility of providing flood control improvements. To date, the study is unfunded.
C. River basin planning: Hawaii region comprehensive plan.	A comprehensive study of Hawaii's rivers and harbors was authorized by the Flood Control Act of 1962. This study has not been funded.

GENERAL INVESTIGATIONS—FLOOD PLAIN INFORMATION REPORTS

Item	Description and status, Oct. 1, 1968
A. Flood plain information reports:	These reports provide information on floods, and identify areas subject to flooding by various magnitudes and frequencies of floods They also serve to provide general criteria for guidance in flood plain management.
1. Kihei, Maui	This study was approved on Dec. 7, 1964, and a report is currently under preparation. The scope of the study was expanded to include the entire Kihei area. Additional surveys, funded by the State, have been completed.
2. Anahola, Kauai	This study was approved on Mar. 23, 1965, and a report is currently under preparatio . The report is scheduled for publication in fiscal year 1969.
3. Pupukea-Paumalu, Oahu	This study was approved Aug. 2, 1965. The completed report will be turned over to the State of Hawaii for distribution in late 1968.
4. Kaaawa, Oahu	This study was approved Apr. 3, 1967. The study is fully funded and the report is scheduled to be completed in late 1968.
5. Waialua, Oahu	An application to conduct a study in this area received from the State of Hawaii in November 1966 has been approved. The study will be initiated in mid-fiscal year 1969.

OTHER INVESTIGATIONS, NOT SPECIFICALLY AUTHORIZED BY CONGRESS

A. Beach erosion:	
1. Kaimu Beach, Hawaii	A reconnaissance report completed under sec. 103a authority indicated the need for further detailed study. The detailed project study has been fully funded with completion of the study scheduled for 1969.
2. Pokai Bay, Oahu	A reconnaissance report under sec. 103a authority is being prepared to determine feasibility of shore protection. The study is scheduled for completion in 1969.
B. Flood control:	
1. Waimalu Stream, Oahu.	A fully funded detailed project study is being conducted under sec. 205 authority. The project is scheduled for completion in 1969.
2. Waialae-Nui, Kapakahi Streams, Oahu.	A detailed project study is being conducted under sec. 205 authority. Phase I of this project is fully funded and is scheduled for completion in 1969. At the completion of phase I studies, the project will be reviewed and phase II studies will be scheduled as required.
3. Wailupe Stream, Oahu	A fully funded detailed project study is being conducted under sec. 205 authority. The completion of this study is scheduled for 1969.
4. Aiea Stream, Oahu	A fully funded detailed project study is being conducted under sec. 205 authority. The completion of the project study is scheduled for 1969.
5. Wailua River, Kauai	A survey study on this project was authorized by House resolution dated Aug. 16 1950. However, work is currently being conducted under sec. 205 authority as amended at the request of the State of Hawaii on July 23, 1965. The report is scheduled for completion in 1969.
6. Waimano Stream, Oahu	A reconnaissance report under sec. 205 authority is being prepared to determine feasibility of flood control improvements for Waimano Stream. The study is scheduled for completion in 1969.
7. Waialae-Iki Stream, Oahu.	A reconnaissance report under sec. 205 authority is being prepared to determine feasibility of flood control improvements for Waialae-Iki Stream. The study is scheduled for completion in 1969.
8. Kalauao Stream, Oahu	A reconnaissance report under sec. 205 authority is being prepared to determine feasibility of flood control improvements for Kalauao Stream. The study is scheduled for completion in 1969.
C. Special projects:	
1. Barking Sands, Kauai	This study is being conducted at the request of the Navy to determine the feasibility of constructing a harbor and docking facilities in the area of the Barking Sands Missile Range. 4 beach-profile surveys have been made and the data are being analyzed to evaluate the littoral processes at the proposed harbor site. Coordination is being maintained through Headquarters, Pacific Missile Range, Point Mugu, Calif.
2. Collection and compilation of basic data pertinent to coastal work.	This study was initiated in August 1967 at the request of the Coastal Engineering Research Center for the purpose of developing relationships and information to improve present criteria used in planning and design of coastal works. 2 programs are now underway; the 1st is collection of basic data on littoral transport at Haleiwa, Barking Sands, Kaanapali, Kailua, and Kekaha. This 3-year program is scheduled for completion in late 1970. The 2d program consists of collection of data on coastal structures on shallow coral reefs. This program is scheduled for completion in mid-1969.
3. Hydrologic Relations in Hawaii (ES–182).	The objective of this research project is to establish criteria for hydrologic design of flood control projects and flood plain information studies. Data have been collected from a dense network of rainfall gages and one or two streamflow gages located in each of three small drainage basins in the State. The three are: Kalihi Stream—island of Oahu, Wailua River—island of Kauai, and Kohakohau Stream—island of Hawaii. Project Bulletin No. 1, printed Nov. 30, 1964, shows the preliminary results of studies in the Kalihi Basin. The final report is scheduled for completion in fiscal year 1970.
4. Hydrologic Studies (Storm Studies) Hawaiian Is.	The purpose of this continuing study is to make detailed analyses of selected Hawaiian Island storms of the past. These data are submitted to the Hydrometeorological, Section of the Weather Bureau for use in their preparation of design rainfall curves.

OTHER INVESTIGATIONS, NOT SPECIFICALLY AUTHORIZED BY CONGRESS—Continued

Item	Description and status, Oct. 1, 1968
D. Public Law 84–99 emergency repair.	In response to requests by the city and county of Honolulu, the Honolulu Engineer District conducted investigations on 7 Oahu streams damaged by the storms of Dec. 18, 1967, and Jan. 2, 1968. 5 streams were recommended for emergency repair under authority of Public Law 84–99. These are Waialae-Nui, Kapakahi, Waialae-Iki, Niu, and Hahaione, all on southeastern Oahu. The recommendations were approved by the Chief of Engineers. Construction is complete for Hahaione, Waialae-Iki, Niu, and Kapakahi Streams. Work on Waialae-Nui Stream will be complete in October 1968. As a result of floods on Mar. 13 to 17, 1968, the city and county of Honolulu requested additional investigations be made for 3 streams on Oahu. These studies were completed in April. Federal participation and emergency repair work were recommended for 1 of the streams (Moanalua Stream). The damages on the other 2 streams were of a minor nature, posing no serious threat to lives or to property; thus, Federal assistance is not warranted. The emergency repair and restoration contract for Moanalua Stream was awarded on July 18, 1968. Construction is scheduled to be complete in December 1968.
E. Kahului breakwater repair, Maui.	Repair of the west breakwater, damaged by storm waves in December 1967, was authorized by the Chief of Engineers. In September 1968, the district awarded a contract to E. T. Ige Construction, Inc., in the amount of $346,300 for the work of repair consisting of the casting and placement of about 260 19-ton tribars buttressed by a heavy row of concrete ribs connected by lateral beams, and placement of quarry stone to replace stone washed out of the breakwater core. Work is scheduled to be completed in mid-1969.

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