Technical Note PMR-TN-67-2

HAWAIIAN ISLANDS AND THE BARKING SANDS TACTICAL UNDERWATER RANGE FACILITIES: GEOGRAPHIC BACKGROUND

By

J. K. PRINCE
Geographer
Naval Missile Center

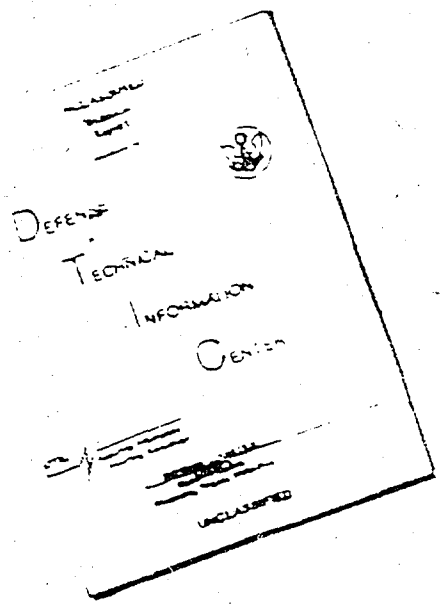
1 February 1968

PACIFIC MISSILE RANGE

Point Mugu, California

45

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

INITIAL DISTRIBUTION

EXTERNAL	Copies
Commander Naval Air Systems Command Washington, D.C. 20360 Attn: AIR-604	2
Defense Documentation Center Cameron Station Alexandria, Va. 22314 Attn: TIOG	20
Commanding Officer Pacific Missile Range Facility FPO San Francisco 96615	175

INTERNAL	Copies
Commander, Pacific Missile Range Code 001 LT A.L. Johnson	1
Program Management Division II Code 313 E.J. Luck	25
Air Force Liaison Office Code 510 MAJ N.L. DeLoache	1
Technical Consultant Code 530 E.Q. Smith, Jr.	1
Operations Research Division Code 5170 Dr. W.M. Simpson	1
Photo/Graphics Department Code 5600 CDR C.R. Longo	1
Code 5631 D.S. Walker	1
Code 5632 J.K. Prince	1
Code 5632.2 Technical Library	2

This report was reviewed and approved by Mr. E. J. Lack, Head, [illegible]

Technical Note PMR-TN-67-2

Published by . . . . Editorial Branch
Technical Publications Division
Photo/Graphics Department
First printing . . . . 2[illegible] copies
Security classification . . . . UNCLASSIFIED

HAWAIIAN ISLANDS AND THE BARKING SANDS TACTICAL UNDERWATER RANGE FACILITIES: GEOGRAPHIC BACKGROUND

J.K. Prince

Pacific Missile Range
Point Mugu, California

February 1963

TABLE OF CONTENTS

TABLE OF CONTENTS (CONCLUDED)

INTRODUCTION

This technical note is intended to provide geographic and other background information to persons who have an interest in the Pacific Missile Range facilities at Barking Sands, Kauai, and in the State of Hawaii of which Kauai is a part.

The information set forth herein should be both useful and interesting to residents and visitors alike.

HAWAIIAN ISLANDS

Location and Size

The Hawaiian Archipelago in the north-central Pacific Ocean comprises eight large volcanic islands and a long chain of islets, reefs, and shoals that rise above an elongated submarine ridge and stretch southeast to northwest some 1,400 nautical miles (figure 1).

The State of Hawaii consists of all of the islands, islets, and reefs from the large island of Hawaii in the southeast to Kure Island in the northwest except Midway Islands. The atoll of Midway is a possession of the United States within a naval defensive sea area and is not a part of the State of Hawaii (figure 2). The state lies between the parallels of 18° and 29° north latitude and between the meridians of 154° and 179° west longitude. It extends farther south than any other state of the United States. The most northern island is about as far north as Tampa, Florida; the most southern is about as far south as Mexico City. Hawaii has a total land area of 6,415 square statute miles, a population (1960 census) of 632,772 (figure 3), and an estimated population for 1965 of 711,000. It ranks 47th in size and 43rd in number of inhabitants. Honolulu, the capitol and principal city, on the island of Oahu is 2,233 nautical miles from Los Angeles (figure 4).

Geologic History and Structure

The Hawaiian Archipelago stands on a submarine platform erupted from a zone of fissures on the ocean floor (figure 5). Volcanic activity is believed to have moved progressively toward the southeast. The completeness of the erosion cycle and its stage of development have proceeded in the same direction. The western portion of the chain, the leeward group, is almost completely eroded. Only a few rocky islets and coral atolls remain. The volcanoes that once existed have been eroded below sea level, and their truncated cones form the platform on which coral grew to form reefs and islands. The eight islands of the southeastern end, the windward group, are volcanic mountains of varying age and show various phases of development. They represent the remnants of 15 distinct volcanoes, 5 forming the island of Hawaii, 2 each forming Oahu, Maui, and Molokai, and 1 forming each of the other islands. Four volcanoes

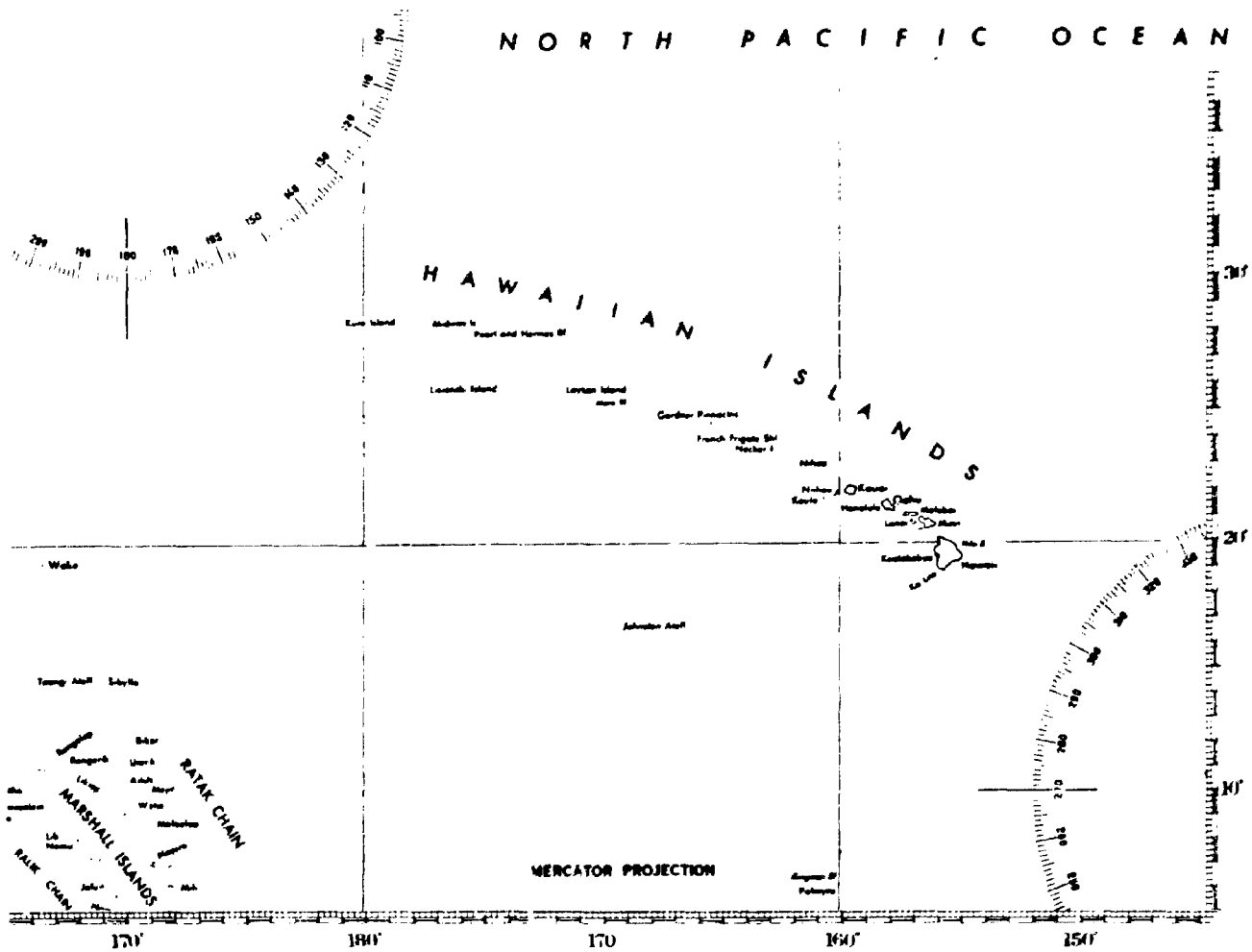


Figure 1. Location Map, Hawaiian Islands.

Sec. 2. The State of Hawaii shall consist of all the islands, together with their appurtenant reefs and territorial waters, included in the Territory of Hawaii on the date of enactment of this Act, except the atoll known as Palmyra Island, together with its appurtenant reefs and territorial waters, but said State shall not be deemed to include the Midway Islands, Johnston Island, Sand Island (offshore from Johnston Island), or Kingman Reef, together with their appurtenant reefs and territorial waters.

Figure 2. Delimitation of the State of Hawaii. Section 2, Public Law 86-3.

have erupted in historic times, one on the island of Maui, and three on the island of Hawaii. The oldest domes, those at the western end of the windward group, are characterized by exceptionally heavy erosion, and deep canyons are evident where water action has scoured away the basaltic lava rock.

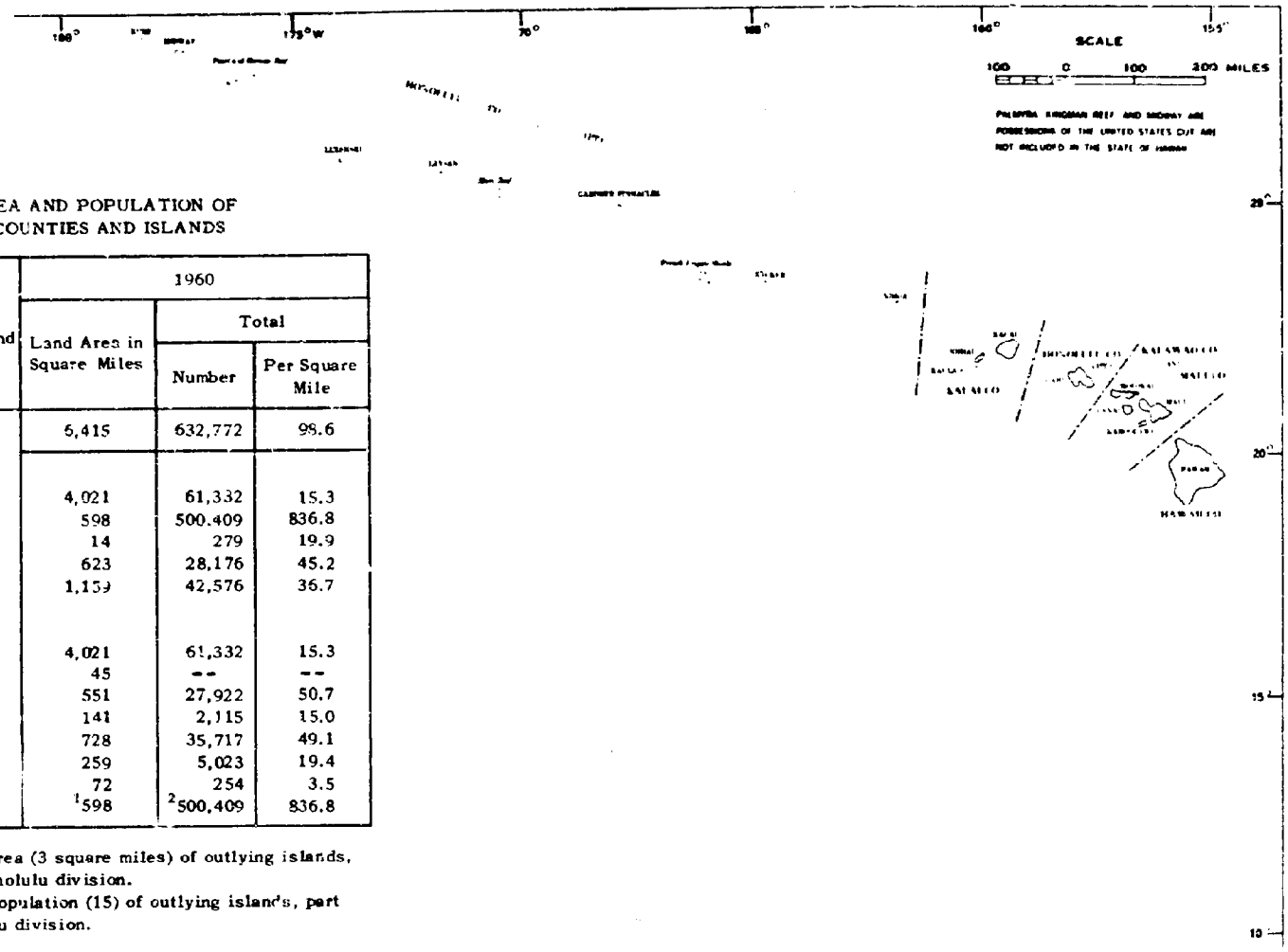
History and Government

The Hawaiian Islands were introduced to Europeans as a result of the third voyage of Captain James Cook, famous navigator of the British Royal Navy. Captain Cook first sighted the island of Kauai in January 1778, and anchored in Waimea Bay on the southwest side of the island on January 20th. The islands were named the Sandwich Islands in honor of the Earl of Sandwich, the First Lord of the British Admiralty. In 1779, after voyaging to North America, Captain Cook returned to the Hawaiian Islands where he was killed in a conflict with natives on the island of Hawaii.

Warlike chiefs ruled various islands until Kamehameha succeeded in establishing a Polynesian Kingdom and became undisputed ruler of the whole group. In 1894 a republic was declared, and in 1898 a petition from the Hawaiian Government was passed by the Congress of the United States annexing the Hawaiian Islands to the United States. In 1900 Congress established a territorial government for the islands, and the area was known as the Territory of Hawaii. By presidential proclamation on August 21, 1959, Hawaii officially became the 50th state of the United States.

Race and Language

The original people of the Hawaiian Islands were part of the Polynesian race whose ancestors are believed to have migrated eastward from Malaysia early in the Christian era. The main body of Polynesians settled in the Society Islands. From there, centuries later, Polynesian voyagers and explorers ranged out to occupy the islands from Hawaii in the north to New Zealand in the south and to the Tuamotu Archipelago and other islands in the east.



AREA AND POPULATION OF
COUNTIES AND ISLANDS

County and Island	1960		
	Land Area in Square Miles	Total	
		Number	Per Square Mile
The State	6,415	632,772	98.6
Counties:			
Hawaii	4,021	61,332	15.3
Honolulu	598	500,409	836.8
Kalawao	14	279	19.9
Kauai	623	28,176	45.2
Maui	1,159	42,576	36.7
Islands:			
Hawaii	4,021	61,332	15.3
Kahoolawe	45	--	--
Kauai	551	27,922	50.7
Lanai	141	2,115	15.0
Maui	728	35,717	49.1
Molokai	259	5,023	19.4
Niihau	72	254	3.5
Oahu	[1]598	[2]500,409	836.8

[1]Includes area (3 square miles) of outlying islands, part of Honolulu division.
[2]Includes population (15) of outlying islands, part of Honolulu division.

Figure 3. Census County Divisions in Hawaii, and Area and Population of Counties and Islands

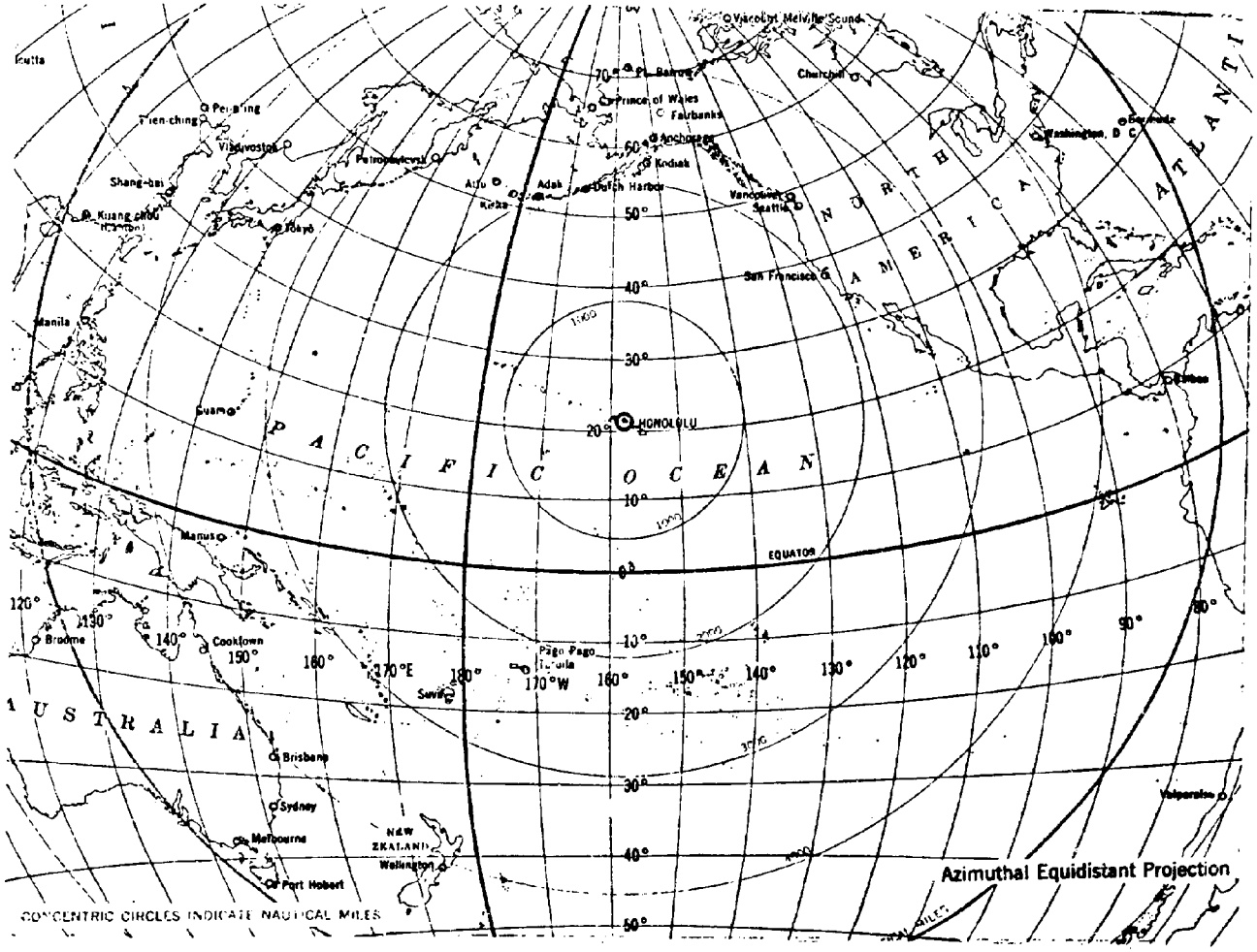


Figure 4. Map of Great Circle Distances and Azimuths From Honolulu, Oahu.

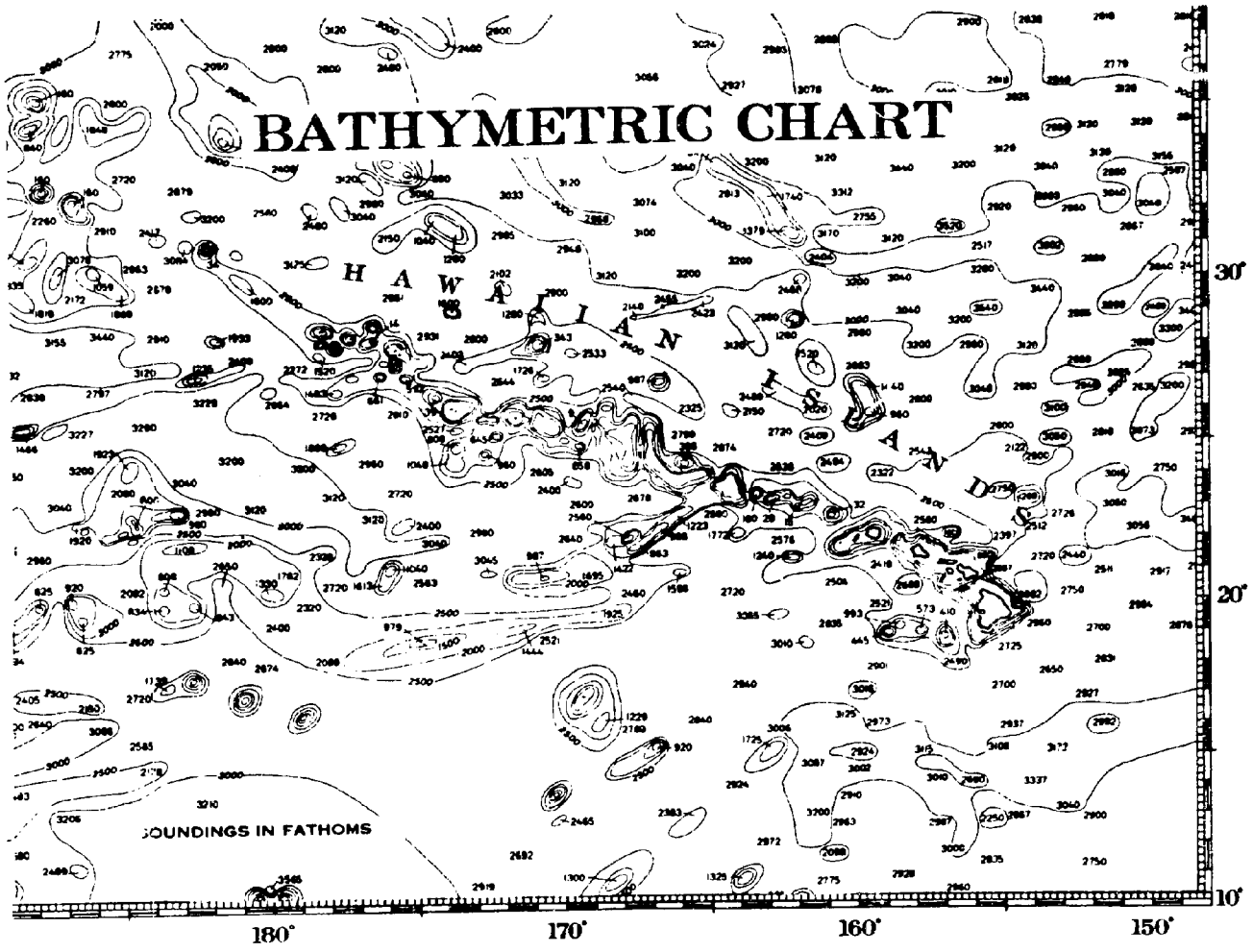


Figure 5. Bathymetric Chart of the Hawaiian Archipelago Area.

At the time of Captain Cook's visit, the Hawaiian Islands had a homogeneous population estimated to have been approximately 300.000. Travelers from Europe brought diseases against which the Hawaiians had no immunity and, as a result, the death rate increased sharply. By 1872 the population had dropped to 56,897. However, immigration from many different countries reversed this trend and eventually produced the extraordinary intermixing of races that is evident today.

There are enough similarities in the languages of the Hawaiians, Tahitians, Samoans, and the Maoris of New Zealand to establish their affinity and common progenitors. Today the language of Hawaii is English, but Hawaiian, Chinese, Tagalog, Japanese, and many other languages may be heard. The Hawaiian language is soft and musical with vowels and liquids predominating. Only 12 letters (the vowels and h, k, l, m, n, p, and w) are used to represent the 40 syllables that make up the more than 20,000 words. Today the place-names of the islands reflect much of the original Polynesian culture (table 1). Many of the names are difficult to translate because of their great antiquity and the changes they have undergone.

Biota: Flora and Fauna

The isolation of the islands and their great diversity of soil, relief, drainage and climate have led to the development of a unique and diversified flora. Many of the indigenous species are found nowhere else. There are more than 1,000 native flowering plants, including 300 kinds of trees, about 150 species of ferns (among them tree ferns 25 to 30 feet high), and hundreds of species of mosses, fungi, and algae.

The animals of the islands have likewise evolved into many species, with particularly large numbers of birds, insects, and crustacea. In contrast, there are but few land animals. There are no native reptiles or amphibians, and the only native land mammal is a bat. Domesticated animals brought to the islands by the Hawaiians included the pig, the dog, and the jungle fowl. The introduction of animals by Europeans was begun by Captain Cook in 1778 and by English navigator George Vancouver some years later.

Climate

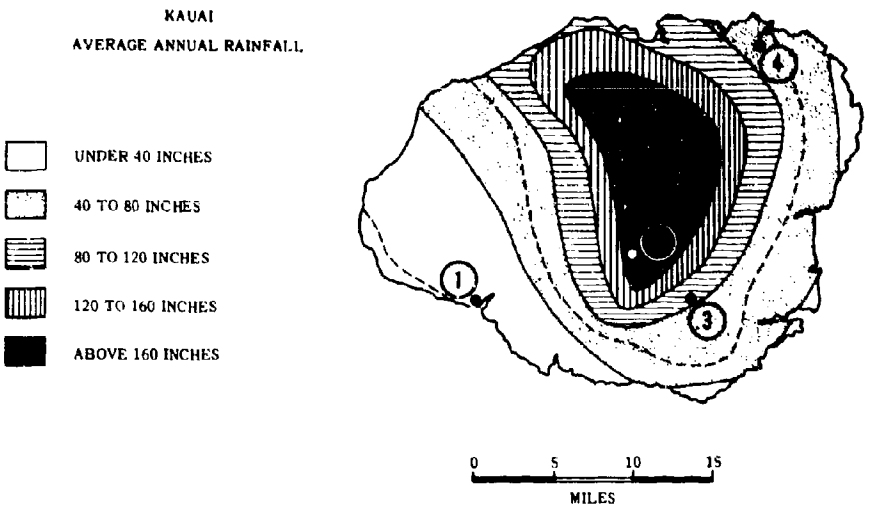
The remarkable features of the climate of the Hawaiian Islands are the vast differences in rainfall over adjacent areas; the persistently equable temperature devoid of seasonal or sudden changes and with only a very moderate difference between the averages of winter and summer months; and the tenaciousness of the trade winds over the general locality.

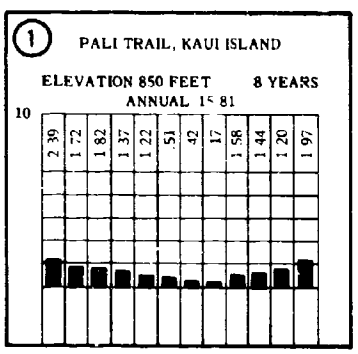
Table 1. Glossary of Words Frequently Occurring in Hawaiian Geographic Names

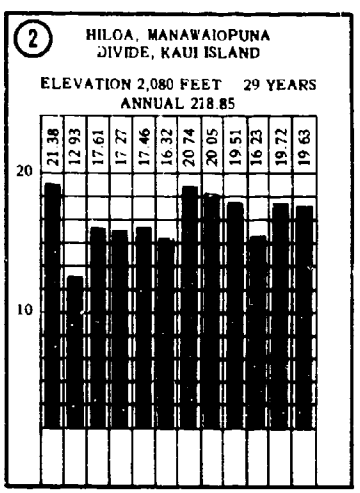
A'ā	rough lava	La	the sun
Akina	gray	Lae	a cape
Ahua	a mound, a heap	Lani	the sky, heaven
'Aina	land	Lapa	a narrow ridge
Alaea	red ochre	Lena	yellow
Ale	a wave	Liu	bilgewater
Ana	a cave	Loa	long
Ao	light	Lo'i	a taro patch
Apana	a district	Loihi	long
Au	a current, time	Loko	a fish pond
Awa	a harbor	Lua	a pit, crater
'awawa	a valley	Lua	two
Ehoeho	a monument, cairn	Luu	to dive
Ekeele	black	Makani	wind
Haiki	narrow, close	Malino	calm
Hala	Pandanus tree	Manawai	a branch of a stream
Hale	house	Manoa	thick, broad
Hau	a tree, Hibiscus tiliaceus	Manu	a bird
Hihiu	wild	Mauna	a mountain
Hikina	east	Moana	ocean
Hina	grey	Moku	an island, a district
Hono	a harbor	Mokupuni	an island
Honua	land	Muliwai	a river
Hou	new	Niu	a coconut tree
Hu'a	sea foam	Nui	great
Iki	little	Nuku	a narrow entrance of a river or harbor
Ili	a division of land	Nuu	a terrace, steps
Iliili	pebbles	Ohe	bamboo
Iwa	nine	One	sand
Ka	the	Pa	a fence, an enclosure
Kahawai	water course	Paakea	limestone
Kahiko	ancient	Pae	to land
Kahua	site, foundation	Pahochoe	smooth
Kai	sea	Pahi	a place where there is a waterfall only in rainy weather
Kaikuono	bay		
Kala	rough, prickly	Pali	a precipice
Kamani	a tree, Calophyllum inophyllum	Pelolo	clay
Kapu	taboo	Pohaku	a rock
Kapuai	a foot	Poho	a dead calm
Kauhale	village	Pono	right
Kea	white	Po'o	head
Kee and K'kee	crooked	Puu	post
Kele	muddy	Puhi	to blow
Ke'oke'o	white	Puka	an opening, a door
Kini	numerous	Pau	a hill
Ko	sugarcane	Ua	rain
Koa	a tree, Acacia koa	Uka	inland
Kolu	three	Ula and Ulaula	red
Kona	leeward	Uli and Uliuli	blue
Kou	a tree, Cordia subcordata	Uuku	little
Kowā	a channel	Waa	a canoe
Kua	a back, a ridge	Waa	a furrow, channel
Kukui	a tree, Aleurites moluccana	Waha	a mouth
Kukui eeo	stilts, the stilt plover	Wai	water
Kula	dry upland	Waihu	a gushing fountain
		Wailele and Waihi	a waterfall

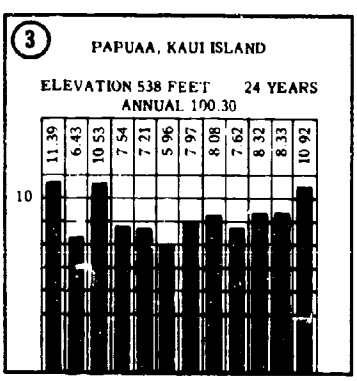
As a general statement it may be said that the climate of the Hawaiian Islands is unusually pleasant for an area situated at such a latitude. The northeast trade winds, blowing in from cool ocean areas, modify the temperature and carry a heavy load of moisture, much of which is dropped on the islands. Rough relief and a wide range in elevation produce great differences in temperature and rainfall within short distances.

For example, from windward to leeward slopes instances of pronounced and sudden decline in rainfall can be found. This is well illustrated in central Kauai, where, near the summit of Mount Waialeale, at an elevation of 5,075 feet, the average amount of rain is over 450 inches, while 15 miles southwest on the leeward side it is less than 20 inches (figure 6).









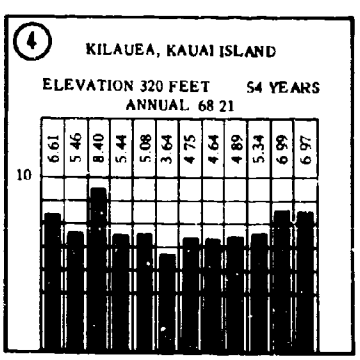


Figure 6. Rainfall Map of Kauai, With Monthly Distribution of Precipitation for Selected Stations.

The marked marine influence combined with the persistent trade winds permit relatively little uncomfortable heat. Discomfort is sometimes experienced when the trade winds temporarily give way to light changeable or southerly winds with resultant comparatively high humidity. In summer the trade winds blow with a high degree of persistency; the periods of so-called kona weather are most noticeable in the fall. The word kona, of Polynesian origin, means leeward. In the climatological sense it refers to the southerly winds and the accompanying weather on the normally leeward sides of the principal Hawaiian Islands, which have become, temporarily, the windward sides. The konas are the major element of climatic variation with time in the Hawaiian Archipelago. They cause the greatest portion of the differences between cool and warm seasons; they also bring rain to otherwise arid portions of the major islands.

Temperatures are generally lower than in similiar latitudes and altitudes elsewhere. There is a decrease of temperature with rise in elevation. Freezing temperatures, frost, and snow rarely occur below 4,000 feet. Thunderstorms are infrequent and practically never severe. Hail seldom occurs. Local storms are occasionally accompanied by winds of sufficient force to do limited damage to trees and other property, but severe storms such as tornadoes, hurricanes, or typhoons are very uncommon. So-called thick weather is almost unknown and usually confined to mist or rain, but on rare occasions fog may develop for a day or two.

Tides and Currents; Ocean Temperature and Salinity

The periodic tides in the Hawaiian Islands are small; the average rise and fall is only 1 to 2 feet. The tides along the southern coasts of islands occur 1 to 1 1/2 hours later than along the northern coasts, with high water intervals of 2 to 4 hours. Tidal currents are generally weak and are influenced by winds and oceanic movements. In the channels between the larger islands, tidal currents are mainly reversing, but they are rotary in more open waters, and continually shift direction in a clockwise movement. Oceanic currents are variable but generally depend on the velocity and direction of the wind. Great seismic sea-waves or tsunamis have visited the islands from time to time and cause widespread destruction and loss of life. The United States Coast and Geodetic Survey administers a sea-wave warning system that alerts the Hawaiian Islands, other Pacific islands, and most of the countries bordering the Pacific.

Seasonal changes of ocean surface variables are relatively small. The seasonal surface water temperature range, for example, is approximately 4° to 5°F. The mean summer high is about 78°F and varies locally from 75° to 80°F. The mean winter low is about 74°F, with local variations from 73° to 76°F. The mean salinity is about 35‰ (parts per thousand), ranging from 34.4‰ to 35.3‰ (see appendix for detailed charts).

ISLAND OF KAUAI AND THE BARKING SANDS TACTICAL UNDERWATER RANGE FACILITIES

Location

The Barking Sands Tactical Underwater Range (BARSTUR) is located in a 50-square-mile ocean area in the north-central Kaulakahi Channel that separates Kauai some 15 nautical miles from the privately owned island of Niihau to the west. The support facilities for the underwater range are located on the low western coastal plain of the island of Kauai. Included are an instrumentation site to the east on Niu Ridge at an elevation of 760 feet, and an instrumentation complex some 5 miles northeastward on Makaha Ridge at an elevation of about 1,500 feet (see figures 7 through 10).

Kauai, the northernmost island of the Hawaiian windward islands and fourth largest of the eight major islands in the southeastern part of the archipelago, is located at 22°05' north latitude and 159°30' west longitude. The island measures about 33 statute miles east to west by 25 miles north to south; it is roughly circular, with a land area of 551 square statute miles. Kauai has a population of 27,922 according to the 1960 census. (Additional census information is presented in the appendix.)

Physical Geography

Kauai is the deeply eroded and dissected remains of a former volcanic dome that now culminates in the central part of the island in Kawaikini peak at an elevation of 5,170 feet, the highest point on the island (figures 11 and 12). The former caldera that extends northwestward and is now filled by erosional deposits forms a 4,000-foot-high upland that is occupied by the boggy Alakai Swamp. The mountains on the west and north sides are deeply dissected by numerous streams that have cut deep gorges and left steep, jagged ridges. The slopes on the east and south are gullied, and a coastal plain extends seaward from the mountain flanks. The northwest Na Pali coast is steep-to and backed by high bluffs where the elevated upland drops abruptly to the sea.

A coastal alluvial plain extends 2 or 3 miles inland and fringes the west side of the island for about 10 miles--from the Waimea River around Kokole Point northward to the Barking Sands area beyond Nohili Point. The Barking Sands sand hills, a dune area composed of sand, white coral, and lava fragments, received their name because of the peculiar woofing noise they make when skidded on or rubbed. The shore of the western coastal plain is largely sand dunes and windblown deposits; the eastern edge of the plain is marked by talus deposits along prominent, abrupt cliffs that front the mountainous slopes. The coast along the south and east is low and rocky, with some sandy beaches. The 20-fathom depth curve is seldom more than a mile from shore and is usually not far from the coral reefs that fringe parts of the coast.

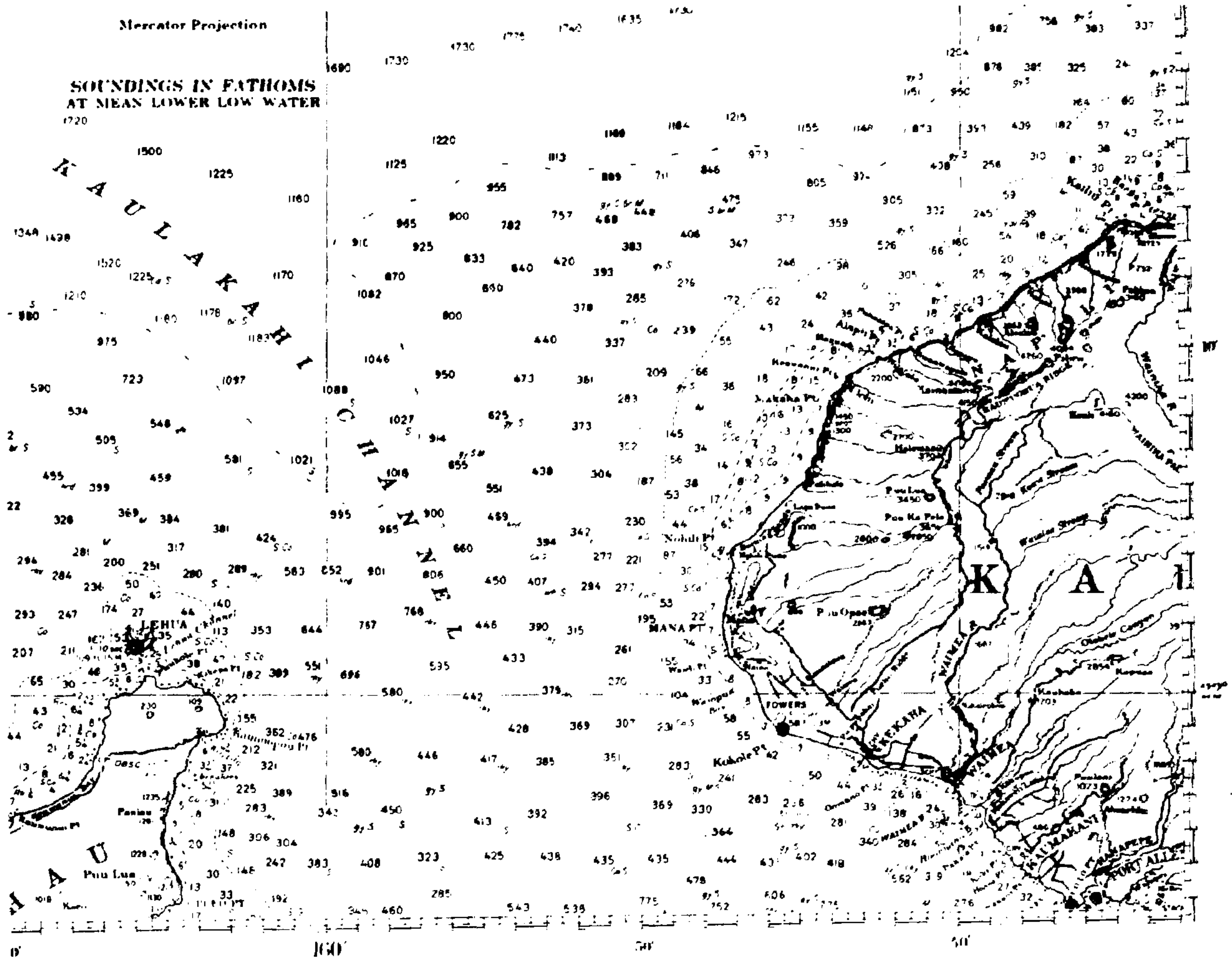


Figure 7. Hydrographic Chart of Kaulakahi Channel.

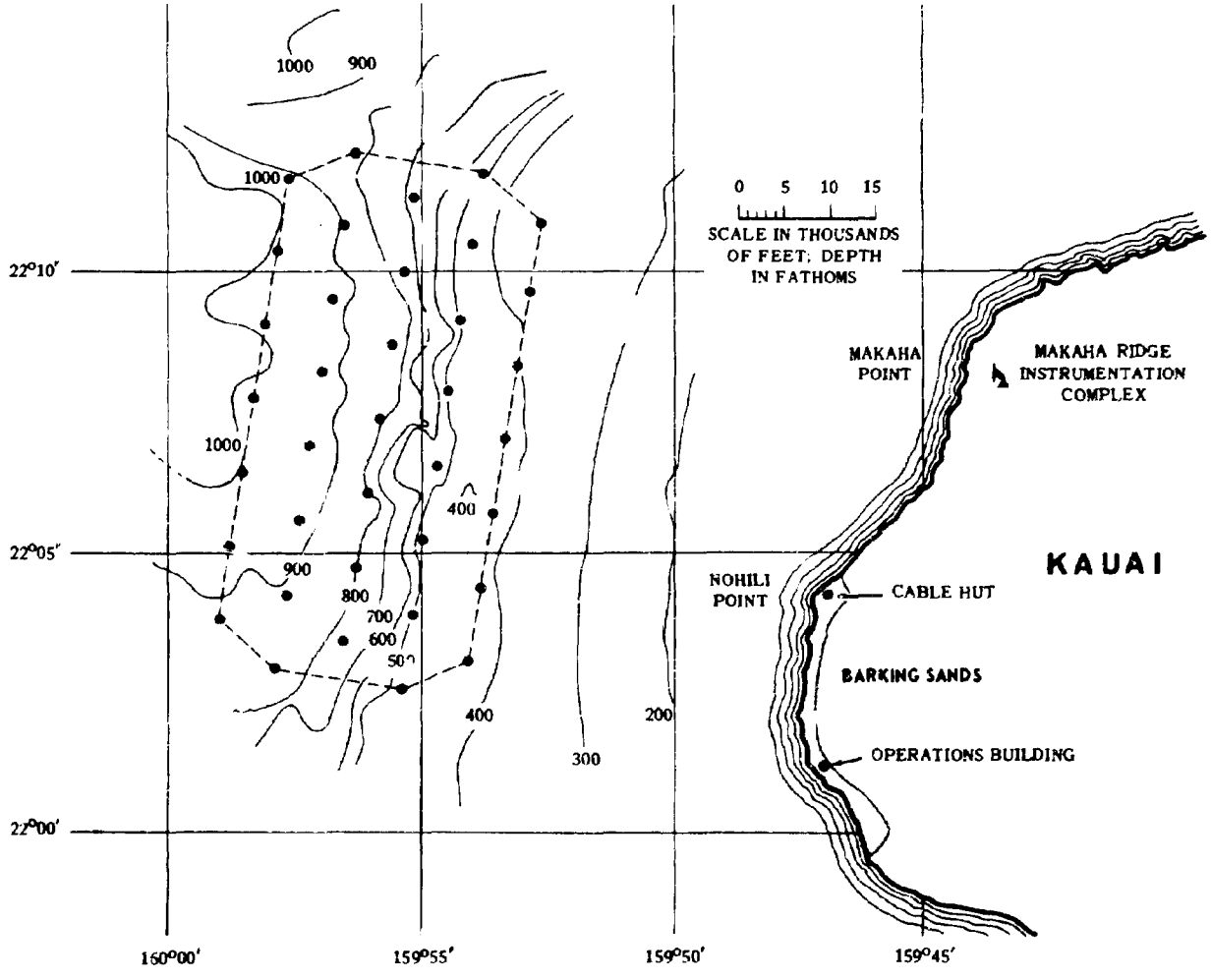


Figure 8. Location Map, Barking Sands Tactical Underwater Range and Facilities.

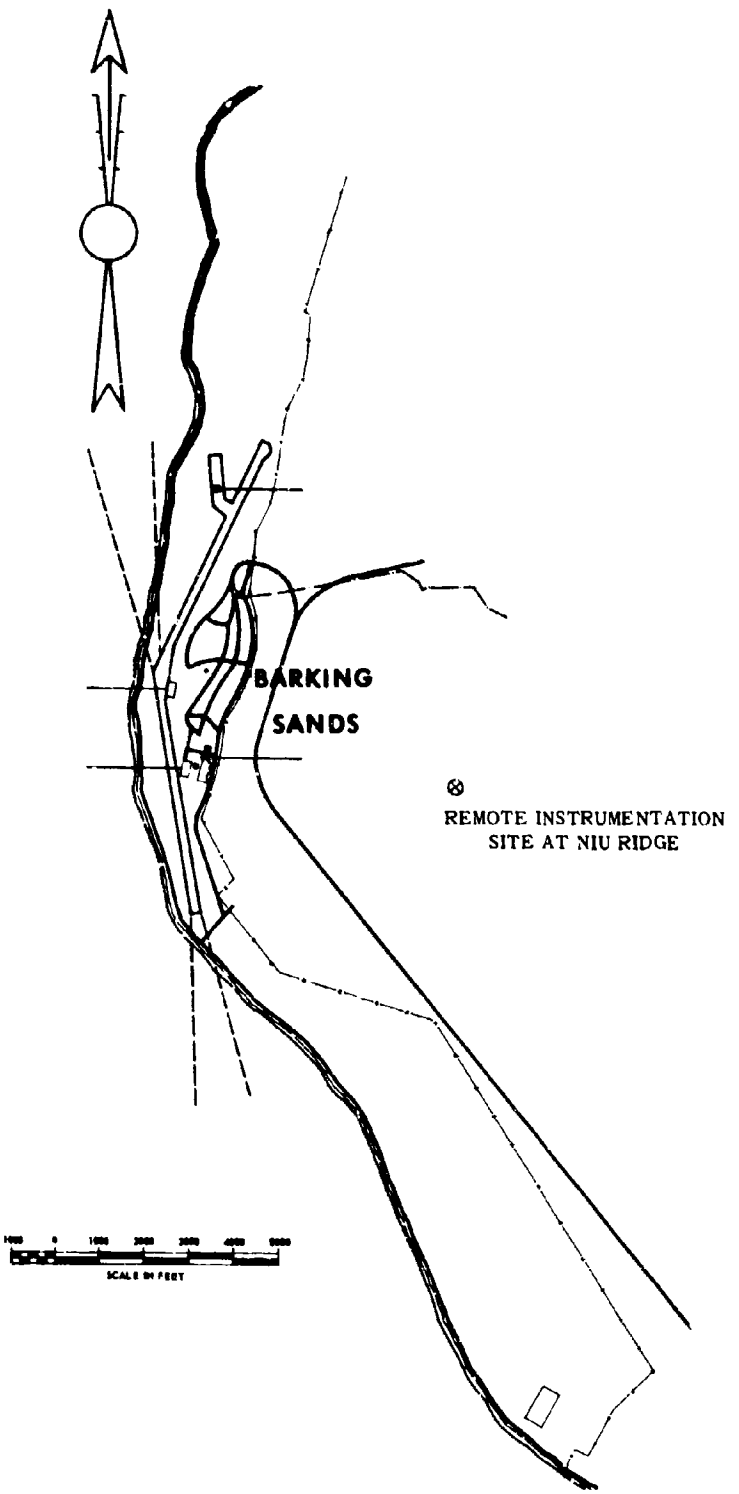


Figure 9. Site Map of Barking Sands Facilities.

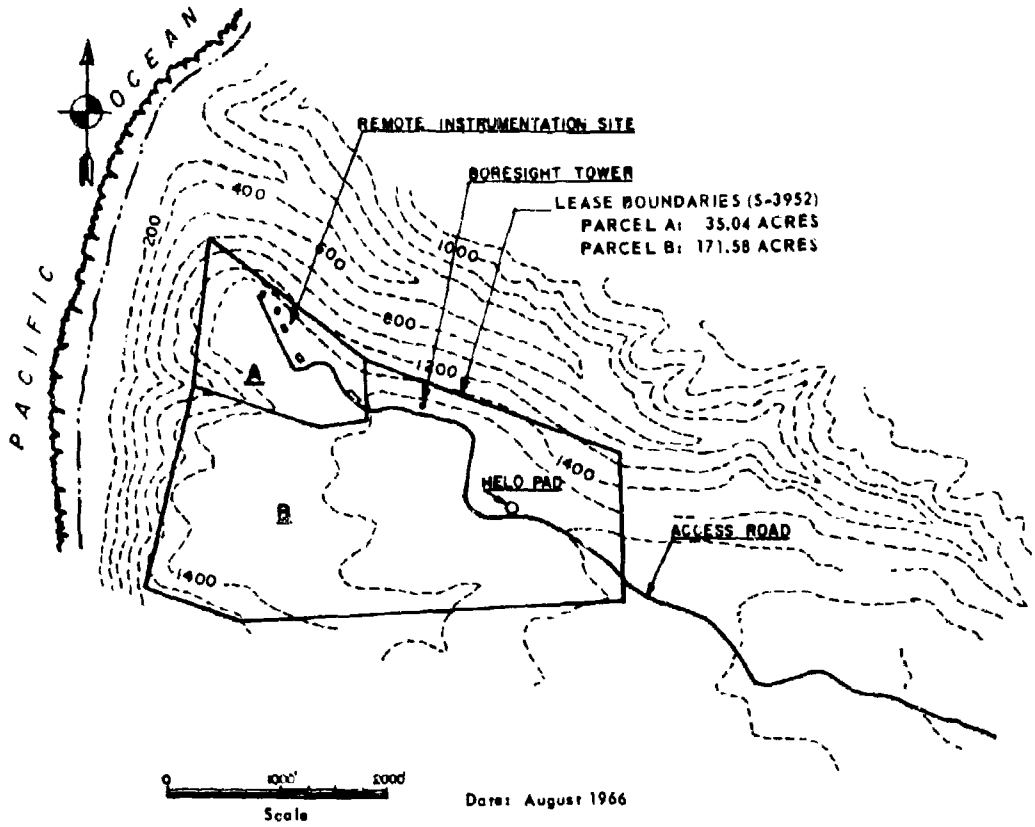


Figure 10. Site Map of Makaha Ridge Instrumentation Complex.

Waimea Canyon, often called the Grand Canyon of the Pacific, is the spectacular, deeply cut valley of the Waimea River. The canyon, which heads in the west-central highlands, is about 10 miles long, nearly 3,000 feet deep, and a mile wide. The upper canyon and its tributaries form the southeastern edge of the plateau that drops off to the northwest along the Na Pali coast. The coast, which is inaccessible except by helicopter or boat, includes several state parks.

There are some local variations from the general climatic pattern of the Hawaiian Islands (see tables 12 and 13 in appendix). The trade winds tend to divide on the easterly side of Kauai. Part of the windflow follows the north coast and part the south coast. On the west side between Mana and Makaha Points, calm to light variable airs prevail, although north to northwest winds are found slightly inland at Mana. Toward the southwest coast, a moderate southwest wind sometimes occurs at Waimea Bay while a strong east wind is blowing about 2 miles offshore. At Makaweli, easterly winds prevail during most months.

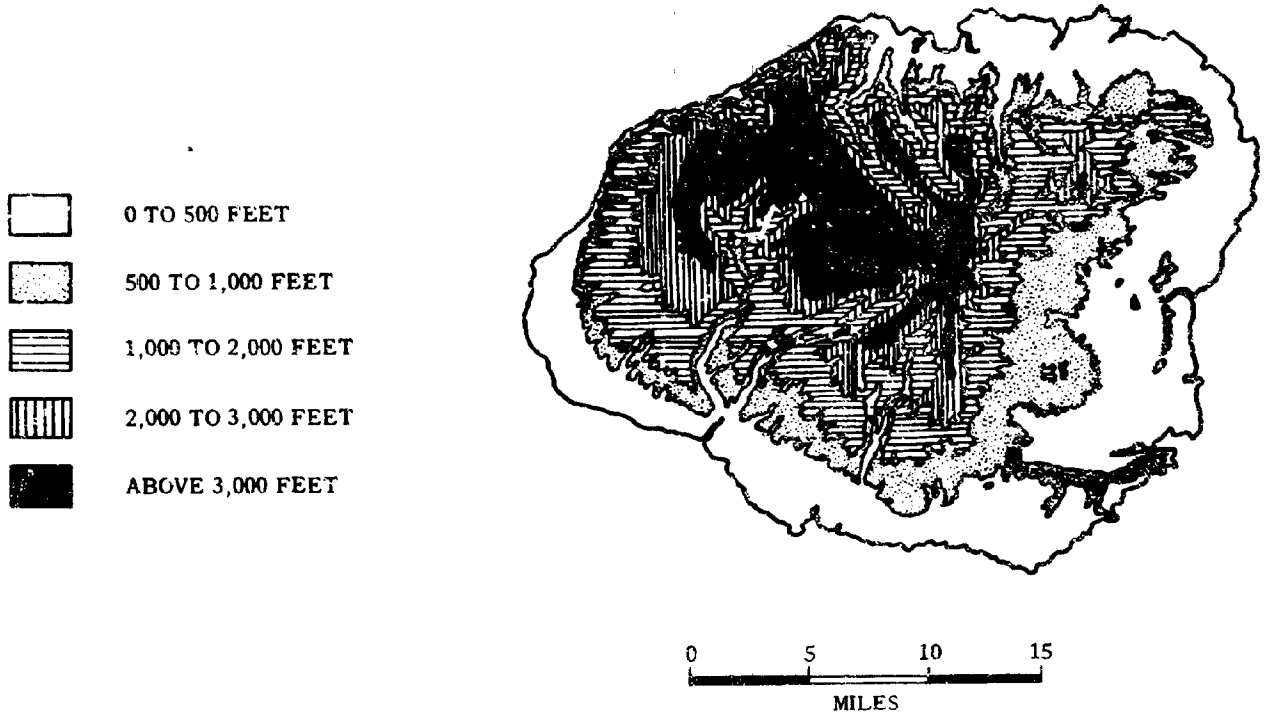


Figure 11. Elevation Map of Kauai.

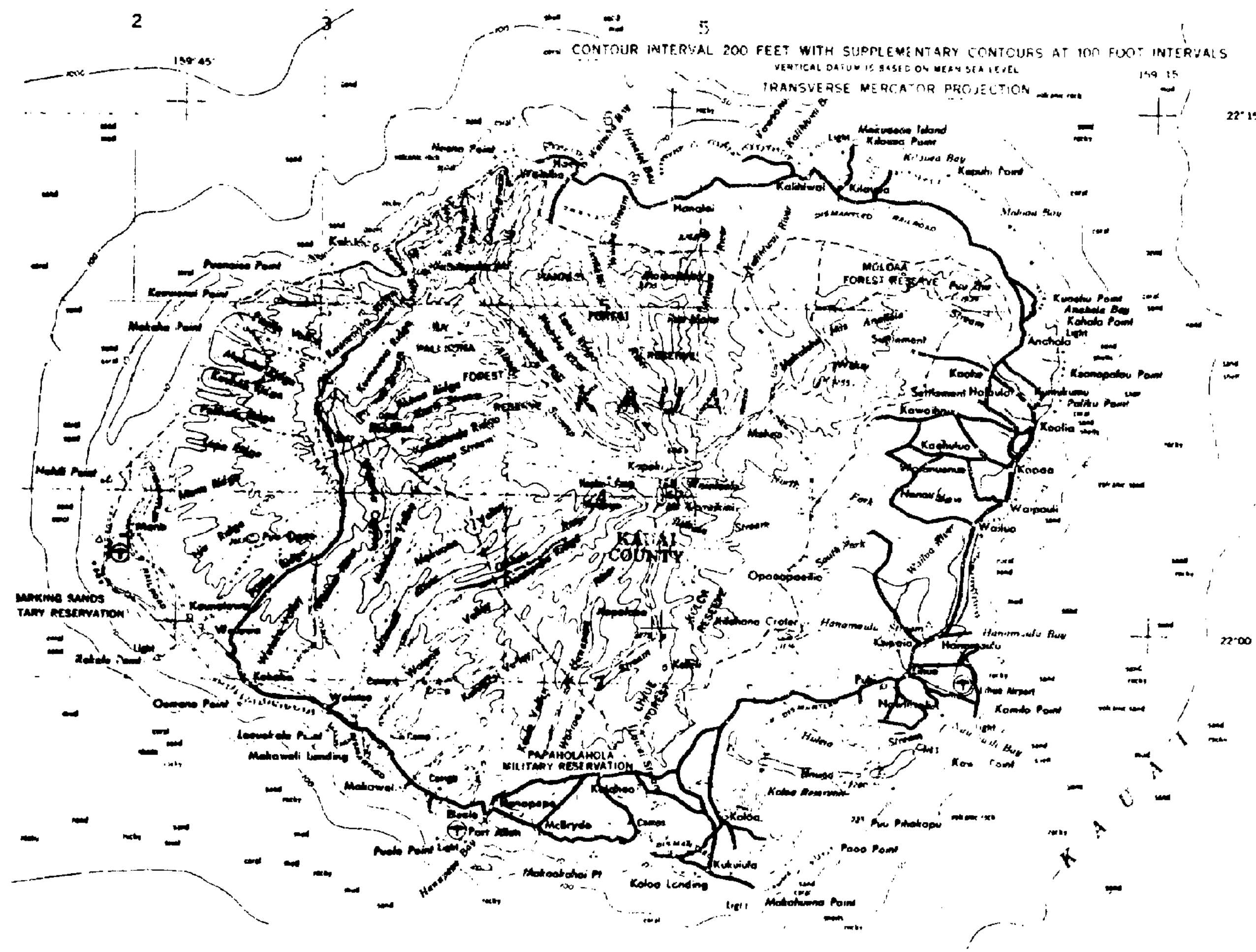


Figure 12. Topographic Map of Kauai.

Ocean currents around Niihau are usually from north to south, but currents through the channel between Niihau and Kauai are usually from southeast to northwest. These currents are extremely variable, especially during the winter months when strong southerly and southwesterly winds occur. Currents around Kauai are also quite variable, usually following the winds, but sometimes reversing during the first calm after strong trade winds.

Transportation and Accommodations

Kauai is called the Garden Isle of the islands and tourism vies with agriculture (sugarcane, pineapple, cattle) as the most important industry. Hawaii's two scheduled airlines, Aloha Airlines and Hawaiian Airlines, provide many daily flights to Kauai. There are also a number of certified, dependable air taxi services operating between the islands. The 95-mile flight from Honolulu to Lihue, the principal town and county seat of Kauai, takes about 25 minutes. There are no scheduled commercial flights to any other points on the island except Lihue, although there are airfields at Port Allen and at Barking Sands.

Lihue Airport is situated about 2 miles from the town. Rental cars and transportation to various island hotels are available. The Hawaii Visitors Bureau Visitor Information Center is located at the airport.

The standard time used in most of Hawaii is 10 hours slow of Greenwich Mean Time; 2 hours earlier than Pacific standard time.

There are no accommodations (table 2) for visitors at the Barking Sands facility. Most of the hotels and motels are located in the Lihue area or along the south coast in the Port Allen/Poipu area. The east coast features accommodations and resort hotels in the Wailua/Kapaa area and north at Hanalei. Rates for accommodations and meals at most resort hotels are moderate to high. See table 3 for mileage and driving times.

The island of Kauai has grown as a tourist attraction and offers a great variety of outdoor activities. There are bathing beaches and such offshore water sports as surfing, water-skiing, outrigger canoeing, deep sea fishing, and coastal cruising. Hiking, golf, horseback riding, and mountain goat and wild boar hunting are also available. Visits to historical sites and scenic localities, including the Fern Grotto, and rides by river launch on the Wailua River are always popular.

Directions to the Barking Sands Facility

To reach the Barking Sands facility from Lihue Airport, one follows the main road through Lihue and on southwest along the southern coast of the island. The road, State Highway 50, winds through fields of sugarcane to Port Allen. At Port Allen, one of the island's two major harbors, berthing space for ships that

Table 2. Accommodations on Kauai

Lihue Area:
Kauai Surf
Hale-Ka-Lani Motel
Hale Lihue
Hale Pumehana
Hi-Way Motel
Motel Lanai
Palm Haven Hotel
Port Allen/Poipu Area: West of Lihue, South Coast
Jerves Motel
Waiohai
Prince Kuhio Hotel and Apartments
Polynesia Inn
Poipu Shores
Garden Isle Beach Apartments
Poipu Beach
Waimes/Kokee Area: West of Lihue, Southwest Coast
Kokee Lodge
Menehune Manor
Wailua/Kapaa Area: North of Lihue, East Coast
Coco Palms Resort Hotel
Tropical Inn
Lihi-Kai
Wailua Crest
Hotel Coral Reef
Hanalei Area: North of Lihue, North Coast
Hanalei Plantation
Hanalei Apartments

Table 3. Mileage and Driving Times

From Lihue south to:		
Poipu	14 miles	40 minutes
Waimea	25 miles	1 hour
Kekaha	29 miles	1 hour 5 minutes
Waimea Canyon	40 miles	2 hours
Kaialau Lookout	50 miles	2 hours 10 minutes
From Lihue north to:		
Wailua River	7 miles	20 minutes
Hanalei	35 miles	1 hour 15 minutes
Haena	41 miles	1 hour 30 minutes

support the underwater range has been provided by the State of Hawaii. Port Allen on the south coast and Nawiliwili on the east coast are the only commercial harbors and the only places that afford shelter in almost all types of weather. They are ports for a few interisland barges and transpacific vessels. Most interisland passenger traffic is by air.

Continuing along the south coast, 25 miles from Lihue and about 1-hour driving time, the settlement of Waimea at the mouth of the Waimea River is reached. Here is the site of Captain Cook's first Hawaiian landing and, in the past, a favorite provisioning port of Pacific traders and whalers. Here also one may see the ruins of a fort built in 1815 by the Russian Fur Company, which hoped to seize Kauai for the Czar. The United States Department of Interior has suggested this site as a historical monument.

Twenty-nine miles from Lihue at the town of Kekaha, the road branches with the road to Barking Sands continuing along the coast. The road from Kekaha runs along the west coast for about 8 miles to the settlement of Mana. The land is relatively flat and nearly all planted to sugarcane. The Barking Sands facility lies along the coast west of Mana. The remote instrumentation complex at Niu Ridge is reached by sugar plantation roads south and eastward of Mana.

At Kakaha where the road branches, the Waimea Canyon road leaves the coastal fields of sugarcane and winds northward up arid, cactus-covered hills along Puehu Ridge to an elevation of about 2,200 feet, where it reaches the rim of Waimea Canyon. The road continues along the canyon rim to Kokee State Park, a distance of some 16 miles from Kakaha.

Three miles farther, some 50 miles from Lihue, the road ends at Kalalau Lookout, where the upland drops off some 4,000 feet through a lush green valley to the Pacific Ocean. The remote instrumentation complex at Makaha Ridge is reached by a 4 1/2-mile access road that heads west from the Waimea Canyon road south of Kokee Park. The National Aeronautics and Space Administration's Kokee satellite and missile tracking station is located near the junction of the Makaha Ridge access road.

BIBLIOGRAPHY

Applied Physics Laboratory. Oceanographic Evaluation of a Fleet Range Site off the West Coast of Kauai, Hawaii, by G. R. Garrison. Seattle, Wash., University of Washington, 7 Jan 1965. (APL-UW 6513) UNCLASSIFIED.

Borden, Charles A. South Sea Islands. Philadelphia, Macrae Smith, 1961.

Briggs, Donald Sea. South Seas Guide. Nagoya, Japan, Donald Sea Briggs Productions, 1963.

Buck, Peter H. Explorers of the Pacific: European and American Discoveries in Polynesia. Honolulu, Hawaii, Bernice P. Bishop Museum, 1953. (Special Publication 43)

-----. Vikings of the Pacific. Chicago, The University of Chicago Press, 1959.

Carter, George F. "Movement of People and Ideas Across the Pacific," in Plants and the Migrations of Pacific Peoples, A Symposium. Tenth Pacific Science Congress, Honolulu, Hawaii, 1961. Honolulu, Hawaii, Bishop Museum Press, 1963. Pp. 7-22.

Daniel, Hawthorne. Islands of the Pacific. New York, Putnam, 1943.

Encyclopedia of World Travel, Vol. 1, United States and Canada, ed. by Nelson Doubleday and C. Earl Cooley. New York, Doubleday, 1961.

Geography of the Pacific. Ed. by Otis W. Freeman, New York, Wiley, 1951.

Hamilton, Edwin L. "Marine Geology of the Pacific Basin," in Geology and Solid Earth Geophysics of the Pacific Basin. Tenth Pacific Science Congress of the Pacific Science Association. Honolulu, Hawaii, University of Hawaii Press, 1963. Pp. 135-154.

Hawaii Dredging and Construction Company. Nearshore Oceanographic Investigations: Cable Route Surveys, Mana Point, Kauai, by Theodore Chamberlain. Apr 1965. (Preliminary report)

Hawaii Institute of Geophysics. Coastal Currents and Sewage Disposal in the Hawaiian Islands, by Taivo Laevastu, Don E. Avery and Doak C. Cox. University of Hawaii, Jun 1964. (HIG-64-1)

-----. Seasonal Measurement of Oceanographic Parameters in the Kaulakahi Channel, Hawaii, by John C. Belshé. University of Hawaii, May 1967. (Applied Oceanographic Series No. 3; HIG-67-5)

Keesing, Felix M. Native Peoples of the Pacific World. New York, Macmillan, 1954.

Macdonald, Gorden A. "Geology and Geophysics of Hawaii," in Geology and Solid Earth Geophysics of the Pacific Basin. Tenth Pacific Science Congress of the Pacific Science Association. Honolulu, Hawaii, University of Hawaii Press, 1963. Pp. 127-133.

Menard, H. W. Marine Geology of the Pacific. New York, McGraw-Hill, 1964.

Motel and Hotel Red Book 1967. New York, American Hotel Association Directory Corporation, 1967.

Official Airline Guide, Quick Reference. North American Edition, 15 Mar 1967. Chicago, Ill., Reuben H. Donnelley Corporation, 1967.

Oliver, Douglas L. The Pacific Islands. Cambridge, Harvard University Press, 1958.

Osborn, Fairfield. The Pacific World: Its Vast Distances, Its Lands and the Life Upon Them, and Its Peoples. New York, Norton, 1944.

Pacific Islands, Volume I: General Survey. Naval Intelligence Division, Great Britain Admiralty, 1945. (B.R. 519 Geographical Handbook Series.)

Pacific Islands, Volume II: Eastern Pacific. Naval Intelligence Division, Great Britain Admiralty, 1943. (B.R. 519A Geographical Handbook Series.)

Pacific Islands Year Book. Ed. by R. W. Robson. 8th ed. Sydney, New South Wales, Pacific Publications Pty. Ltd., 1959.

Sandia Corporation. Study of Surface Meteorological Observations for Barking Sands, Kauai, Hawaii, and Upper-Level Wind Measurements Made at Barking Sands and Lihue, Kauai, Hawaii, and Johnston Island, by R. F. Gentzler and C. A. Olson. Mar 1963. (Technical Memorandum 5-63(72))

Sharp, Andrew. The Discovery of the Pacific Islands. London, Oxford University Press, 1960.

Statesman's Year-Book: Statistical and Historical Annual of the States of the World for the Year 1966-1967. Ed. by S. H. Steinberg. 103rd ed. New York, St. Martin's Press, 1966.

Sverdrup, H. U., Martin W. Johnson and Richard H. Fleming. The Oceans: Their Physics, Chemistry, and General Biology. New York, Prentice-Hall, 1942.

U.S. Bureau of the Census. U.S. Census of Population: 1960. Washington, D.C., U.S. Government Printing Office, 1961. (Vol. I, Characteristics of the Population, Part A, Number of Inhabitants.)

-----. Statistical Abstract of the United States: 1966, 87th ed. Washington, D.C., U.S. Government Printing Office, 1966.

U.S. Coast and Geodetic Survey. Surface Water Temperature and Salinity, Pacific Coast, North and South America and Pacific Ocean Islands. Washington, D.C., U.S. Government Printing Office, 1962. (C&GS Pub 31-3)

-----. Surface Water Temperatures at Tide Stations, Pacific Coast, North and South America and Pacific Islands, 5th ed. Washington, D.C., U.S. Government Printing Office, 1956. (Spec. Pub. No. 280)

-----. Tidal Current Tables, Pacific Coast of North America and Asia, 1967. Washington, D.C., U.S. Government Printing Office, 1966.

-----. Tide Tables, High and Low Water Predictions, West Coast of North and South America including the Hawaiian Islands, 1967. Washington, D.C., U.S. Government Printing Office, 1965.

-----. United States Coast Pilot, Hawaiian Islands, 3rd ed. Washington, D.C., U.S. Government Printing Office, 1950.

-----. United States Coast Pilot 7, Pacific Coast, California, Oregon, Washington, and Hawaii, 9th ed. Washington, D.C., U.S. Government Printing Office, 1963.

U.S. Fish and Wildlife Service. Atlas of the Oceanographic Climate of the Hawaiian Islands Region, by Gunter R. Seckel. Washington, D.C., U.S. Government Printing Office, 1962. (Fishery Bulletin 193, Vol. 61)

U.S. National Park Service. Parks for America: A Survey of Park and Related Resources in the Fifty States, and a Preliminary Plan. Washington, D.C., U.S. Government Printing Office, 1964.

U.S. Naval Oceanographic Office. World Port Index. Washington, D.C., U.S. Government Printing Office, 1963. (Pub. 150)

U.S. Office of Geography. Hawaiian Islands: Official Standard Names Approved by the United States Board on Geographic Names. Washington, D.C., U.S. Government Printing Office, September 1956. (Gazetteer No. 24)

U.S. Weather Bureau. Weather Summary for Naval Air Pilot, Central Pacific, Hawaiian Islands Area. Washington, D.C., U.S. Navy Hydrographic Office, 1944. (H.O. No. W-270)

U.S. Weather Bureau and U.S. Navy Hydrographic Office. Climatological and Oceanographic Atlas for Mariners, Volume II, North Pacific Ocean. Washington, D.C., U.S. Government Printing Office, 1961.

Waldo, Myra. Travel Guide to the Orient and the Pacific. New York, Macmillan, 1965.

Wiens, Harold J. Pacific Island Bastions of the United States. New York, Van Nostrand, 1962.

APPENDIX

Table 4. List of Available Hawaiian Island Charts, U.S. Naval Oceanographic Office and U.S. Coast and Geodetic Survey

Chart	Title and Contents of Charts	Scale		Edition		
		Natural 1:	Inch To Mile	No.	Date	Price
	U.S. NAVAL OCEANOGRAPHIC OFFICE CHARTS					
5355	Approaches to Johnston Island	200,000	0.36	1	Apr 1964	2.00
5356	Johnston Island and Reef	25,000	2.92	6	Aug 1964	2.60
5652	Hawaiian Islands Area--Eastern Part	3,130,860	0.02	1	Mar 1939	2.00
5655	Hawaiian Islands to Samoa	3,373,450	0.02	1	Jan 1942	2.60
	U.S. COAST AND GEODETIC SURVEY CHARTS					
†4000	Hawaiian Archipelago	3,121,170	0.02	8	Apr 1965	.75
†4001	Hawaii to French Frigate Shoals	1,650,000	0.04	4	Oct 1963	1.00
4171	French Frigate Shoals Anchorage	25,000	2.92	2	Jul 1965	1.00
4172	French Frigate Shoals	80,000	0.91	2	Apr 1965	1.00
4173	Gardner Pinnacles and Approaches Plan: Gardner Pinnacles (Not shown on Index)	100,000 20,000	0.73 3.65	1	Jan 1947	1.00
4174	Moro Reef	80,000	0.91	1	Feb 1945	.75
4175	Pearl and Hermes Reef	40,000	1.82	1	Feb 1947	1.00
4176	Midway Islands	10,000	7.30	5	Aug 1961	[illegible]
4177	Kure Island	20,000	3.65	1	Feb 1946	.50
†4179	Hawaiian Islands, Southern Part	675,000	0.11	3	Aug 1965	.75
†4180	Hawaiian Islands, Northern Part	675,000	0.11	4	Nov 1964	.75
†4181	Nihoa Island to French Frigate Shoals Plans: Necker Island Nihoa	663,392 20,000 20,000	0.11 3.65 3.65	2	Nov 1963	1.00
4182	French Frigate Shoals to Laysan Island	653,219	0.11	1	Feb 1941	1.00
4183	Laysan Island to Kure Island	642,271	0.11	3	Dec 1964	1.00
4185	Midway Islands and Approaches	80,000	0.91	2	Aug 1965	1.00
4186	Lisianski and Laysan Islands Plans: Lisianski Island Laysan Island West Coast of Laysan Island	40,000 40,000 10,000	1.82 1.82 7.30	1	Dec 1942	1.00
4188	Midway Islands	32,500	2.25	3	May 1963	1.00

†Includes LORAN lines of position.

Table 5. List of Available Charts, Hawaii to Niihau, U.S. Naval Oceanographic Office and U.S. Coast and Geodetic Survey

Chart	Title and Contents of Charts	Scale		Edition		
		Natural 1:	Inch To Mile	No.	Date	Price
	U.S. NAVAL OCEANOGRAPHIC OFFICE CHARTS—FOR OFFICIAL USE ONLY					
1800	Pearl Harbor	12,500	5.84	24	Jun 1963	
	Anchorage Charts					
Anch DA	Port Walanae	10,000	7.30	1	Feb 1952	
	Operating Area Charts					
5695-0A	Hawaiian Islands (Hawaiian Operating Areas)	600,000	0.12	11	Jan 1965	
5696-0A	Oahu Area (Hawaiian Operating Areas)	219,000	0.33	5	Jul 1963	
5697-0A	Area West of Oahu (Hawaiian Operating Areas)	248,260	0.29	4	Jul 1963	
5698-0A	Hawaiian Operating Areas, Maui, Molokai, Lanai, and Kahoolawe Area	80,000	0.91	2	Mar 1965	
5699-0A	Kahului Harbor and Approaches (Island of Maui) (Hawaiian Operating Areas)	30,000	2.43	3	Aug 1965	
	Plan: Kahului Harbor	10,000	7.30			
	U.S. COAST AND GEODETIC SURVEY CHARTS					
4100	Island of Kauai	80,000	0.91	1	Sep 1959	1.00
4101	Mahukona Harbor and Approaches	5,000	14.59	2	Jan 1931	.25
14102	Hawaiian Islands	600,000	0.12	20	Jul 1964	1.00
4103	Hilo Bay--Island of Hawaii	10,000	7.30	14	Jan 1965	.50
4104	Maalaea Bay (Island of Maui)	10,000	7.30	4	Jun 1964	1.00
4108	Port Allen (Kauai)	5,000	14.59	10	Aug 1965	.25
4109	Honolulu Harbor (Island of Oahu)	5,000	14.59	25	Aug 1965	1.00
	Plan: Continuation of Keehi Lagoon Barge Channel (Not shown on Index)	5,000	14.58			
4110	Island of Oahu	80,000	0.91	8	Jan 1964	1.00
4111	Nawiliwili Bay (Kauai)	5,000	14.59	11	Sep 1965	.50
4112	Hanamaulu Bay (Kauai)	2,500	29.19	4	Aug 1939	.25
4113	Hana Bay (Maui)	5,000	14.59	3	Oct 1941	.25
4114	Approaches to Waimea Bay	10,000	7.30	3	Jul 1963	.75
4115	Island of Hawaii	250,000	0.29	8	Sep 1963	1.00
4116	Hawaii to Oahu	250,000	0.29	12	Aug 1964	1.00
4117	Oahu to Niihau	247,482	0.30	7	Aug 1965	1.00
4118	Haena Point to Kepuhi Point (North Coast of Kauai)	20,000	3.65	1	Mar 1930	.75
4120	Channels between Oahu, Molokai, and Lanai	80,000	0.91	1	Mar 1942	1.00
4121	Harbors of Molokai			4	Oct 1937	.75
	Plans: Kaunakai Harbor	5,000	14.59			
	Pukoo Harbor	5,000	14.59			
	Kamalo Harbor	5,000	14.59			
	Kolo Harbor	5,000	14.59			
	Papohaku Roadstead	5,000	14.59			
4122	Kaumalapau Harbor (Lanai)	2,500	29.19	1	Nov 1929	.25
4123	Kealakekua Bay to Honaunau Bay	10,000	7.30	1	Jul 1928	.50
4124	Kahului Harbor and Approaches (Island of Maui)	30,000	2.43	3	May 1965	.75
	Plan: Kahului Harbor	10,000	7.30			
4125	Approaches to Lahaina--Island of Maui	15,000	4.86	1	Mar 1965	1.00
4130	Channels between Molokai, Maui, Lanai, and Kahoolawe	80,000	0.91	4	Aug 1964	1.00
4131	Southeast Coast of Oahu--Waimanalo Bay to Diamond Head	20,000	3.65	4	May 1950	1.00
4132	South Coast of Oahu--Diamond Head to Pearl Harbor Entrance	20,000	3.65	11	Apr 1964	1.00
4133	South Coast of Oahu--Ahua Point to Barbers Point	20,000	3.65	6	Apr 1964	.75
4134	Kaneohe Bay (Oahu--East Coast)	15,000	4.86	3	Jun 1964	1.00
4140	West Coast of Hawaii--Cook Point to Upolu Point	80,000	0.91	2	Jun 1964	1.00
4161	Paauhau Landing	5,000	14.59	1	Oct 1933	.50
4162	Harbors and Landings on the Northeast and Southeast Coasts of Hawaii			1	Apr 1931	.75
	Plans: Kukuihaele Landing	2,500	29.19			
	Honokaa Landing	2,500	29.19			
	Punaluu Harbor	2,500	29.19			
	Honuapo Harbor	2,500	29.19			
4163	Keauhou Bay	2,500	29.19	2	Sep 1956	.25
4164	Kailua Bay	5,000	14.59	1	Aug 1932	.25
4167	Kawaihae Bay	10,000	7.30	2	Jun 1959	1.00

[1]Includes LORAN lines of position.

Table 6. Transpacific Distances

Figure at intersection of columns opposite ports in question is the nautical mileage between the two. Example: San Francisco, California, is 2091 nautical miles from Honolulu, Hawaii.

Panama Canal (Pac. Ent.) 8°53.0'N., 79°31.0'W.	San Diego, Calif. 32°43.0'N., 117°10.5'W.	Long Beach, Calif. 33°46.2'N., 118°13.3'W.	Los Angeles, Calif. 33°45.0'N., 118°16.2'W.	San Francisco, Calif. 37°48.5'N., 122°24.0'W.	Astoria, Oreg. 46°11.7'N., 123°50.0'W.	Portland, Oreg. 45°33.0'N., 122°41.7'W.	CAPE FLATTERY, WASH. 48°26.0'N., 124°47.0'W.	SWIFTSURE BANK, WASH. 48°31.0'N., 125°00.0'W.	Seattle, Wash. 47°36.2'N., 122°20.3'W.	Ketchikan, Alaska 55°20.5'N., 131°38.7'W.	Sitka, Alaska 57°03.1'N., 135°20.5'W.	CAPE SPENCER, ALASKA 58°10.0'N., 136°38.3'W.	Seward, Alaska 60°06.0'N., 149°26.0'W.	Anchorage, Alaska 61°14.2'N., 149°53.3'W.	Kodiak, Alaska 57°47.1'N., 152°25.1'W.	UNIMAK PASS, ALASKA 54°20.0'N., 164°45.0'W.	Uk Bay, Alaska °51.6'N., 176°37.6'W.	Hilo, Hawaii 19°44.1'N., 155°03.5'W.	Kawaihae, Hawaii 20°02.3'N., 155°49.9'W.	Kahului, Hawaii 20°54.0'N., 156°28.2'W.	Honolulu, Hawaii 21°18.5'N., 157°52.3'W.	Pearl Harbor, Hawaii 21°20.0'N., 157°58.3'W.	Nawiliwili, Hawaii 21°57.4'N., 159°21.5'W.	Port Allen, Hawaii 21°54.1'N., 159°35.6'W.	Midway Islands 28°13.0'N., 177°22.0'W.
2887																										
2939	94																									
2939	95	3																								
3270	455	374	371																							
3803	989	908	904	367																						
3888	1074	992	989	652	85																					
3920	1104	1024	1020	685	153	238																				
--	--	--	--	--	--	--	10																			
4044	1228	1148	1144	807	278	362	124	134																		
4387	1575	1497	1493	1156	660	745	--	518	659*																	
4538	1723	1643	1639	1302	815	900	--	681	815	224																
4603	1787	1707	1703	1366	883	968	--	739	976*	307	85															
4940	2124	2043	2040	1702	1242	1327	--	1100	1234	682	494	422														
5117	2302	2223	2220	1882	1435	1520	--	1294	1428	892	708	641	274													
4924	2115	2034	2031	1693	1261	1346	--	1124	1258	742	564	505	175	242												
5228	2412	2331	2328	1990	1626	1771	--	1510	1644	1193	1027	987	652	888	505											
5604	2806	2725	2722	2403	2071	2156	--	1973	2107	1656	1490	1450	1115	1151	968	463										
4527	2175	2143	2140	2019	2214	2299	2260	--	2384	2398	2410	2447	2439	2542	2296	2126										
4594	2219	2183	2180	2051	2235	2320	2276	--	2400	2405	2412	2445	2432	2535	2289	2110	2184	83								
4609	2212	2173	2170	2036	2207	2292	2245	--	2369	2361	2365	2398	2377	2479	2233	2044	2099	121	85							
4685	2278	2236	2233	2091	2246	2331	2285	--	2409	2383	2385	2411	2373	2477	2230	2028	2061	196	140	89						
4690	2283	2241	2238	2096	2251	2336	2290	--	2414	2388	2390	2416	2378	2482	2235	2024	2057	201	145	94	9					
4767	2330	2284	2281	2128	2262	2347	2289	--	2413	2368	2361	2388	2332	2440	2184	1963	1989	287	230	181	96	92				
4777	2347	2302	2299	2146	2281	2366	2308	--	2432	2387	2380	2407	2351	2459	2203	1972	1990	297	240	193	108	102	21			
5707	3097	3034	3031	2792	2724	2809	2694	--	2818	2570	2481	2472	2250	2305	2088	1680	1460	1338	1278	1232	1150	1146	1069	1042		

*Via inside passage

Table 7. Hawaii Distances

Figure at intersection of columns opposite ports in question is the nautical mileage between the two. Example: Hilo is 196 nautical miles from Honolulu.

Hilo, Hawaii 19°44.1'N., 155°03.5'W.	Napoopoo, Hawaii 19°28.6'N., 155°55.3'W.	Kailua, Hawaii 19°38.6'N., 156°00.0'W.	Kawaihae, Hawaii 20°02.3'N., 155°49.9'W.	Mahukona, Hawaii 20°11.2'N., 155°54.2'W.	Hana, Maui 20°45.6'N., 155°59.1'W.	Lahaina (Mala), Maui 20°53.5'N., 156°41.5'W.	Kahului, Maui 20°54.0'N., 156°28.2'W.	Kaumalapau, Lanai 20°47.4'N., 156°58.7'W.	Kamalo, Molokai 21°02.9'N., 156°52.7'W.	Kaunakakai, Molokai 21°05.1'N., 157°02.0'W.	Halcolono, Molokai 21°05.2'N., 157°15.2'W.	Kalaupapa, Molokai 21°11.7'N., 156°59.3'W.	Honolulu, Oahu 21°18.5'N., 157°52.3'W.	Pearl Harbor, Oahu 21°29.0'N., 157°58.3'W.	Ahukini, Kauai 21°58.7'N., 159°20.1'W.	Nawiliwili, Kauai 21°57.4'N., 159°21.5'W.	Port Allen, Kauai 21°54.1'N., 159°35.6'W.	Waimea, Kauai 21°57.4'N., 159°40.4'W.	Hanalei, Kauai 22°12.8'N., 159°30.1'W.	Nonopapa, Niihau 21°52.0'N., 160°14.1'W.	Midway Islands 28°13.0'N., 177°22.0'W.	Johnston Island 16°44.6'N., 169°31.2'W.	Palmyra Island 5°52.5'N., 162°08.0'W.
120																								
109	11																							
83	45	34																						
72	50	39	12																					
85	84	73	48	36																				
125	99	88	72	63	57																			
121	120	110	85	74	37	27																		
136	101	91	82	76	72	25	50																	
137	112	102	86	77	59	15	30	25																
145	120	109	93	85	69	23	39	21	12															
155	124	114	103	95	80	34	50	24	22	13														
154	138	127	110	102	70	39	41	54	37	45	33													
196	157	147	140	133	119	73	89	60	61	52	40	53												
201	162	152	145	138	124	78	94	65	66	57	45	58	9											
287	245	236	230	223	210	165	181	151	153	144	132	143	96	92										
287	244	235	230	223	210	165	181	151	153	144	132	144	96	92	5									
297	254	245	240	233	220	177	193	161	163	154	142	156	106	102	23	21								
303	260	251	246	239	226	182	199	167	169	160	148	162	112	108	29	27	8							
308	266	257	251	244	224	186	194	172	173	164	152	159	116	112	29	32	42	35						
332	287	278	277	272	262	214	232	199	203	193	181	194	147	143	65	63	45	40	52					
1338	--	--	1278	--	--	--	1232	--	--	--	--	--	1150	1146	--	1069	1042	--	--	--				
905	--	--	811	--	--	--	798	--	--	--	--	--	725	722	--	668	656	--	--	--	825			
959	--	--	928	--	--	--	1010	--	--	--	--	--	959	960	--	986	979	--	--	--	1606	785		

Table 8. Climatic Data, Honolulu, Hawaii (Federal Building) 21°19′N 157°52′W. Elevation (ground) 12 feet. WB–1961

Month	Air Temperature (Degrees Fahrenheit)					Precipitation (Inches)			Humidity (Percent)		Wind (Knots)			Percent of Possible Sunshine	Mean Sky Cover Sunrise to Sunset	Mean Number of Days						
	Normal			Extreme												Sunrise to Sunset			Precipitation 0.01 inch or More	Snow, Sleet 1.0 Inch or More	Thunder-storms	Heavy Fog
	Daily Maximum	Daily Minimum	Monthly	Record Highest	Record Lowest	Normal Total	Maximum in 24 Hours	Snow, Sleet, Mean Total	8:00 a.m. HST	2:00 p.m. HST	Mean Speed	Prevailing Direction	Maximum Speed and Direction			Clear	Partly Cloudy	Cloudy				
(a)				39	39		39	39	15	15	12	12	10	9	15	12	12	12	39	39	12	12
January	76.7	67.2	72.0	83	57	4.31	8.06	0.0	80	61	8.7	ENE	58 SW	66	5.2	11	12	8	12	0	1	0
February	76.7	67.2	72.0	82	58	2.49	8.07	0.0	78	61	9.6	ENE	55 W	63	6.0	7	12	9	12	0	1	0
March	76.8	67.6	72.2	83	58	2.30	17.41	0.0	74	58	10.0	ENE	51 SE	73	5.8	8	14	9	13	0	1	0
April	77.7	68.8	73.3	83	59	2.05	7.98	0.0	71	57	10.6	ENE	35 NE	73	6.1	7	12	11	12	0	*	0
May	79.5	70.6	75.1	84	64	1.01	2.14	0.0	69	56	11.2	ENE	30 E	73	6.0	8	13	10	11	0	*	0
June	81.3	72.4	76.9	86	64	0.63	0.81	0.0	68	56	11.6	ENE	34 E	75	5.5	7	17	6	11	0	0	0
July	82.2	73.5	77.9	87	68	0.86	1.22	0.0	69	56	11.9	ENE	30 E	77	5.1	9	18	4	13	0	0	0
August	82.8	74.1	78.5	88	68	1.09	2.53	0.0	70	56	12.2	ENE	45 SE	76	5.2	8	17	6	13	0	0	0
September	82.9	73.7	78.3	88	69	1.34	6.02	0.0	70	55	10.3	ENE	30 NE	77	4.9	10	15	5	12	0	*	0
October	82.0	72.9	77.5	87	66	2.28	7.06	0.0	72	58	9.6	ENE	35 SE	72	5.5	8	14	9	12	0	1	0
November	79.7	70.7	75.2	86	62	2.08	6.18	0.0	74	61	9.9	ENE	36 NE	67	5.5	8	13	9	13	0	1	0
December	77.7	68.9	73.3	85	59	3.48	6.54	0.0	75	61	9.9	ENE	51 NE	61	5.4	9	13	9	14	0	1	0
Year	79.7	70.6	75.2	88	57	23.92	17.41	0.0	73	58	10.4	ENE	58 SW	71	5.5	100	170	95	148	0	5	0

Table 9. Climatic Data, Hilo, Hawaii (General Lyman Airport) 19°43'N 155°04'W. Elevation (ground) 31 feet. WB–1961

Month	Air Temperature (Degrees Fahrenheit)					Precipitation (Inches)			Humidity (Percent)		Wind (Knots)			Percent of Possible Sunshine	Mean Sky Cover Sunrise to Sunset	Mean Number of Days						
	Normal			Extreme												Sunrise to Sunset			Precipitation 0.01 Inch or More	Snow, Sleet 1.0 Inch or More	Thunder-storms	Heavy Fog
	Daily Maximum	Daily Minimum	Monthly	Record Highest	Record Lowest	Normal Total	Maximum in 24 Hours	Snow, Sleet, Mean Total	8:00 a.m. HST	2:00 p.m. HST	Mean Speed	Prevailing Direction	Maximum Speed and Direction			Clear	Partly Cloudy	Cloudy				
(a)				15	15		19	19	12	12	12	12		11	15	15	15	15	19	19	16	16
January	78.4	62.4	70.4	89	55	14.13	9.94	0.0	80	67	6.5	SW		46	6.8	5	11	15	19	0	*	0
February	79.0	62.4	70.7	88	55	0.48	13.41	0.0	82	69	6.8	SW		41	7.1	3	10	15	19	0	2	0
March	78.5	63.1	70.8	88	55	15.72	9.18	0.0	81	67	6.8	SW		41	7.7	2	10	19	23	0	1	0
April	79.2	64.0	71.6	87	56	13.27	9.39	0.0	82	69	6.5	WSW		33	8.2	1	7	22	25	0	1	0
May	81.1	65.1	73.1	85	58	9.00	5.94	0.0	81	69	6.3	WSW		31	8.2	1	9	21	25	0	*	0
June	82.5	66.3	74.4	88	60	6.75	2.25	0.0	79	65	6.3	WSW		42	7.5	2	11	17	24	0	*	0
July	82.6	67.0	74.8	88	62	9.89	5.42	0.0	82	67	6.3	WSW		44	7.6	1	12	18	28	0	*	0
August	83.1	67.7	75.4	93	63	11.92	9.27	0.0	83	70	6.3	WSW		38	7.9	1	9	21	27	0	*	0
September	83.0	67.5	75.3	92	62	10.42	6.02	0.0	80	66	6.2	WSW		41	7.1	2	12	16	24	0	*	0
October	81.5	66.8	74.5	91	62	11.02	8.88	0.0	81	68	6.0	SW		40	7.4	2	11	18	25	0	1	0
November	80.2	65.7	73.0	88	58	12.39	15.59	0.0	83	71	5.8	WSW		32	7.6	2	9	19	24	0	1	0
December	78.8	64.0	71.4	85	56	15.99	10.50	0.0	82	71	6.4	SW		37	7.4	3	10	18	24	0	*	0
Year	80.7	65.2	73.0	93	55	139.98	15.59	0.0	81	68	6.3	WSW		39	7.5	25	127	219	287	0	6	0

Table 10. Climatic Data, Lihue, Hawaii (Lihue Airport) 21°59'N 159°21'W. Elevation (ground) 115 feet. WB–1961

Month	Air Temperature (Degrees Fahrenheit)					Precipitation (Inches)			Humidity (Percent)		Wind (Knots)			Percent of Possible Sunshine	Mean Sky Cover Sunrise to Sunset	Mean Number of Days						
	Normal			Extreme												Sunrise to Sunset						
	Daily Maximum	Daily Minimum	Monthly	Record Highest	Record Lowest	Normal Total	Maximum in 24 Hours	Snow, Sleet, Mean Total	8:00 a.m. HST	2:00 p.m. HST	Mean Speed	Prevailing Direction	Maximum Speed and Direction			Clear	Partly Cloudy	Cloudy	Precipitation 0.01 Inch or More	Snow, Sleet 1.0 Inch or More	Thunder-storms	Heavy Fog
(a)				11	11		11	12	12	12	11	11	11	11	12	11	11	11	11	12	11	12
January	77.4	62.7	70.1	84	53	6.23	11.09	0.0	84	67	8.9	ENE	31 SW	51	5.9	8	12	11	15	0	1	0
February	77.7	62.5	70.1	86	53	4.44	7.28	0.0	82	67	10.0	NE	30 E	51	6.4	6	11	11	16	0	1	0
March	77.7	63.5	70.6	85	51	4.07	4.74	0.0	79	65	9.9	NE	31 N	50	6.4	5	14	12	16	0	1	0
April	78.2	65.7	72.0	87	56	3.03	1.50	0.0	76	66	10.4	NE	25 NE	47	7.1	4	12	14	15	0	*	0
May	79.8	68.3	74.1	85	59	2.51	3.30	0.0	75	65	10.8	NE	43 NE	53	6.9	3	14	14	16	0	*	0
June	81.2	71.1	76.2	88	64	1.65	0.80	0.0	75	65	10.9	NE	26 NE	61	6.6	3	15	12	17	0	0	0
July	82.4	72.4	77.4	88	65	1.87	5.04	0.0	76	65	10.9	NE	27 NE	61	6.5	3	18	10	20	0	*	0
August	83.3	72.9	78.1	89	66	2.27	5.43	0.0	76	66	11.2	NE	63 NE	61	6.7	3	16	12	19	0	*	0
September	83.6	72.0	77.8	89	65	2.20	1.98	0.0	77	65	9.7	NE	26 NE	68	5.8	6	16	8	16	0	1	0
October	82.6	70.3	76.5	90	63	4.63	4.99	0.0	79	67	9.3	NE	28 E	59	6.2	5	14	12	19	0	1	0
November	79.7	67.5	73.6	86	57	4.24	11.20	0.0	81	69	10.2	NE	37 S	52	6.4	4	14	12	18	0	1	0
December	77.8	65.2	71.5	85	52	5.35	5.40	0.0	80	68	9.9	NE	90 NE	49	6.5	5	14	12	18	0	1	0
Year	80.1	67.8	74.0	90	51	42.49	11.20	0.0	78	66	10.2	NE	63 NE	55	6.5	55	170	140	205	0	8	0

Table 11. Mean Surface Water Temperatures and Salinities

Station	Years	January		February		March		April		May		June		July		August		September		October		November		December		Mean	
		Temp. °F	Sal. ‰	Temp °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰	Temp. °F	Sal. ‰
Honolulu, Hawaii 21°18 N 157°52 W	18	76.0	34.2	76.0	34.5	75.9	34.5	76.6	34.8	77.6	34.8	78.7	34.9	79.8	34.9	80	34.9	80.5	34.9	80.4	34.9	78.8	34.8	77.0	34.8	78.1	34.7
Kaneohe Bay, Hawaii 21°26 N 157°48 W	6	73.1	34.5	72.9	34.4	74.0	34.0	75.2	34.4	77.0	34.6	79.3	35.0	79.4	35.0	80.0	35.0	79.6	35.1	79.1	34.9	76.3	34.4	73.2	34.4	76.6	34.6
Midway Islands 28°13 N 177°22 W	16	67.6	35.5	67.2	35.5	68.4	35.5	69.8	35.7	72.6	35.8	77.0	35.8	79.4	35.9	80.3	35.8	80.4	35.8	77.3	35.7	73.7	35.8	70.5	35.5	73.7	35.7

‰: This symbol denotes the salinity of sea water, and is defined as the number of grams of salts in 1,000 grams of sea water. For sea water temperature and salinity in greater detail, see Coast and Geodetic Survey Publication 31-3, Surface Water Temperature and Salinity, Pacific Coast, North and South America and Pacific Ocean Islands.

Table 12. Climatic Data, Kauai, Comparing Leeward Stations With Upland Stations

Station Elevation (Feet) Years of Record	Coastal			Upland	
	Mana 11 54		Kekaha 9 64	Puehu Ridge 1,660 19	Kanalohuluhulu 3,600 4
	Average Temperature (Degrees Fahrenheit)	Average Rainfall (Inches)	Average Rainfall (Inches)	Average Rainfall (Inches)	Average Rainfall (Inches)
January	70.5	3.77	3.70	6.04	14.53
February	70.7	2.53	2.83	3.44	14.19
March	71.0	2.23	2.16	3.10	6.10
April	72.4	1.41	1.21	2.76	3.20
May	74.6	0.99	0.79	2.01	1.55
June	76.4	0.82	0.61	0.97	1.24
July	77.4	0.79	0.60	1.13	2.74
August	78.1	1.23	1.09	2.10	2.56
September	77.6	0.97	0.77	1.18	2.40
October	76.3	1.63	1.62	1.55	4.69
November	73.8	1.84	1.55	2.19	10.62
December	71.4	3.37	3.44	5.11	12.58
Annual average	74.2	21.58	20.37	32.58	76.40
Extreme high	92 (1958)	42.46 (1951)	45.99 (1951)	65.04 (1951)	85.72 (1956)
Extreme low	50 (1950)	10.39 (1953)	6.85 (1953)	18.08 (1952)	65.09 (1958)

Table 13. Rainfall Data, Kauai, Selected Stations

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Anahola, latitude missing, longitude missing, elevation 20 feet													
Average, 7 years	5.33	5.20	6.06	3.99	3.57	1.73	2.50	2.94	3.64	5.68	4.73	4.53	49.90
Hanalei, latitude 22°13'N, longitude 159°30'W, elevation 10 feet													
Average, 18 years	6.48	9.83	15.02	7.90	6.36	5.28	6.67	8.35	6.40	7.61	9.24	9.31	98.50
Maximum, 24 hours, 5 years	5.30	8.00	5.60	3.48	3.10	2.80	2.59	8.00	4.70	2.23	3.85	4.13	8.00
Number days 5 years	15	12	19	15	14	14	14	17	13	17	14	19	183
Hanamaulu, latitude 22°00'N, longitude 159°21'W, elevation 175 feet													
Average, 46 years	7.51	4.81	6.72	3.88	3.37	2.52	3.29	2.91	3.66	4.59	5.90	6.53	55.69
Maximum, 24 hours, 34 years	12.80	6.85	7.84	6.98	5.99	3.46	19.94	3.16	9.58	10.45	9.00	13.01	19.94
Number days 34 years	13	11	14	12	13	13	15	15	15	16	15	14	166
Hiloa Manawalopuna Divide, latitude 22°01'N, longitude 159°32'W, elevation 2,030 feet													
Average, 29 years	21.38	12.91	17.61	17.27	17.46	16.32	20.74	20.05	19.51	16.23	19.72	19.63	218.85
Homestead, latitude 21°56'N, longitude 159°32'W, elevation 700 feet													
Average, 29 years	6.91	3.96	4.96	3.52	3.11	3.11	4.04	3.62	4.27	4.21	5.16	5.90	53.02
Maximum, 24 hours, 29 years	8.25	3.50	9.05	4.40	2.15	6.03	4.17	3.63	3.50	2.95	6.67	3.70	9.05
Number days 28 years	15	11	12	10	13	13	17	15	15	15	14	14	164
Pali Trail, latitude 21°58'N, Longitude 159°40'W, elevation 850 feet													
Average, 5 years	2.39	1.72	1.82	1.37	1.22	0.51	0.42	0.17	1.58	1.44	1.20	1.97	15.81
Papuaa, latitude 21°58'N, longitude 159°28'W, elevation 538 feet													
Average, 24 years	11.30	6.43	10.53	7.54	7.21	5.96	7.?7	8.08	7.62	8.32	8.33	10.92	100.30
Maximum, 24 hours, 20 years	10.45	10.54	8.47	4.94	5.14	10.02	7.85	6.09	4.07	4.13	5.85	20.75	20.75
Number days 20 years	19	16	19	19	22	22	27	26	24	22	19	18	253
West Lawai, latitude 21°54'N, longitude 159°31'W, elevation 240 feet													
Average, 37 years	5.64	3.65	5.12	2.84	2.33	2.07	2.85	2.85	3.28	3.43	4.06	4.88	43.00
Maximum, 24 hours, 34 years	8.76	3.20	8.55	6.61	2.86	4.40	2.15	5.50	4.13	3.36	8.80	4.60	8.80
Number days 34 years	13	10	12	12	13	13	17	16	15	14	12	14	161

Table 14. Monthly Temperatures, Extreme Temperature Ranges, and Number of Days of Observations for Barking Sands

Month	Average Maximum (Degrees Fahrenheit)	Average Minimum (Degrees Fahrenheit)	Absolute Range (Degrees Fahrenheit)	Days
January	80	65	84 to 59	93
February	80	65	85 to 56	85
March	80	65	85 to 60	93
April	82	66	87 to 62	94
May	84	68	88 to 65	93
June	86	69	90 to 67	107
July	86	70	91 to 67	124
August	87	70	90 to 67	124
September	86	70	90 to 65	120
October	85	69	91 to 65	124
November	85	68	86 to 62	120
December	81	65	89 to 59	124
Annual	83	67	91 to 56	1,301

PROCLAMATIONS

No. 3309

August 25, 1959, 24 F.R. 6868

ADMISSION OF THE STATE OF HAWAII INTO THE UNION BY THE PRESIDENT OF THE UNITED STATES OF AMERICA A PROCLAMATION

WHEREAS the Congress of the United States by the act approved on March 18, 1959 (73 Stat. 4),[1] accepted, ratified, and confirmed the constitution adopted by a vote of the people of Hawaii in an election held on November 7, 1950, and provided for the admission of the State of Hawaii into the Union on an equal footing with the other States upon compliance with certain procedural requirements specified in that act; and

WHEREAS it appears from the information before me that a majority of the legal votes cast at an election of June 27, 1959, were in favor of each of the propositions required to be submitted to the people of Hawaii by section 7(b) of the act of March 18, 1959; and

WHEREAS it further appears from information before me that a general election was held on July 18, 1959, and that the returns of the general election were made and certified as provided in the act of March 18, 1959; and

WHEREAS the Governor of Hawaii has certified to me the results of the submission to the people of Hawaii of the three propositions set forth in section 7(b) of the act of March 18, 1959, and the results of the general election; and

WHEREAS I find and announce that the people of Hawaii have duly adopted the propositions required to be submitted to them by the act of March 18, 1959, and have duly elected the officers required to be elected by that act:

NOW, THEREFORE, I, DWIGHT D. EISENHOWER, President of the United States of America, do hereby declare and proclaim that the procedural requirements imposed by the Congress on the State of Hawaii to entitle that State to admission into the Union have been complied with in all respects and that admission of the State of Hawaii into the Union on an equal footing with the other States of the Union is now accomplished.

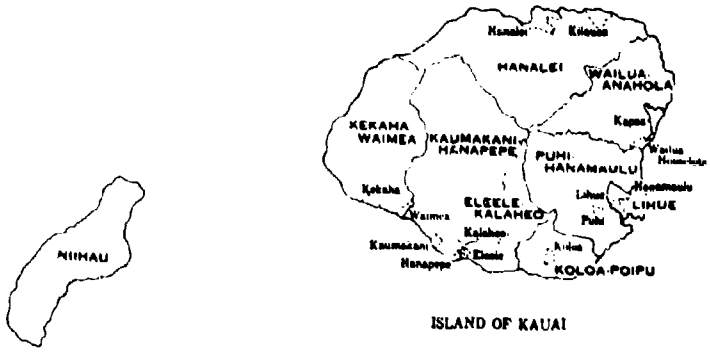
IN WITNESS WHEREOF, I have hereunto set my hand and caused the Seal of the United States of America to be affixed.

Done at the City of Washington at four p. m. E.D.T. on this twenty-first day of August in [SEAL] the year of our Lord nineteen hundred and fifty-nine, and of the Independence of the United States of America the one hundred and eighty-fourth.

DWIGHT D. EISENHOWER

CHRISTIAN A. HERTER,
Secretary of State.

Figure 13. Proclamation of Admission of the State of Hawaii Into the Union.



KAUAI COUNTY

Kauai County	28,176
Eleele-Kalaheo division	4,212
Hanapepe (U)	384
Kalaheo (U)	1,185
Hanalei division	1,312
Kapaa division	3,439
Kapaa (U)	3,439
Kaumakani-Hanapepe division	2,834
Hanapepe (U)	999
Kekaha-Waimea division	3,969
Kekaha (U)	2,082
Waimea (U)	1,312
Koloa-Poipu division	2,800
Koloa (U)	1,426
Lihue division	4,106
Lihue (U)	3,908
Niihau division	254
Puhi-Hanamaulu division	2,191
Wailua-Anahola division	3,059
Wailua Houselots (U)	1,129

"U" denotes an unincorporated place.

Figure 14. Population of Kauai County by Census Divisions, 1960.

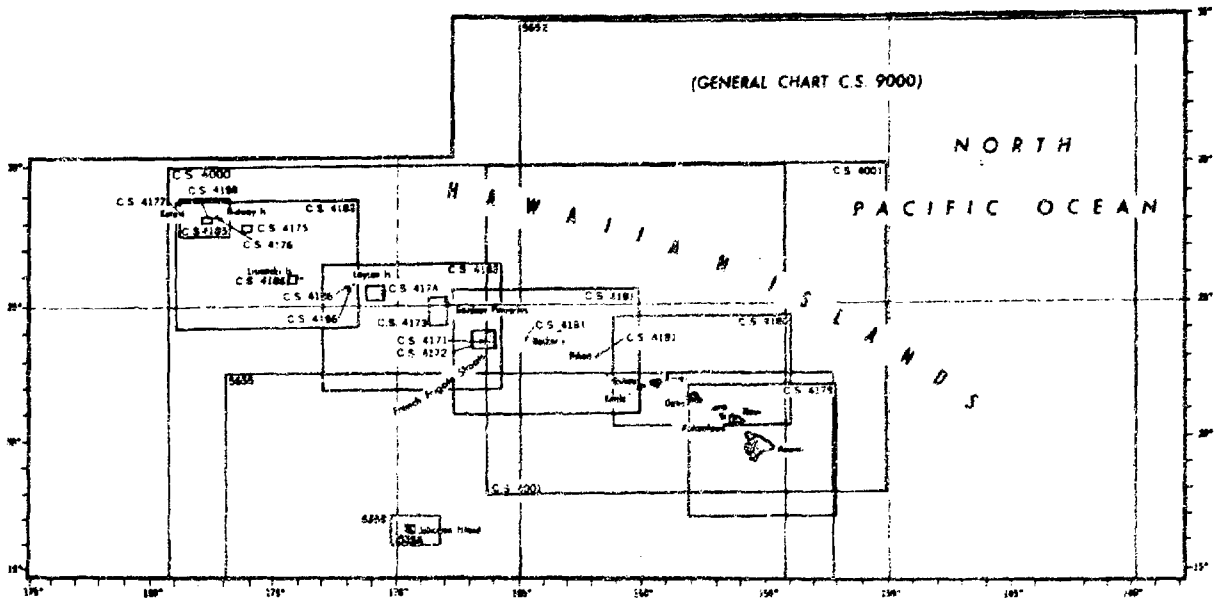


Figure 15. Graphic index of U.S. Oceanographic Office and U.S. Coast and Geodetic Survey Charts: Hawaiian Islands.

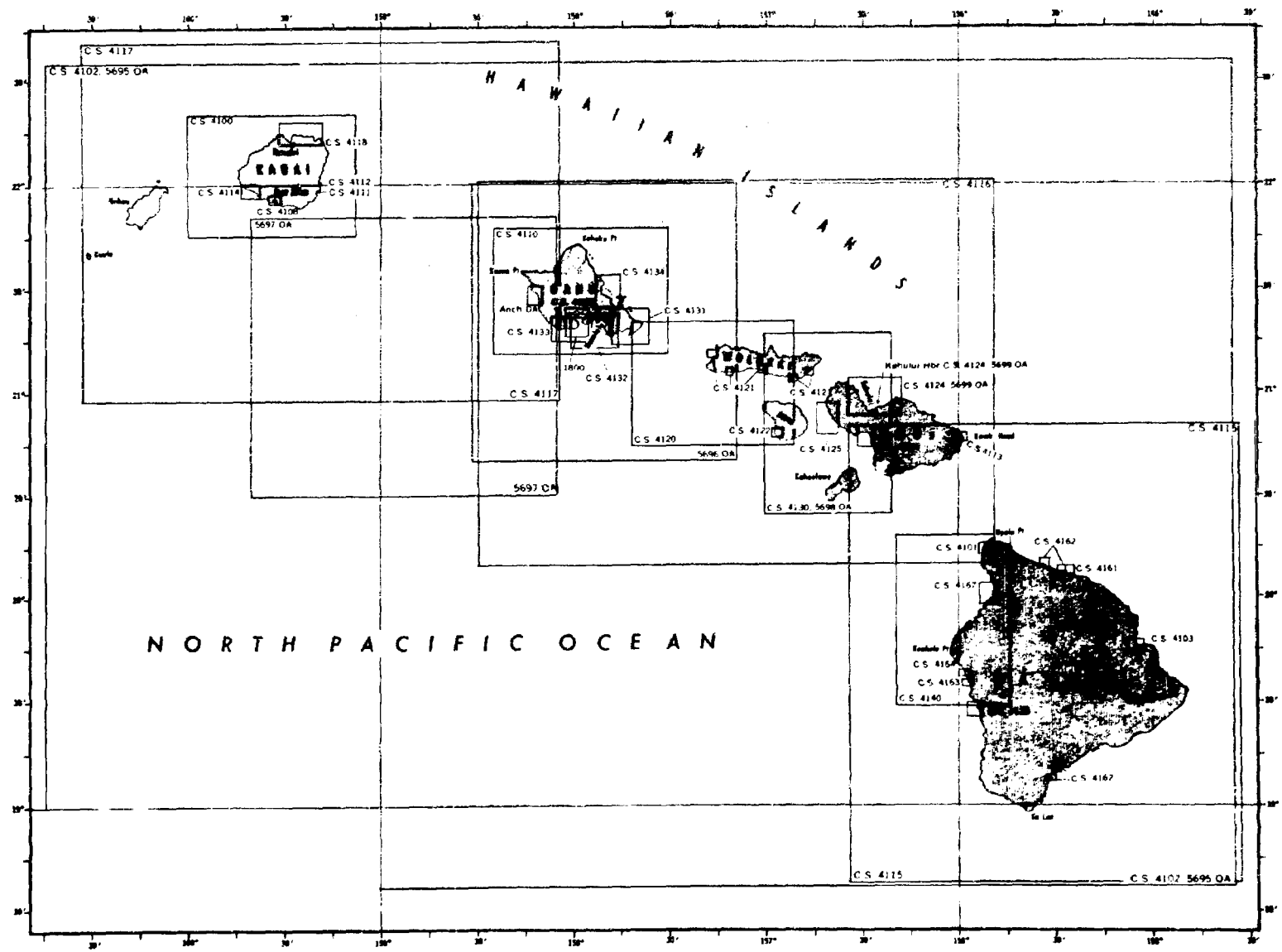
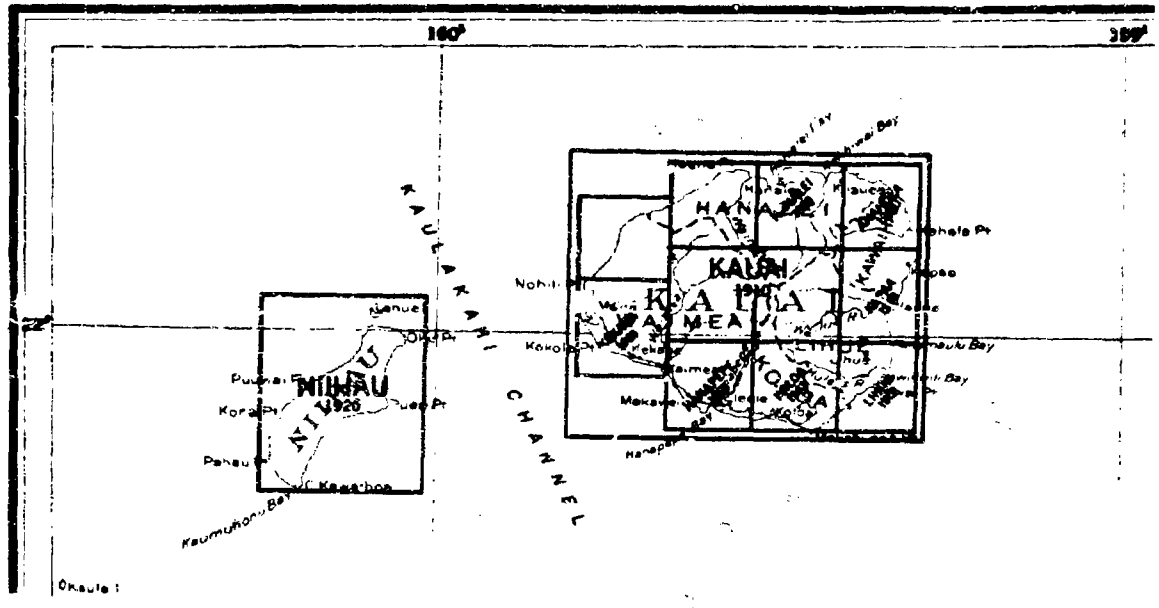


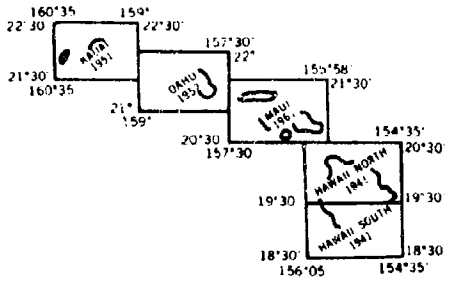
Figure 16. Graphic Index of U.S. Oceanographic Office and U.S. Coast and Geodetic Survey Charts: Hawaii to Niihau.



Kauai (Island), Hawaii. This map shows the island of Kauai, which is also the county of Kauai. Limiting parallels, 21°50′ and 22°15′. Limiting meridians, 159°15′ and 159°50′. Scale, 1:62,500, or about 1 mile to 1 inch. Contour interval, 50 feet. Size, 33 by 43 inches. 1910. Price, $1.

Niihau (Island), Hawaii. This map shows the island of Niihau. Limiting parallels, 21°46′ and 22°02′. Limiting meridians, 160°02′ and 160°15′. Scale, 1:62,500, or about 1 mile to 1 inch. Contour interval, 50 feet. Size, 19 by 22 inches. 1926. Price, 50 cents.

Figure 17. Index of U.S. Geological Survey Maps Available for Kauai and Niihau.



United States Series of Topographic Maps. This is a series of topographic maps produced by the Army Map Service, and published and distributed for civilian use by the Geological Survey. The following maps cover areas in Hawaii:

Hawaii North. Limiting parallels, 19°30′ and 20°30′. Limiting meridians, 154°35′ and 156°05′. Contour interval, 200 feet. Size, 22 by 34 inches. 1941. Also available in a woodland edition.

Hawaii South. Limiting parallels, 18°30′ and 19°30′. Limiting meridians, 154°35′ and 156°05′. Contour interval, 200 feet. Size, 22 by 32 inches. 1941. Also available in a woodland edition.

Kauai. Limiting parallels, 21°30′and 22°30′. Limiting meridians, 159° and 160°35′. Contour interval, 200 feet, with supplementary contours at 100-foot intervals. Size, 24 by 29 inches. 1951.

Maui. Limiting parallels, 20°30′ and 21°30′. Limiting meridians, 155°58′ and 157°30′. Contour interval, 200 feet. Size, 24 by 29 inches. 1961. Available in a woodland edition only.

Oahu. Limiting parallels, 21° and 22°. Limiting meridians, 157°30′ and 159°. Contour interval, 200 feet. Size, 22 by 34 inches. 1952.

Figure 18. Index of Army Map Service/Geological Survey 1:250,000 Scale Maps of the Hawaiian Islands.

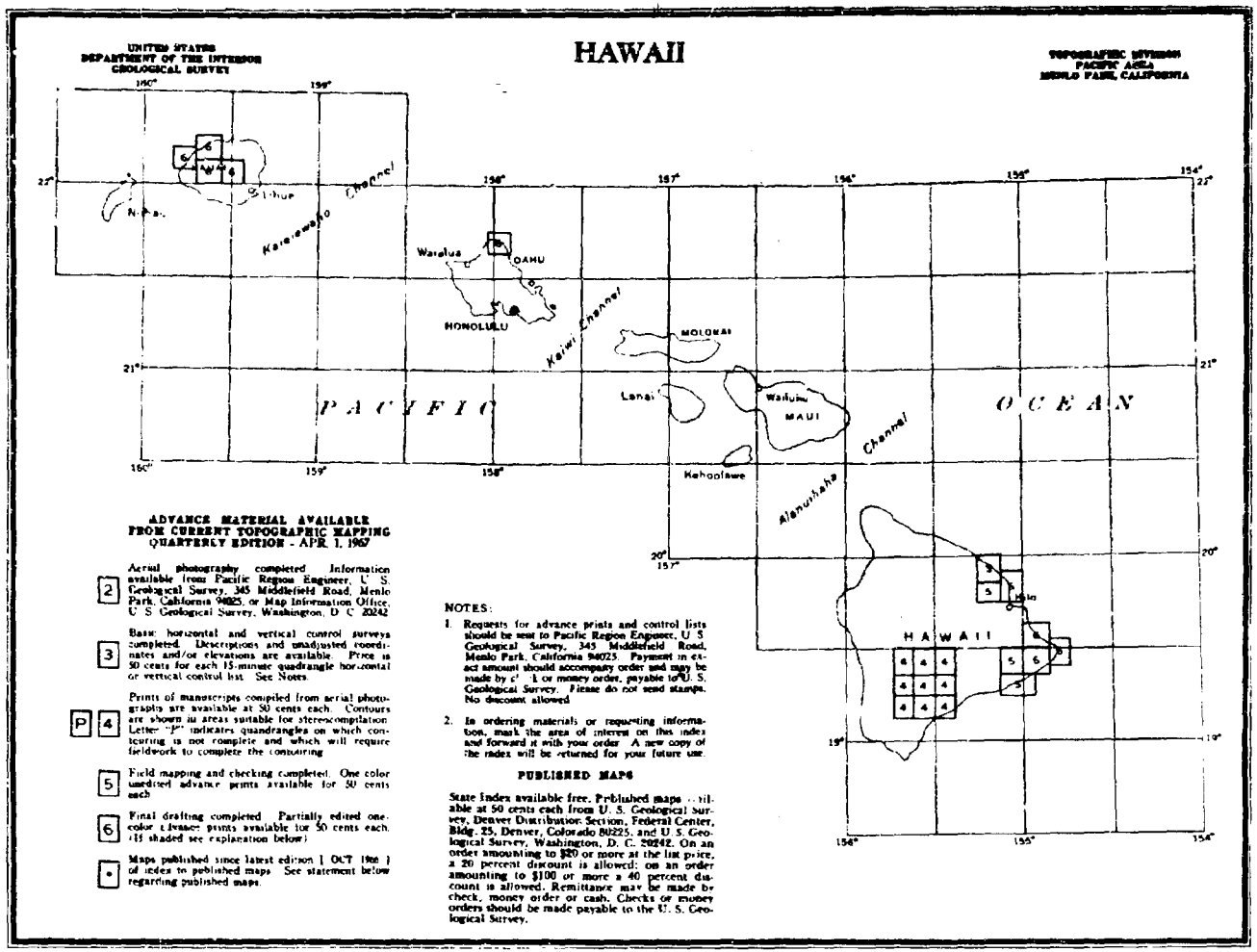


Figure 19. Index of Advance Material Available From U. S. Geological Survey From Current Topographic Mapping, 1 April 1967.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Pacific Missile Range Point Mugu, California	UNCLASSIFIED
	2b GROUP --

3 REPORT TITLE

HAWAIIAN ISLANDS AND THE BARKING SANDS TACTICAL UNDERWATER RANGE FACILITIES: GEOGRAPHIC BACKGROUND

4 DESCRIPTIVE NOTES (*Type of report and inclusive dates*)

5 AUTHOR(S) (*First name, middle initial, last name*)

J. K. Prince

6 REPORT DATE	7a. TOTAL NO OF PAGES	7b NO OF REFS
1 February 1968	42	43

8a CONTRACT OR GRANT NO	9a ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO --	PMR-TN-67-2
c.	9b. OTHER REPORT NO(S) (*Any other numbers that may be assigned this report*)
d.	

10 DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY
	Naval Air Systems Command

13 ABSTRACT

This technical note is intended to provide geographic and other background information to persons who have an interest in the Pacific Missile Range facilities at Barking Sands, Kauai, and in the State of Hawaii of which Kauai is a part.

The information set forth herein should be both useful and interesting to residents and visitors alike.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

UNCLASSIFIED

Security Classification

UNCLASSIFIED

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Geography Hawaiian Islands Island of Kauai BARSTUR Meteorological data Oceanographic data Charts and maps						

DD FORM 1 NOV 65 1473 (BACK)

(PAGE 2)

UNCLASSIFIED

Security Classification