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JOHN WAIHEE
GOVERNOR OF HAWAII

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

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

DOC. NO.: 2822

MAY 26 1993

MEMORANDUM

TO: Mr. Brian Choy, Director
Office of Environmental Quality Control

FROM: Keith W. Ahue, Chairperson
Department of Land and Natural Resources

Subject: Final Environmental Assessment for GTE Hawaiian Tel Submarine Interisland Fiber Optic Cable System, State of Hawaii

The Department of Land and Natural Resources has reviewed the final Environmental Assessment (EA) for the subject project and has determined the project will not have any significant impacts on the environment. Based on our determination, we are filing a negative declaration for this project.

Enclosed are four copies of the final EA.

Please do not hesitate to contact Mr. Don Horiuchi of our Office of Conservation and Environmental Affairs at 587-0377 if you have any questions.

Enclosure

cc: Brian Takeda, R.M. Towill Corp.

1993-06-23-OA-FEA-GTE Hawaiian Tel Interisland Fiber Optic Cable System

FILE COPY JUN 23 1993

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Final Environmental Assessment for the

GTE HAWAIIAN TEL INTERISLAND FIBER OPTIC CABLE SYSTEM

Wailua Golf Course, Kauai
Kahe Point Beach Park, Oahu
Sandy Beach Park, Oahu
Mokapu Beach, Maui
Spencer Beach Park, Hawaii

PREPARED FOR:
GTE Hawaiian Tel
1177 Bishop Street
Honolulu, Hawaii 96813

MAY 1993

RMTC

R. M. Towill Corporation

420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817-4941
(808) 842-1133 • Fax: (808) 842-1937

FINAL

ENVIRONMENTAL ASSESSMENTS

FOR THE

GTE HAWAIIAN TEL
INTERISLAND FIBER OPTIC CABLE SYSTEM

Wailua Golf Course, Kauai
Kahe Point Beach Park, Oahu
Sandy Beach Park, Oahu
Mokapu Beach, Maui
Spencer Beach Park, Hawaii

Prepared for:

GTE HAWAIIAN TEL
1177 Bishop Street
Honolulu, Hawaii 96813

MAY 1993

Prepared By:

R. M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawaii 96817-4941

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7. The State of Hawaii Data Book 1990: A Statistical Abstract, Department of Planning and Economic Development, State of Hawaii, 1990.

8. Discussion with GTE Hawaiian Tel, December 1991.

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10. Humpback Whales in Hawaiian Waters: A Study in Historical Ecology, L.M. Herman, 1979.

11. Prodigious Submarine Landslides on the Hawaiian Ridge, J.G. Moore, 1989.

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PROJECT SUMMARY

Project:	GTE Hawaiian Tel Interisland Fiber Optic Cable System
Applicant:	GTE Hawaiian Tel 1177 Bishop Street Honolulu, Hawaii 96814 Contact: Larry Hartshorn 546-2378
Agent:	R. M. Towill Corporation 420 Waiakamilo Road, Suite 411 Honolulu, Hawaii 96817 Contact: Brian Takeda 842-1133
Accepting Authority:	Department of Land and Natural Resources Office of Conservation and Environmental Affairs

PROJECT SITES

WAILUA GOLF COURSE, KAUAI

Tax Map Key:	3-9-02:4
Location:	Wailua Golf Course, Wailua, Kauai
Lot Area:	11,000 Square Feet
Owner:	Department of Public Works Division of Parks and Recreation County of Kauai 4193 Hardy Street Lihue, Kauai, Hawaii 96766
Existing Land Uses:	County Golf Course, Recreational Area, Beach usage
State Land Use District:	Conservation
General Plan Land Use Designation:	Conservation
County Zoning Designation:	Public Facilities

KAHE POINT BEACH PARK, OAHU

Tax Map Key:	9-2-3:15
Location:	Kahe Point Beach Park, Waianae, Oahu
Lot Area:	4.47 Acres
Owner:	Department of Parks and Recreation City & County of Honolulu 2015 Kapiolani Boulevard Honolulu, Hawaii 96826 523-4183
Existing Land Uses:	Recreational Area, Beach Park
State Land Use District:	Urban
General Plan Land Use Designation:	Preservation
County Zoning Designation:	P-2 (General Preservation)

SANDY BEACH PARK, OAHU

Tax Map Key:	3-9-12:2
Location:	Sandy Beach Park, Oahu
Project Area:	1,200 Square Feet
Owner	Department of Parks and Recreation City & County of Honolulu 2015 Kapiolani Boulevard Honolulu, Hawaii 96817 961-8311
Existing Land Uses:	Recreational Area, Beach Park
State Land Use District:	Preservation
County Zoning Designation:	Open, allows utility installations

MOKAPU BEACH, MAUI

Tax Map Key:	2-1-8:62
Location:	Mokapu Beach, Maui

Project Area:	10,600 Square Feet
Owner:	McCormack Properties 841 Bishop Street Penthouse, Davies Pacific Center Honolulu, Hawaii 96813 Contact: Mr. Peter Nottage, Senior Vice-President 539-9600
Existing Land Uses:	Beach park with recreational and resort uses
State Land Use District:	Urban
Community Plan Land Use Designation:	N/A
County Zoning Designation:	H-2 (Hotel)

SPENCER BEACH PARK, HAWAII

Tax Map Key:	6-2-02:8, por. 6
Location:	Spencer Beach Park
Project Area:	5,000 Square Feet
Owner (6-2-02:8):	Department of Parks and Recreation County of Hawaii 25 Aupuni Street Hilo, Hawaii 96820 961-8311
Owner (6-2-02: por. 6):	National Park Service U.S. Department of the Interior 300 Ala Moana Boulevard Honolulu, Hawaii 96850 541-2693
Existing Land Uses:	Recreational Area, Beach Park
State Land Use District:	Conservation
General Plan Land Use Designation:	Open
County Zoning Designation:	Open, allows utility installations

SECTION 1
INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

GTE Hawaiian Tel proposes to develop an interisland submarine fiber optic cable system which will link the Islands of Kauai, Oahu, Maui, and Hawaii to supplement its existing interisland radio system. The system will include three interisland submarine cable segments with 5 landing sites (see Figure 1-1). The proposed landing sites are in the vicinity of Wailua Golf Course on Kauai; Kahe Point and Sandy Beach Park on Oahu; Mokapu Beach on Maui; and Spencer Beach Park on Hawaii. The purposes of the project are to provide additional capacity to accommodate projected interisland telecommunication traffic; to increase system integrity; and, to provide additional path diversity. The proposed project will be the first interisland fiber cable system to be installed in the State, and will be the first installation of a fiber optic cable at Kauai, Maui, and the Big Island.

GTE Hawaiian Tel is Hawaii's largest phone service provider. In 1990, Hawaiian Tel processed over 7 million calls per day, or over 4,800 calls per minute. Annually, this accounted for approximately 2.6 billion calls. The current level of service experienced by GTE Hawaiian Tel is at the forefront of a growth trend that has continued uninterrupted, since at least 1981, when Hawaii had almost 432,000 telephone access lines. Today that number has increased by almost 30 percent to over 555,000 lines (The State of Hawaii Data Book, 1990).

GTE anticipates that by 1993 its existing radio facilities will be unable to adequately process interisland phone transmissions, due to continuing and increasing levels of service demand. To overcome this limitation GTE proposes to carry out planning and implementation of a submarine fiber optic interisland cable network to handle the increasing volume of telephone traffic.

1.2 PROJECT LOCATIONS

Wailua Golf Course, Kauai

The proposed landing site on Kauai for the Kauai to Oahu segment of the cable system is Wailua Golf Course along the east coast of the Island of Kauai (see Figure 1-2). The

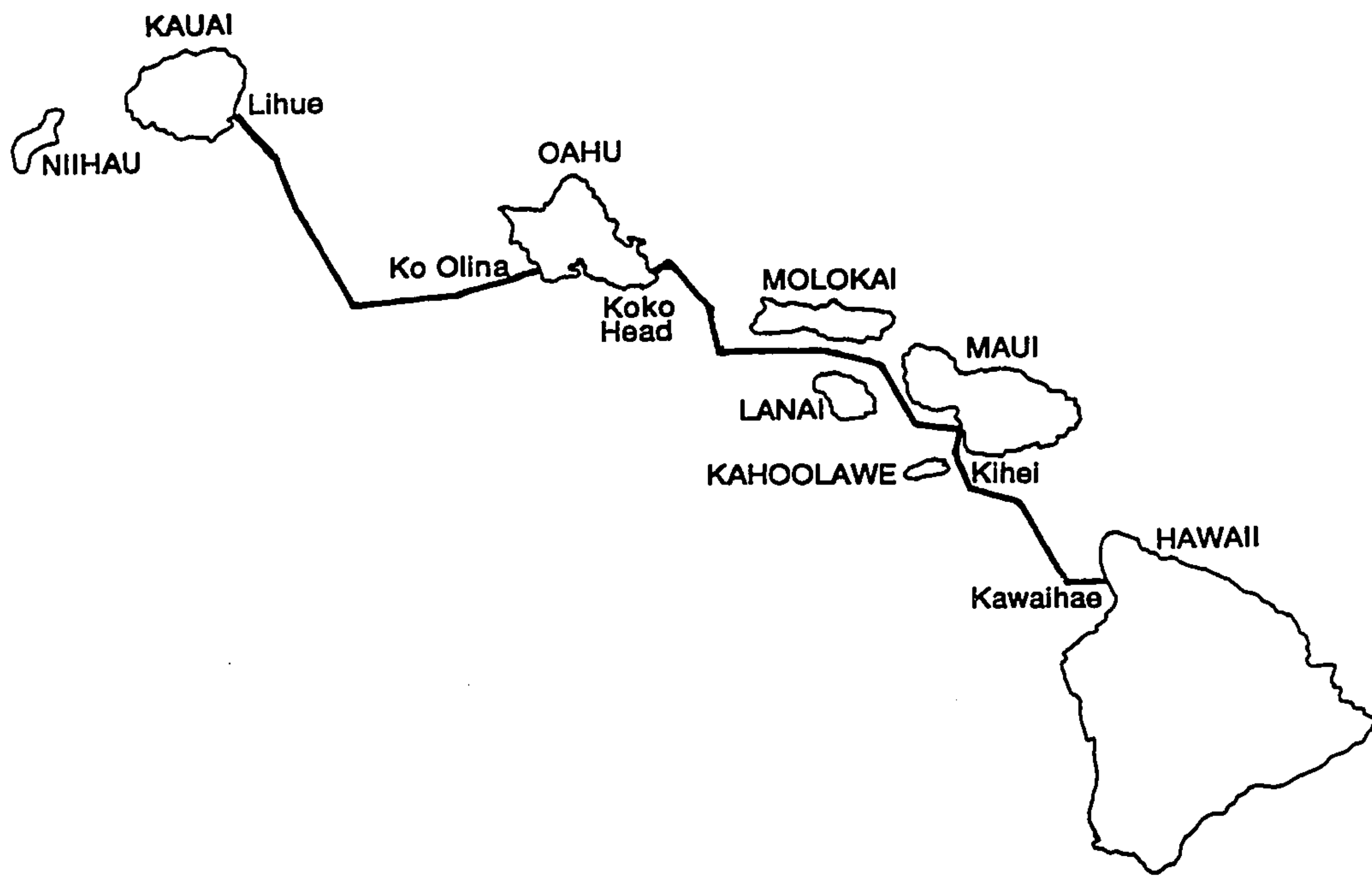

Figure 1-1
INTERISLAND SUBMARINE FIBER

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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JANUARY 1992

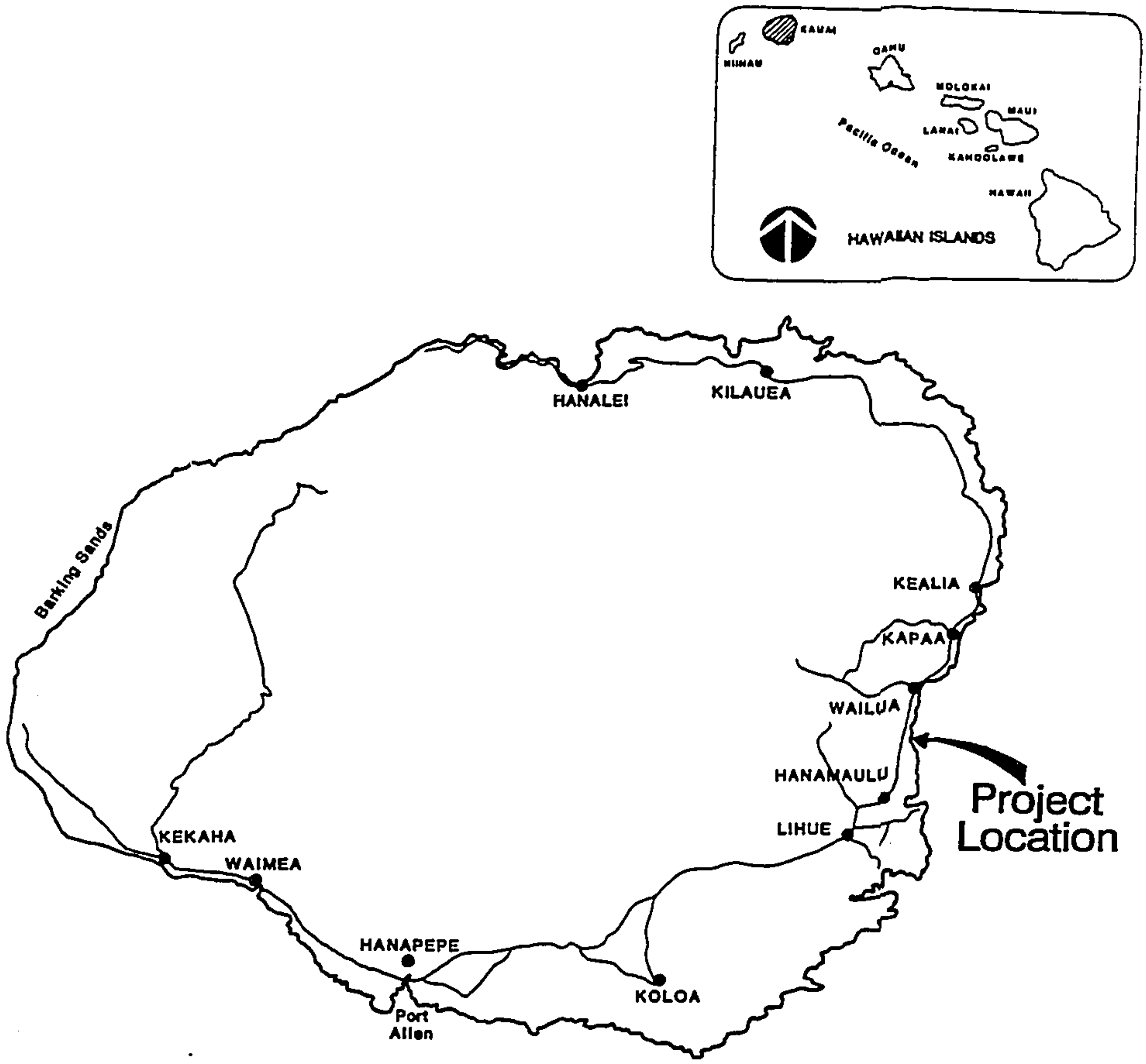

Figure 1-2
LOCATION MAP - WAILUA BEACH PARK

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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nearshore conditions have good access to a sand channel which begins immediately offshore and continues into deeper water. The proposed landing site is currently developed as a golf course with related accessory uses.

The proposed landing site for the cable will be at a location adjacent to the driving range, between the front nine holes located toward the Lihue section of the course and the back nine holes located toward the Kapaa section of the course which was selected to avoid directly crossing any greens and fairways to minimize interruptions to golf play. From there the cable will be routed subsurface to the nearest overhead utility pole located at the southern intersection of the golf course loop road with Kuhio Highway for routing along the makai side of the highway to the GTE Hawaiian Telephone Central Office (CO), near the Lihue Shopping Center.

The beach in the vicinity of the landing site is about 175 feet wide with a gentle slope. Mauka of the beach are mature ironwood trees and the fairways and greens of the golf course beyond. Although the beach is accessible to the public, it is not generally used by the public as frequently due to unfavorable climate and marine conditions. However, fishing, boating and diving have been activities observed taking place in the area. Figure 1-3 illustrates the proposed alignment of the GTE Hawaiian Tel submarine cable from the landing site to the CO.

Kahe Point Beach Park, Oahu

The proposed landing site for the Oahu to Kauai segment of the cable system is Kahe Point Beach Park. Kahe Point Beach Park is located along the southwest coast of Oahu, to the north of Barbers Point (see Figure 1-4). The shoreline in this area is rocky, consisting primarily of low limestone sea cliffs approximately 15 to 20 feet high. The proposed landing site is within a developed beach park. Existing features of Kahe Point Beach Park include two comfort stations, a pavilion, camping and picnic area with barbecues, fourteen marked camping sites with parking, and access via the Kahe Point Beach Park Access Road.

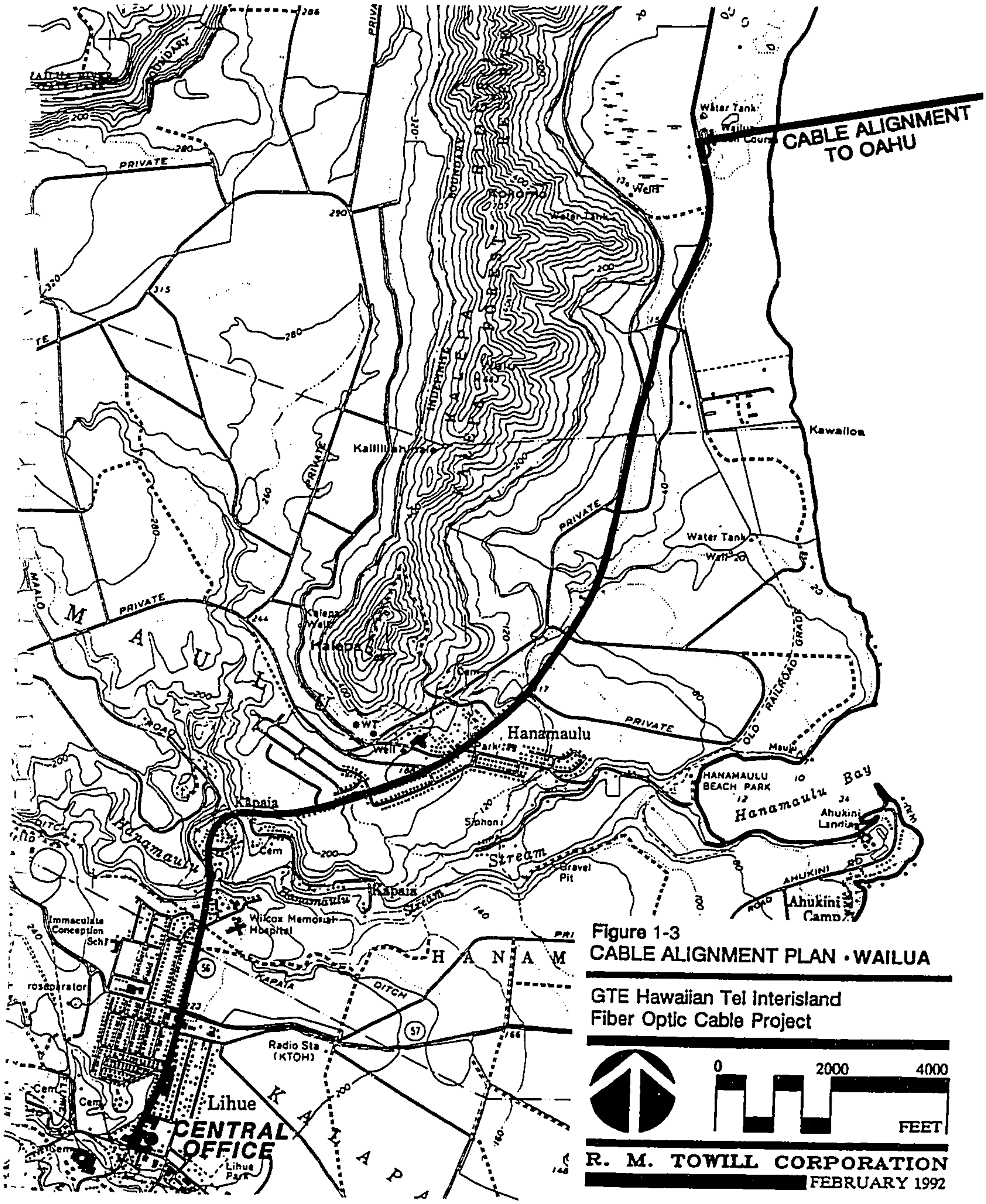

Figure 1-3
CABLE ALIGNMENT PLAN • WAILUA

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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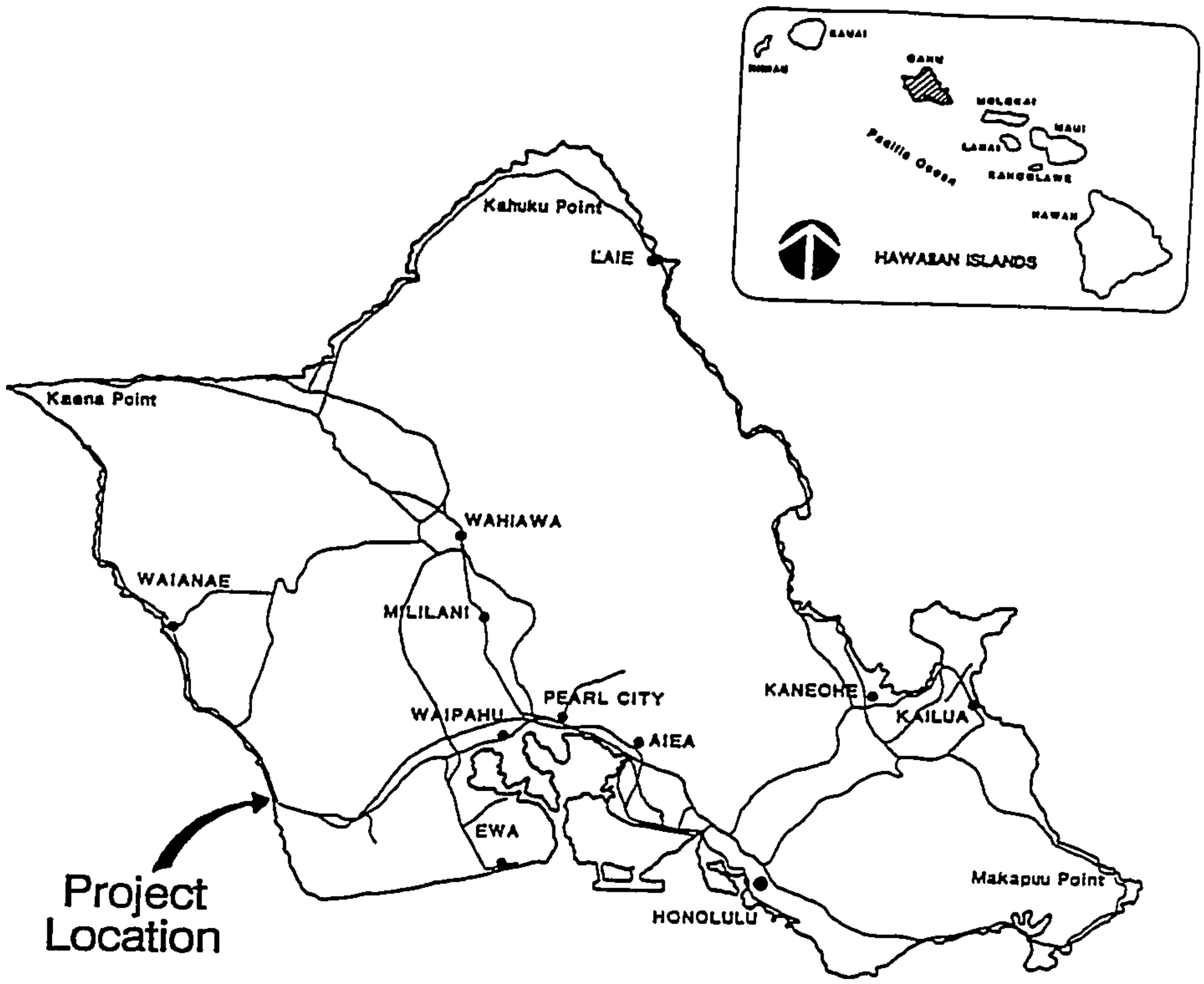

Figure 1-4
LOCATION MAP • KAHE BEACH PARK

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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Figure 1-5 illustrates the proposed alignment of the GTE Hawaiian Tel submarine cable from the landing site to the GTE Hawaiian Tel Central Office (CO). A new reinforced concrete manhole will be constructed at Kahe Point Beach Park approximately 300 feet makai of Farrington Highway. From the new manhole the cable will be installed in a trench to Manhole No. 3455 located on the mauka shoulder of Farrington Highway. The trench will cut across the Park's access road and Farrington Highway. From Manhole No. 3455 the fiber optic cable will be pulled through existing ducts to connect to the CO at 92-1389 Aliinui Drive within the Ko'Olina development.

Sandy Beach

The proposed Oahu landing site for the Oahu to Maui segment of the cable system is the eastern most point of Sandy Beach Park.

Sandy Beach Park is located along the east coast of the Island of Oahu (see Figure 1-6). The eastern most portion of the Beach Park lies along a rocky shoreline punctuated by short, sandy stretches of beachfront. The proposed landing site is currently undeveloped with little vegetation. To the west is the more heavily used and popular sandy beach section which is approximately 1200 feet long, with a wide and sloping foreshore. Existing features of Sandy Beach Park include two comfort stations, numerous patches of naupaka plants lying between the beach and Kalanianaole Highway, the Sandy Beach Park Access Road, and parking adjacent to each of the comfort stations.

From the beach landing site the cable is proposed to follow the Sandy Beach Park Access Road on the makai side, leading up to Kalanianaole Highway. At the vicinity of the highway and the beach park access road, the cable will be routed into an existing underground duct line which will lead to the GTE Hawaiian Tel Central Office (CO), located at 7664 Hawaii Kai drive. Figure 1-7 illustrates the proposed alignment of the GTE Hawaiian Tel submarine cable from the landing site to the CO.

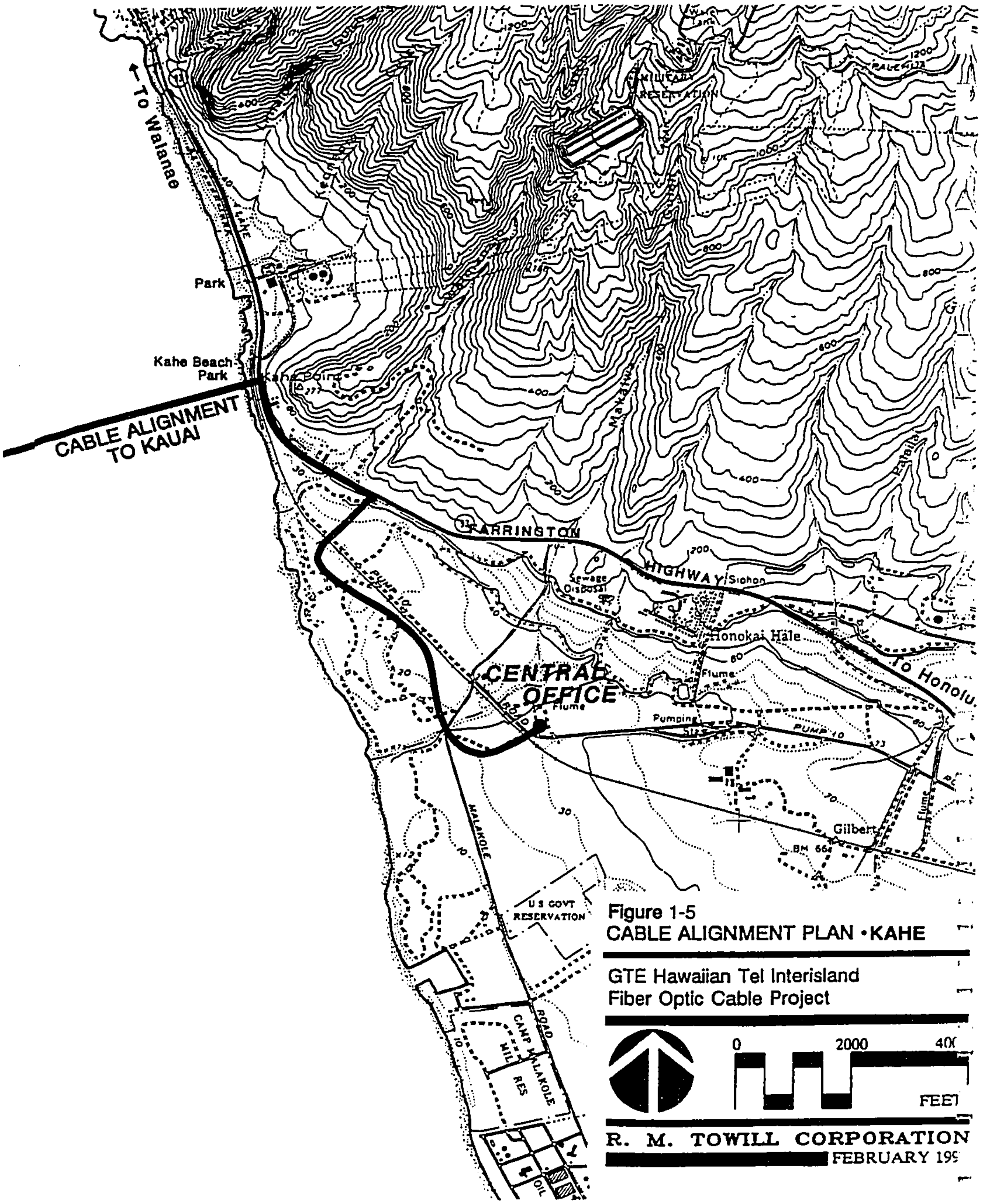

Figure 1-5
CABLE ALIGNMENT PLAN • KAHE

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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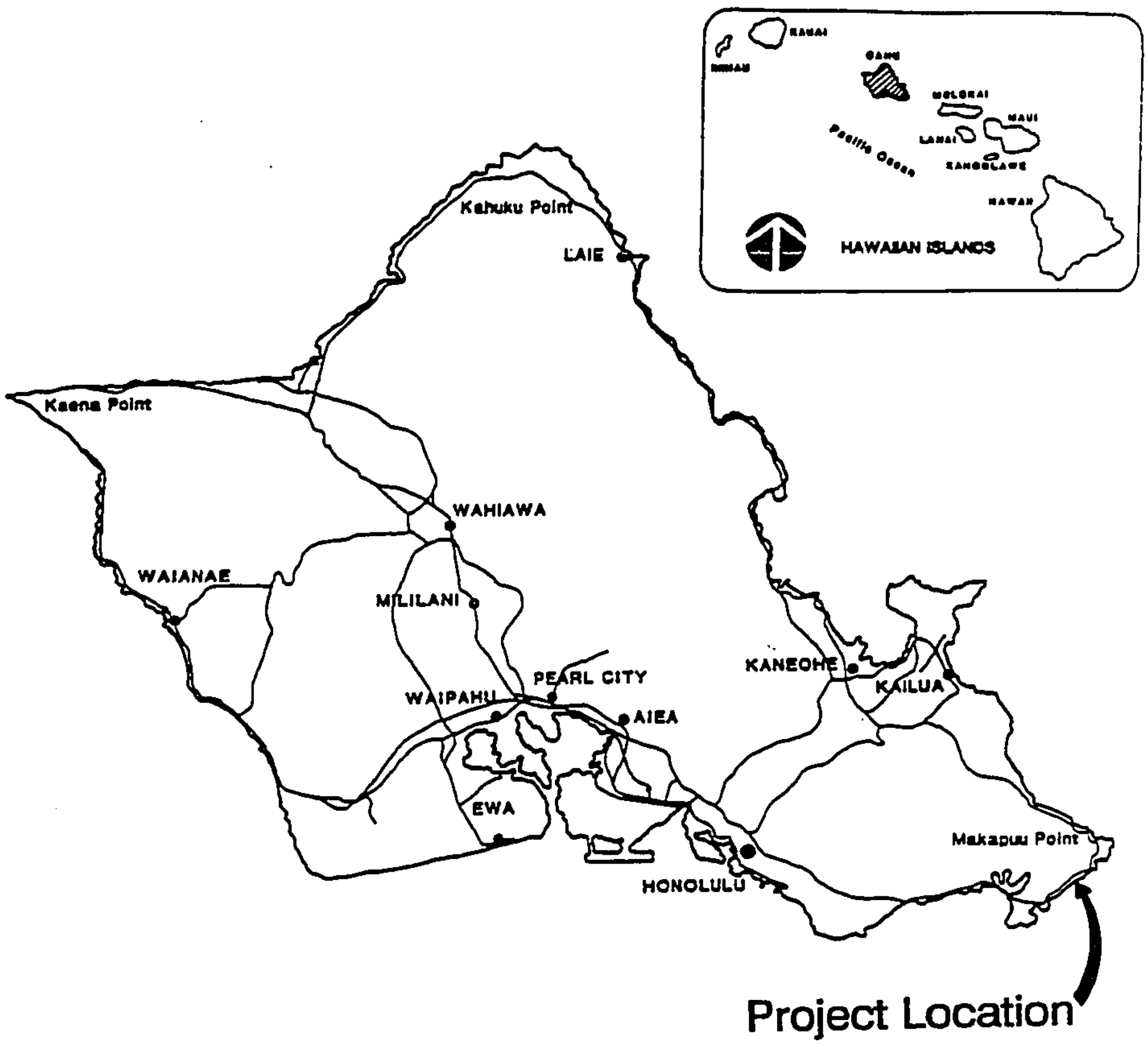

Figure 1-6
LOCATION MAP•SANDY BEACH PARK

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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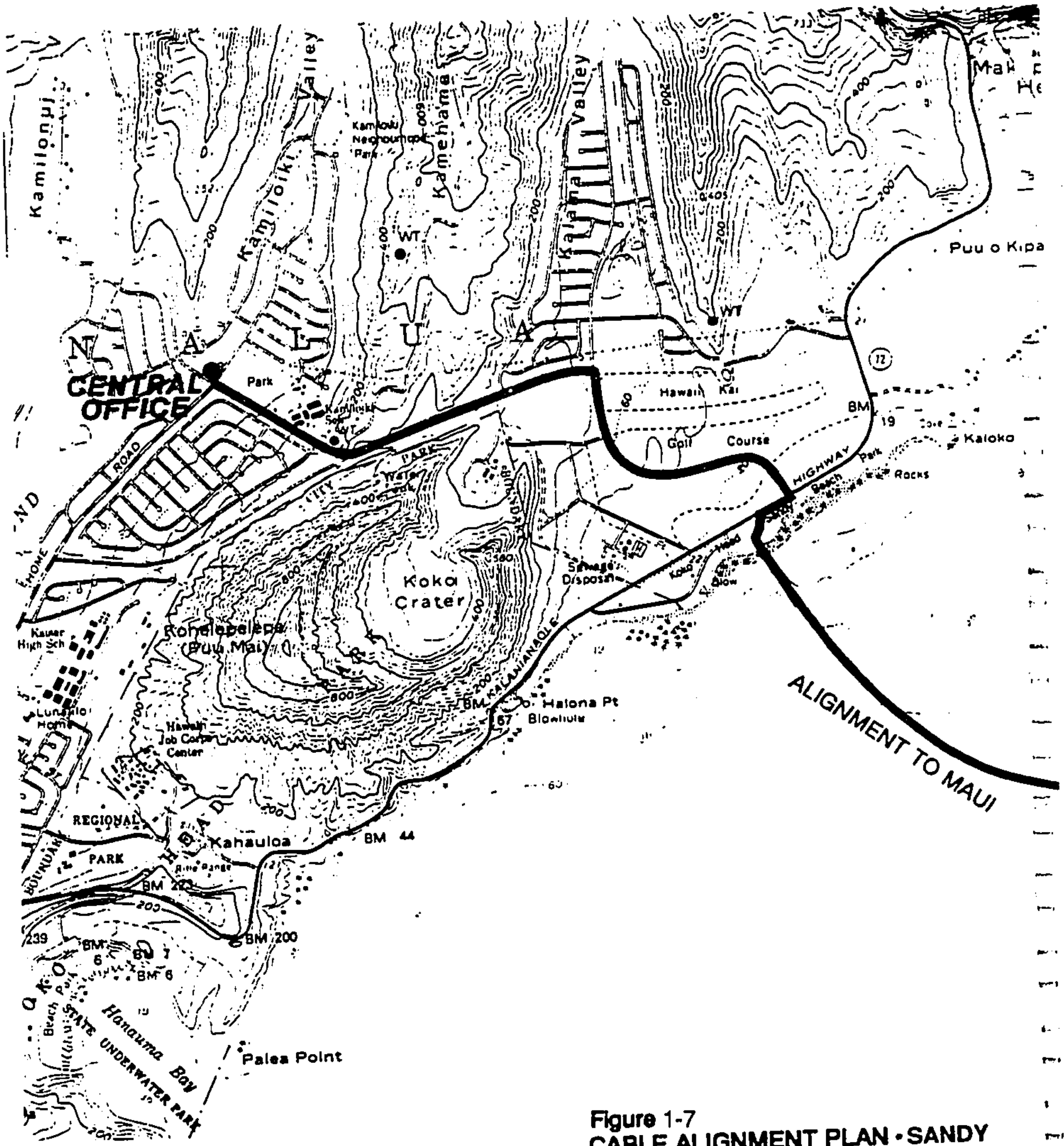

Figure 1-7
CABLE ALIGNMENT PLAN - SANDY

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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JANUARY 1992

Mokapu Beach, Maui

The recommended landing site for the Maui to Oahu segment and Maui to Big Island segment of the cable system is Mokapu Beach (TMK 2-1-8: 62).

Mokapu Beach is located along the West Coast of the Island of Maui (see Figure 1-8). Mokapu Beach is one of five beaches that are part of the Wailea resort complex. The word mokapu is an abbreviated form of moku kapu and means "sacred island." "Prior to World War II, Mokapu was a small rock island offshore from the beach. Sea birds such as the kolea gathered on it in the evenings, and on the rocky point nearby. The birds would feed mauka in Kula during the day and then return to the shoreline for the night. The flocks were immense, making Mokapu a popular hunting area. During the war, however, the rock island was almost entirely destroyed by explosives detonated during combat demolition exercises. So little remains of Mokapu today that it is simply another rock among the others nearby" (Beaches of Maui County, J. Clark, 1980).

Mokapu Beach is a short, wide pocket of white sand with beach rock exposed in the center of the beach. The sandy inshore bottom has a gentle slope to the deeper waters offshore. A study of the ocean bottom along the proposed cable alignment at the landing site indicates a continuous sandy ocean bottom from the beach seaward to the 180-foot depth.

The sand is medium to fine grained, with a noticeable increase in silt content closer to shore. The sand deposit appears to be thick and there are no protruding rock outcrops or coral formations in the deposit. There are patchy growths of Halimeda, coralline algae, extending seaward from the 90-foot water depth. Although this growth presents a different biological environment, the underlying bottom is still sand.

The flat and sandy ocean bottom provides an ideal landing condition as the cable will eventually be covered by sand providing protection against wave action.

The proposed project landing site is located on the northern side of Mokapu Beach. The landing site is undeveloped with little vegetation.

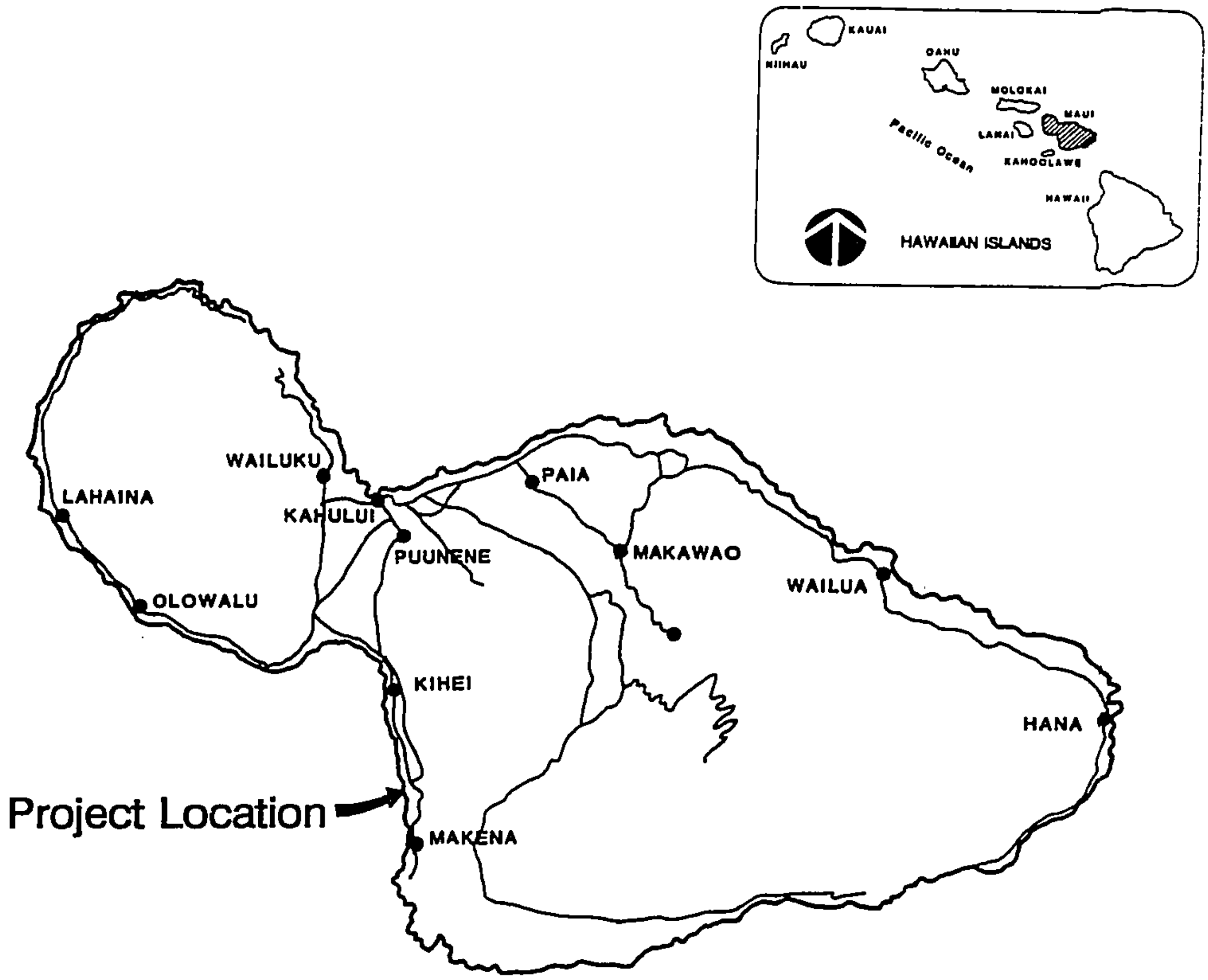

Figure 1-8
LOCATION MAP•MOKAPU BEACH PARK

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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JANUARY 1992

From Mokapu Beach the cable will be installed within an underground duct line to Wailea Alanui Road. The cable will then be pulled through existing underground ducts connecting Manhole 100A to Manhole 75 at Kilohana Avenue. The cables will then be routed overhead onto existing utility poles along Kilohana Avenue and Piilani Highway to the Central Office (CO) on 210 Halona Street in Kihei. Figure 1-9 shows the proposed alignment of the GTE Hawaiian Tel cable from the shore landing to the GTE CO (further site description is provided in Section 3).

Spencer Beach Park, Hawaii

The fiber optic cable landing facility for the Maui to Hawaii segment is proposed to be established at Spencer Beach Park. The facility only involves laying of the cable line from the shoreline to the nearest GTE overhead telephone facility. From there, the fiber optic cable will be routed on existing overhead telephone facilities to the nearest telecommunications substation.

Spencer Beach Park, which is owned by the County of Hawaii (see Figure 1-10), is located 1,000 feet directly south of the Kawaihae Harbor Breakwater, South Kohala District, Tax Map Key: 6-2-02:8. Kailua-Kona is located 30 miles to the south and Waimea Town is located 10 miles to the east.

From Spencer Beach Park the cable will be buried within the Spencer Road right-of-way which leads to Akoni Pule Highway and be installed overhead within the Akoni Pule Highway and Queen Kaahumanu Highway rights-of-way to the applicant's central office located approximately one-half mile south of the Akoni Pule Highway/Queen Kaahumanu Highway Intersection (see Figure 1-11).

Surrounding land uses include the Puukohola Heiau National Historic Site owned by the United States of America and abuts Spencer Beach Park to the north, and vacant lands owned by the Queen Emma Foundation to the east and south. Kawaihae Harbor is located to the north and is a deep water port serving industrial and commercial uses and deep sea fishing activities. Shoreside of the harbor is the town of Kawaihae and harbor support uses.

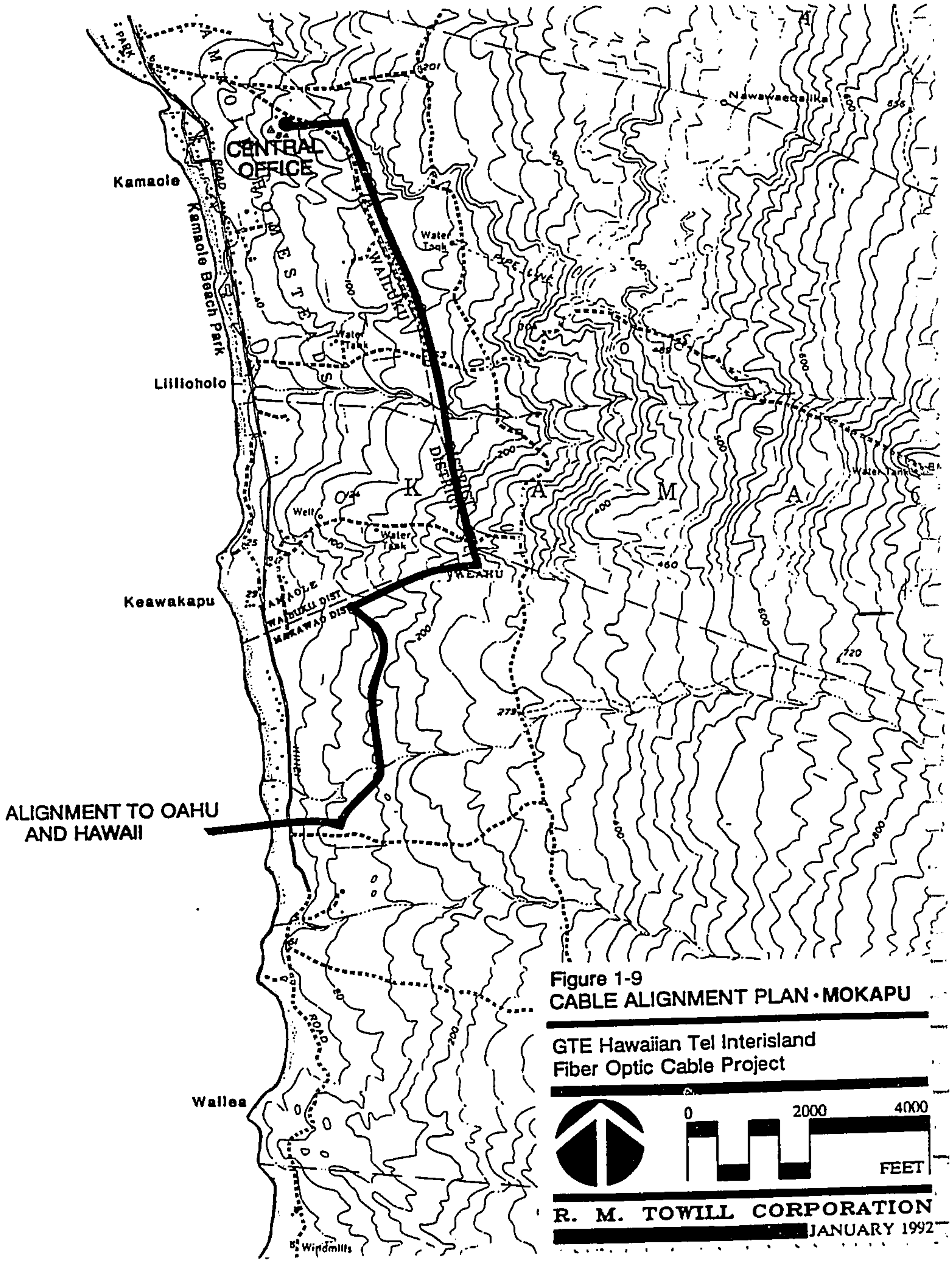

Figure 1-9
CABLE ALIGNMENT PLAN • MOKAPU

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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JANUARY 1992

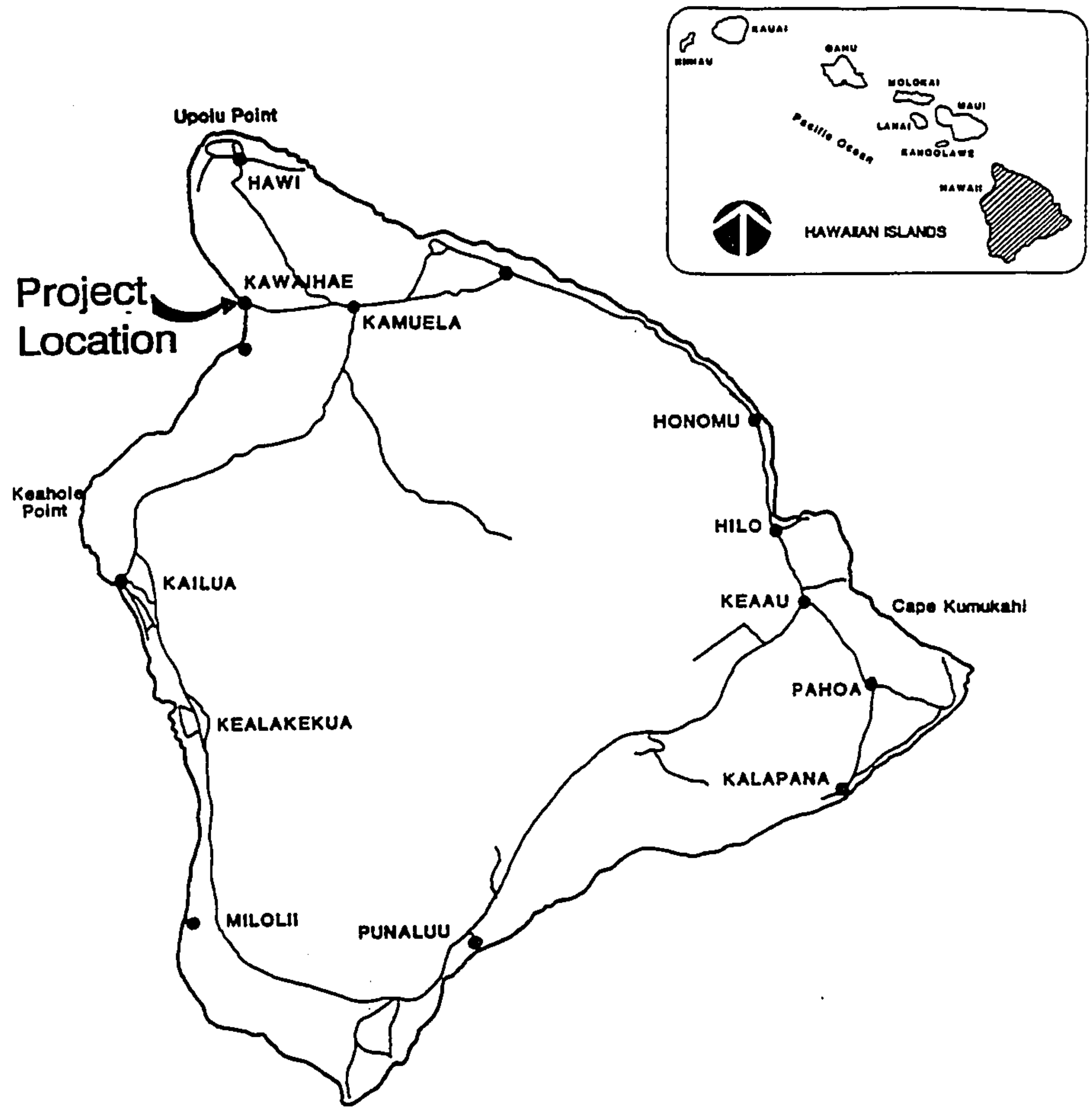

Figure 1-10
LOCATION MAP-SPENCER BEACH PARK

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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FEBRUARY 1992

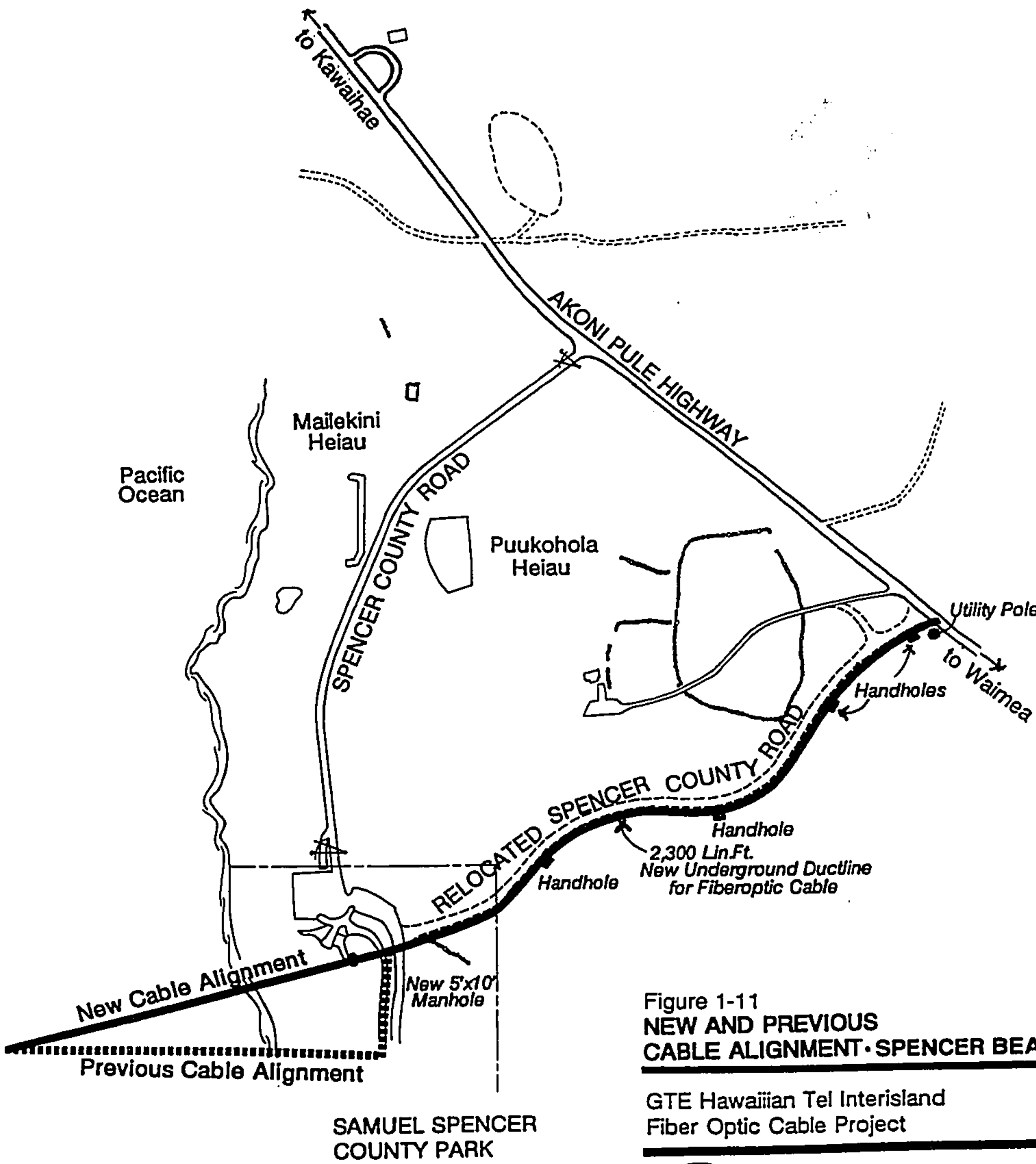

Figure 1-11
NEW AND PREVIOUS CABLE ALIGNMENT · SPENCER BEACH

GTE Hawaiian Tel Interisland Fiber Optic Cable Project

0 200 400 800 FEET

R. M. TOWILL CORPORATION
JUNE 1992

Approximately 200 feet makai of the Puukohola Heiau and adjacent to the beach park access road is the Mailekini Heiau.

SECTION 2

PROJECT BACKGROUND

2.1 CABLE TECHNOLOGY

The following is a discussion of existing telecommunication cable technology and how the determination was made to use fiber optics.

2.1.1 Copper and Fiber Optic Cables

The alternative to fiber optic cable is the use of copper wire cable. Copper wire cables function using a large number of plastic-coated copper wires housed within a plastic or synthetic outer casing. If necessary, steel or other protective materials would be added to ensure strength and resistance to abrasion and breakage. In order to receive a voice transmission an electrical signal must be sent through a pair of copper wires to a receiver, where the electrical signal is converted back into sound. A typical cable, approximately 4 inches in diameter (without the outer protective casing), would house 600 copper wires with the capacity of approximately 3,600 voice circuits.

The copper wire cable will also require use of a repeater to boost the electrical signal over long distances to ensure adequate signal strength at the receiving station. Repeaters will be necessary approximately every 6,000 feet and require a high voltage power source to operate. Repeater dimensions for a 1,200 voice circuit will be approximately 1 to 2 feet in diameter by 3 feet long. Therefore, to accommodate the 4-inch diameter copper cable described above, at least 3 repeaters would be required every 6,000 feet with a requisite power source supplying power to the cable.

In contrast, fiber optic technology relies on use of optical fibers and the transmission of light pulses which are converted into voice signals by the telephone company receiving station. The proposed fiber optic cable would contain approximately 12 fiber optic strands and would be housed in a plastic and steel casing no more than approximately 3 inches in diameter (see Figure 2-1). Like the copper cable, steel or other protective materials would be added as needed for strength. Each pair of fiber optic strands would be capable of

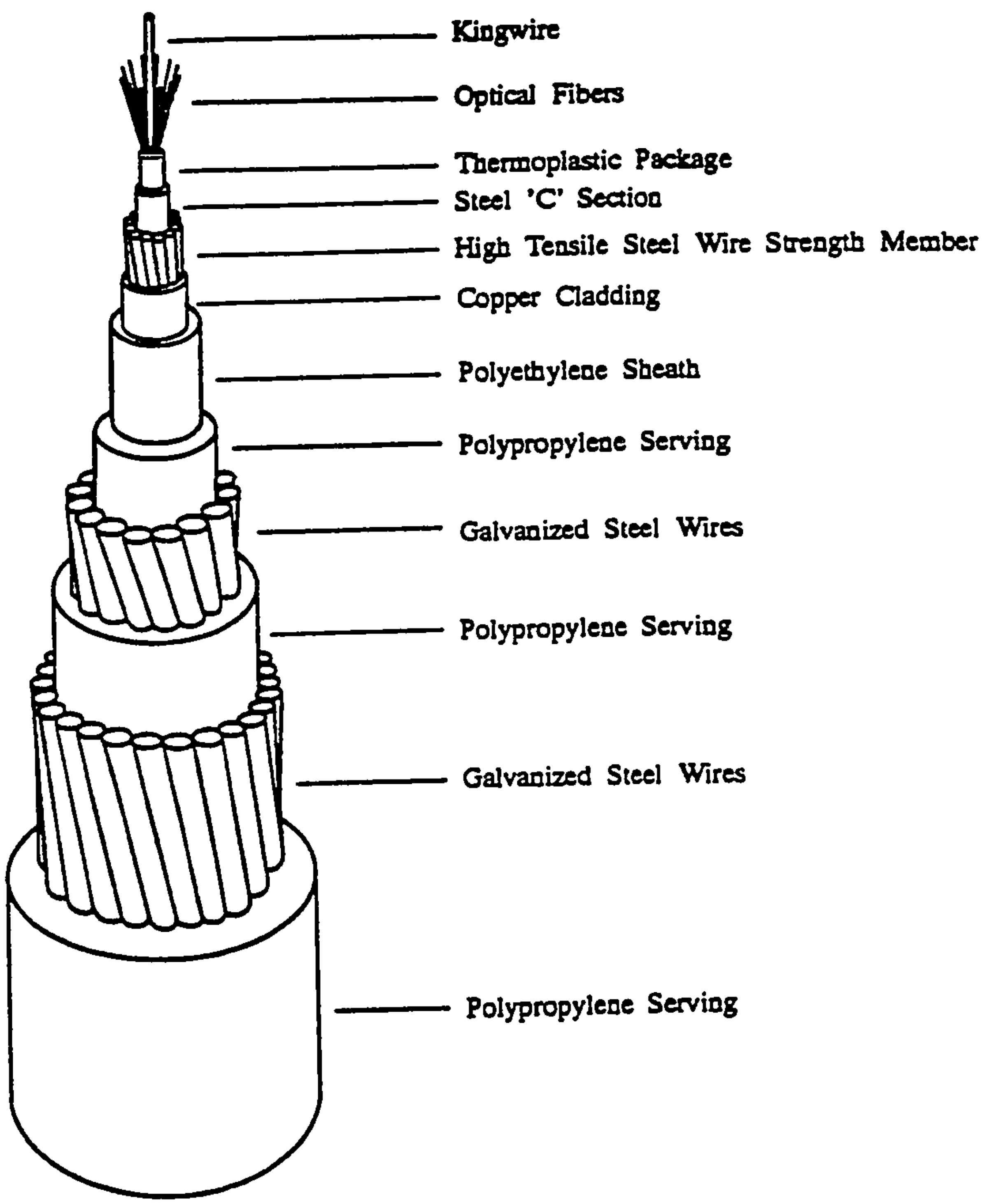

Figure 2-1
DOUBLE ARMOR FIBER OPTIC CABLE

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

R. M. TOWILL CORPORATION
JANUARY 1992

handling approximately 8,000 voice circuits, for a combined total on the order of 40,000 voice circuits (2 strands = 1 pair, 12 strands = 5 pairs working plus 1 pair spare, and 5 pairs x 8,000 voice circuits = 40,000 voice circuits. In addition, in order for a copper cable to achieve the capacity of a fiber optic cable, it would have to approach a diameter of approximately 8 to 10 feet, would require repeaters, and a high-voltage power line in addition to the copper cable.

Fiber optic technology was selected because:

- Fiber optic cables provide superior capacity and do not require high-voltage repeaters;

- The smaller diameter fiber cable ensures there will be minimal disturbance necessary to site the cable. There is less land needing to be graded, cleared and stockpiled in order to site a 3-inch diameter cable versus a 10' diameter cable;

- Sensitive areas that might otherwise be disturbed because of larger equipment and increased mobilization and noise problems would be greatly reduced;

- Length of time on site would be greatly minimized. Sensitive public or open space areas would not require a lengthy stay by the construction team and therefore would minimize any hardships upon beach users including swimmers, fishermen, surfers and other users; and

- The need for future capacity will be met. The proposed cable has a projected 20-year plus service life and is designed to meet GTE Hawaiian Tel's projections for growth. This is based on GTE Hawaiian Tel's best forecasting capability and is itself an effort to minimize need for additional cables and unnecessary disturbance to the environment.

2.2 SUBMARINE CABLE ROUTE

The submarine cable route selection process involved identification of areas warranting study, based on a set of minimum evaluation criteria. The criteria includes rapid erosion, giant landslides, drowned coral reefs, seismic activity, dumping areas, ship and airplane wrecks, other cables, and the length of routes.

In August 1991 a study was conducted by Seafloor Surveys International (SSI) to preliminarily identify an ocean route for the GTE Hawaiian Tel Submarine Fiber Optic Cable System. The route selected was one that minimized potential hazards to the installation, and eased maintenance and operation of the cable over a projected 25 year lifetime.

The following provides a detailed description of each of these criteria:

2.2.1. Rapid Erosion

The greatest danger to this cable system is in the submarine portion of the route as it is related to the geologically young age of the "Hawaiian Islands and the resulting extremely high erosion rates. The rapid erosion places large volumes of unconsolidated sediment into the shallow waters surrounding the islands. These sediment deposits move rapidly down the steep island slopes when they become unstable. This down-slope sediment movement can be initiated by earthquakes, storm runoff, and storm waves. Installation of cables on steep, sediment-covered submarine slopes should be avoided if possible. Where these slopes cannot be avoided, the cable should traverse as directly up the slope as possible (SSI, August 1991)."

2.2.2 Giant Landslides

Over the past several years, mapping of the Hawaiian Exclusive Economic Zone by the U.S. Geological Survey through the use of the long range Gloria sonar system, a relatively low-resolution, reconnaissance sonar, has discovered a series of large landslides surrounding the Hawaiian Islands (Moore, et.al., 1989). "The primary danger presently posed to the cable by these inactive landslides is their extremely rough surface. The seafloor in the slide areas are known to be littered with huge volcanic boulders. These boulders have been observed from submersibles to often be the size of a house. These slide surfaces pose a serious threat by producing unacceptable cable spans where the cable is draped over individual blocks, as well as the possibility of having the cable getting tangled if it had to be retrieved for repair (SSI, August 1991)."

2.2.3 Drowned Coral Reefs

A series of drowned coral reefs surrounding the islands are considered dangerous to the Interisland Fiber Optic Cable System. "Locally steep slopes associated with these reefs could cause unacceptable cable spans in areas where strong bottom currents can be expected (SSI, August 1991)."

2.2.4 Seismic Activity

"The greatest danger to the cable from earthquakes is not the actual fault displacement itself, but the possibility they will initiate movement of unstable sediment deposits on the slopes of the islands. Epicentral locations of earthquakes with magnitude 3 or larger in the Hawaiian region should be avoided by the fiber optic cable (SSI, August 1991)."

"Seismic activity in the Hawaiian Islands is concentrated in the vicinity of the active volcanoes on the Island of Hawaii, where it is primarily related to the on-going volcanic activity. There are also earthquakes related to the tectonic subsidence of the islands due to the load that the growing volcanoes is putting on the earth's crust. These tectonic earthquakes are also concentrated in the area surrounding the island of Hawaii, where the greatest subsidence is taking place (SSI, August 1991)."

2.2.5 Dumping Areas

"A large, presently inactive, explosive dump is located west of Oahu. This dump will have to be avoided by the fiber optic cable. Navy authorities maintain this area has not been used for ordinance disposal since shortly after World War II. However, they advise against laying cables through the area (SSI, August 1991)."

"Dredge Spoils disposal sites authorized by the U.S. Army Corp of Engineers are also located close to all major island harbors and should be avoided by the cable route (SSI, August 1991)."

2.2.6 Ship and Airplane Wrecks

A complete, high resolution side-scan survey of the proposed cable route should be carried out to determine that the route is free of man-made hazards such as ship wrecks and lost airplanes. There have been numerous ships and airplanes lost at sea in the Hawaiian area which have never been located.

2.2.7 Other Cables

There are several other cables in the planning stage including Pac Rim East (from Hawaii to New Zealand), HAW-5 (from California to Hawaii), the Hawaii deep water electric transmission cable (from Hawaii to Oahu via Maui), and the Tri-Island power cables (linking Maui, Molokai and Lanai). Aside from these commercial cables, the University of Hawaii plans to install a fiber optic cable for neutrino research offshore from Keahole Point north of Kailua, Kona.

Along parts of this route the cable will have to be laid in close proximity to other, presently existing communications cables. In these areas, the recommendations of the International Cable Protection Committee (ICPC) should be used as a guideline. At their 1985 Plenary Meeting in Sydney, Australia, ICPC recommended that no previously existing cable be crossed at less than a 45 degree angle, the closer the crossing can be to a right angle the better, and where possible a spacing of five miles should be maintained.

Prior to making final decisions on cable placement, ICPC also recommends that American Telephone and Telegraph (AT&T) be contacted to determine if there are conflicts with military or other government cables.

2.2.8 Length of Routes Less Than 200 Kilometers

All routes are designed to be less than 200 kilometers in length in order to be serviced by repeaterless cables. The fiber optic cable will operate on a single light transmission source generated from its Central Office and transmitted to a receiving Central Office. Since repeaters will not be required to retransmit the signal, no electrical power will need to be routed through the cable.

2.3 LANDING SITES SELECTION

In August of 1991 a study was conducted to select landing sites for the GTE Hawaiian Tel Fiber Optic Cable System connecting the Islands of Kauai, Oahu, Maui, and Hawaii. A set of criteria was used to reduce the field of potential landing sites. The advantages and disadvantages of each site were evaluated to provide the basis for comparing the sites.

The following is a brief discussion of criteria for determining landing sites:

2.3.1 Shoreline/Nearshore Conditions

The shoreline and nearshore conditions are a consideration because the depth of the water from the landing site towards the ocean must be deep enough to protect the cable. Approximately 50 to 60 feet of water will be required before wave forces diminish to levels where wave action does not affect the cable. Areas with extensive shallow water far from shore (i.e.4,000'+) were considered difficult or suboptimal in providing protection during storms and other high wave conditions.

The composition of bottom conditions limits acceptable landing sites. Sandy bottoms are preferred in order to minimize any possible environmental impacts of anchoring, armoring, or trenching through rock or coral in order to securely fasten the fiber optic cable. Also if the ocean bottom has extensive sand deposits, especially adjacent to the shoreline the cable can eventually be covered by sand, providing maximum protection against wave forces.

2.3.2 Public Use Considerations

It is anticipated that impacts to public recreational areas will be minimal given the short-term and relatively minor requirements for installing a fiber optic cable. However, because of potential for difficulties with area users, landing sites in areas of major public use are considered a constraint to selection.

Areas of potential historical and archaeological significance in close proximity to cable landing sites are also considered a constraint to selection, due to the possibility of destroying a historic site.

2.3.3 Environmental/Natural Resource Considerations

The landing sites should not be within proximity to rare or endangered species or their habitats in order not to disturb them.

Impacts to shoreline and ocean water quality should be kept to a minimum. Sites which would require extensive ocean anchoring and cable protection work (i.e., shielding/dredging) and/or on-shore excavation in ground conditions which promote soil erosion should be avoided.

2.3.4 Alternative Landing Sites

Wailua Golf Course, Kauai

Three possible landing sites were identified for the Oahu to Kauai segment of the fiber optic cable where underwater geology would be most suitable: Wailua Golf Course, Wailua Bay, and Hanamaulu Bay. Wailua Golf Course was selected as the preferred landing site because the nearshore conditions of the site have good access to a sand channel which begins immediately offshore and continues into deeper water. This continuous sandy bottom into deeper water condition is not readily available at either the Wailua Bay or Hanamaulu Bay sites.

Consolidation of the cable alignment was considered, but is constrained by the need to locate the cable landing site as near to manned Central Offices as possible. This is necessary because of need for maintenance and to ensure protection and reliability to the interisland communications service the fiber optic cable will provide. Further, because the system is repeaterless (e.g. no high-voltage power will flow through the cable), the maximum length between central offices (island to island) was limited to 200 kilometers (124 miles).

Each Central Office is designed and constructed to ensure safety and security from both man-made and natural hazards (e.g., terrorist activity, vandalism, major storms, and seismic disturbances).

Should Wailua Golf Course be removed from consideration, it is recommended that Wailua Bay be re-considered for an alternative landing site. Primary features of Wailua Bay over Hanamaulu Bay are: 1) Wailua Bay is situated on public lands; 2) the physical features of Wailua Bay are significantly better for siting a fiber optic cable; and 3) Hanamaulu Bay contains private land immediately mauka of a potential shore landing site which would add to development costs and potential delays.

DLNR, Historic Preservation Division, has advised GTE Hawaiian Tel, that Wailua Bay has been recognized as a potentially rich archaeological resource. Any land-side excavation would have good potential for discovery of archaeological or cultural deposits. Care, therefore, will need to be exercised to ensure archaeological concerns are addressed.

<u>Kahe Point Beach Park, Oahu</u>

Three possible landing sites were identified for the Oahu to Kauai segment of the fiber optic cable where underwater geology would be most suitable: Kahe Point Beach Park, Pokai Bay, and Nanakuli Beach Park. Kahe Point Beach Park was selected as the preferred landing site because the site exhibits positive characteristics including nominal land side conditions and workable nearshore waters. Another positive site feature of Kahe Point Beach Park is the low likelihood for discovery of archaeological/historic sites (Discussion with DLNR, Historic Preservation Division).

Consolidation of the cable alignment was considered in areas which have already been disturbed such as Makaha and Yokohama. However, the landing site was selected based on specific criteria which required a location which could not be the same as those which have already been utilized.

Selection of Kahe Beach is largely based on GTE Hawaiian Tel's requirement that the fiber optic cables be located as close as practical to the phone company's Central Offices. This is necessary because of the need to ensure protection and reliability for the interisland communications service the fiber optic cable will provide. Each Central Office is designed and constructed to ensure safety and security from both man-made and natural hazards (e.g., terrorist activity, vandalism, major storms, and seismic disturbances). Kahe Beach is in good proximity to GTE Hawaiian Tel's Central Office, and addresses this need for security.

Should Kahe Point Beach Park be removed from consideration, Pokai Bay would be the alternate landing site. The proximity of Pokai Bay to a small boat harbor could create potential problems due to harbor and/or marine dredging and maintenance. Pokai Bay also has potential for discovery of archaeological remains in the backshore area according to the Department of Land and Natural Resources Historic Preservation Division.

Nanakuli Beach is not considered a viable alternative landing site based on presence of the United States Navy FORACS, underwater submarine testing facility which utilizes the entire Nanakuli beachfront.

Sandy Beach Park, Oahu

Three possible Oahu landing sites were identified for the Oahu to Maui segment of the fiber optic cable where underwater geology would be most suitable: Sandy Beach Park, Waimanalo Beach, and Kailua Beach Park. Sandy Beach Park was selected as the preferred landing site because the site exhibits positive characteristics including a nearshore alignment that can avoid most of the reefs and coral heads which lie alongside and within a small sandy channel leading away from the shoreline to the ocean. Another positive site feature of Sandy Beach Park is the low likelihood for discovery of archaeological/historic sites (Discussion with DLNR, Historic Preservation Division).

Consolidation of the cable alignment was considered in areas which have already been disturbed such as Makaha, Yokohama, and Hanauma Bay. However, as noted for the Kahe Point site the Sandy Beach landing was selected based on specific criteria which required a location distinct from those which have already been utilized.

Selection of Sandy Beach is largely based on GTE Hawaiian Tel's requirement that the fiber optic cables be located as close as practical to the phone company's manned Central Office. This is necessary because of need for maintenance and to ensure protection and reliability for the interisland communications service the fiber optic cable will provide. Each Central Office is designed and constructed to ensure safety and security from both man-made and natural hazards (e.g., terrorist activity, vandalism, major storms, and seismic disturbances). Sandy Beach is in good proximity to GTE Hawaiian Tel's Central Office, and addresses this need for security.

Use of the old cable easement in Hanauma Bay is not recommended due to the construction work required to lay a new cable. The old cable and easement has since been covered by coral and sediments which are now part of the Hanauma Bay Marine Life Conservation District, established in 1967. In order to utilize this site, major coral and rock outcrops would have to be demolished, much as they were when the old cable was deployed. In addition, there has already been strong public interest and demand for greater environmental protection of Hanauma Bay, and any request for ocean construction and temporary closure of the beach would probably be viewed negatively.

Should Sandy Beach Park be removed from consideration, Waimanalo Beach would be the alternate landing site. Waimanalo Beach possesses poorer shoreline and nearshore access given extremely shallow offshore reefs which would have to be crossed by the cable. Waimanalo Beach also has potential for discovery of archaeological remains according to the Department of Land and Natural Resources Historic Preservation Division.

Mokapu Beach, Maui

Three possible landing sites for the Maui to Oahu segment and the Maui to Big Island segment of the fiber optic cable where underwater geology would be most suitable are as follows: Mokapu Beach, Keawakapu Beach, and Kamaole Beach. Mokapu Beach is proposed as the preferred landing site because it has the best available accessway through a lengthy bench reef which extends parallel to shore. This reef system extends across both of the other proposed landing sites at Keawakapu and Kamaole Beach. The opening at

Mokapu Beach would allow the fiber optic cable to access the shore landing without having to cross a major section of reef and/or hard bottom.

Consolidation of the Maui leg of the cable system is addressed through consolidation of the Oahu to Maui, and Big Island to Maui cable segments. The establishment of the Mokapu Beach landing, however, was still considered in relation to the need to locate as near to manned Central Offices as possible. This is necessary to ensure readily available maintenance, protection and reliability for the interisland communications service the fiber optic cable will provide. Further, because the system is repeaterless (e.g., no high-voltage power will flow through this cable), the maximum length between central offices (island to island) was limited to 200 kilometers (124 miles).

Further site investigation of Kamaole Beach Park and Keawakapu Beach indicate continued presence of the reef band for a long distance. Off Kamaole Beach, the coral begins in shallow water (30 feet), and extends seaward to the 90 foot depth for several hundreds of feet. Keawakapu Beach has a similar condition, but is further constrained by difficult access to the shoreline from a parking lot which would have to undergo major demolition and repair in order to access the beach. Mokapu Beach, therefore, is the only preferred alternative for the Maui segment of the cable system.

Spencer Beach Park, Hawaii

Three possible Hawaii landing sites for the Big Island to Maui segment where underwater geology would be most suitable are Spencer Beach, Hapuna Beach, and Mauna Kea Beach. Spencer Beach is proposed as the preferred landing site because it has the most advantageous access to shoreline. A nearshore alignment is available which can avoid most of the reef and coral heads which lie alongside and within a sand channel leading away from the shoreline to the ocean. The site is also close to an existing GTE Hawaiian Tel Central Office which would allow for minimal construction work in order to site the cable.

Consolidation of the cable alignment was considered, but as with all sites, is constrained by the need to locate the cable landing site as near to manned Central Offices as possible. This is necessary because of need for maintenance and to ensure protection and reliability to the interisland communications service the fiber optic cable will provide. Further, because the system is repeaterless (e.g., no high-voltage power will flow through the cable), the maximum length between central offices (island to island) was limited to 200 kilometers (124 miles). Each Central Office is designed and constructed to ensure safety and security from both man-made and natural hazards (e.g., terrorist activity, vandalism, major storms, and seismic disturbances).

Should Spencer Beach be removed from consideration, Hapuna Beach is recommended as an alternative site. Hapuna Beach possesses positive site features including a sandy bottom with available access to shore. Coral heads and finger coral are usually found in deeper water, and may potentially be crossed with minimal disturbance to the area. In addition, historic and archaeological sites are not expected to be discovered (Discussion with DLNR, Historic Preservation Division). However, the single most critical constraint with Hapuna Beach, is its heavy use by the public for scenic and recreational uses.

3-1

CONSTRUCTION ACTIVITIES

3.1 GENERAL

Construction of the project will be accomplished in two phases: the first phase involves all land side construction activities; and the second phase includes all work necessary to prepare the landing site and actually landing the interisland submarine cable.

The second phase involves landing the submarine fiber optic cable and connecting it to the new manhole at Sandy Beach.

The following provides a detailed description of each of these phases:

3.2 LAND-SIDE ACTIVITY

Wailua Golf Course, Kauai

The first phase involves the construction of a new manhole located makai of Wailua Golf Course and the installation of approximately 1,000 feet of underground ducts and cable from the manhole to an existing utility pole (No. P-124) located on the makai shoulder of Kuhio Highway. The cables will then be diverted overhead onto existing utility poles along Kuhio Highway connecting utility Pole P-124 to the GTE Hawaiian Tel Central Office (CO) located immediately adjacent to the Lihue Shopping Center (Tax Map Key 3-9-02:4).

The new 5' x 10' x 4' deep reinforced concrete manhole will be constructed approximately 1,000 feet makai of Kuhio Highway (see Figure 3-1). It is not anticipated that traffic on Kuhio Highway will be affected because of the distance of the manhole from the highway. Work will be accomplished in one or two days.

The terminus of the landside activities will be the manhole which will need to be constructed to accept the submarine cable. Four 4-inch diameter PVC ducts will be installed in a trench from the manhole, along the Wailua Golf Course, to utility Pole P-124 on Kuhio Highway adjacent to the golf course loop road. A 4' x 6'concrete handhole will

SECTION 3
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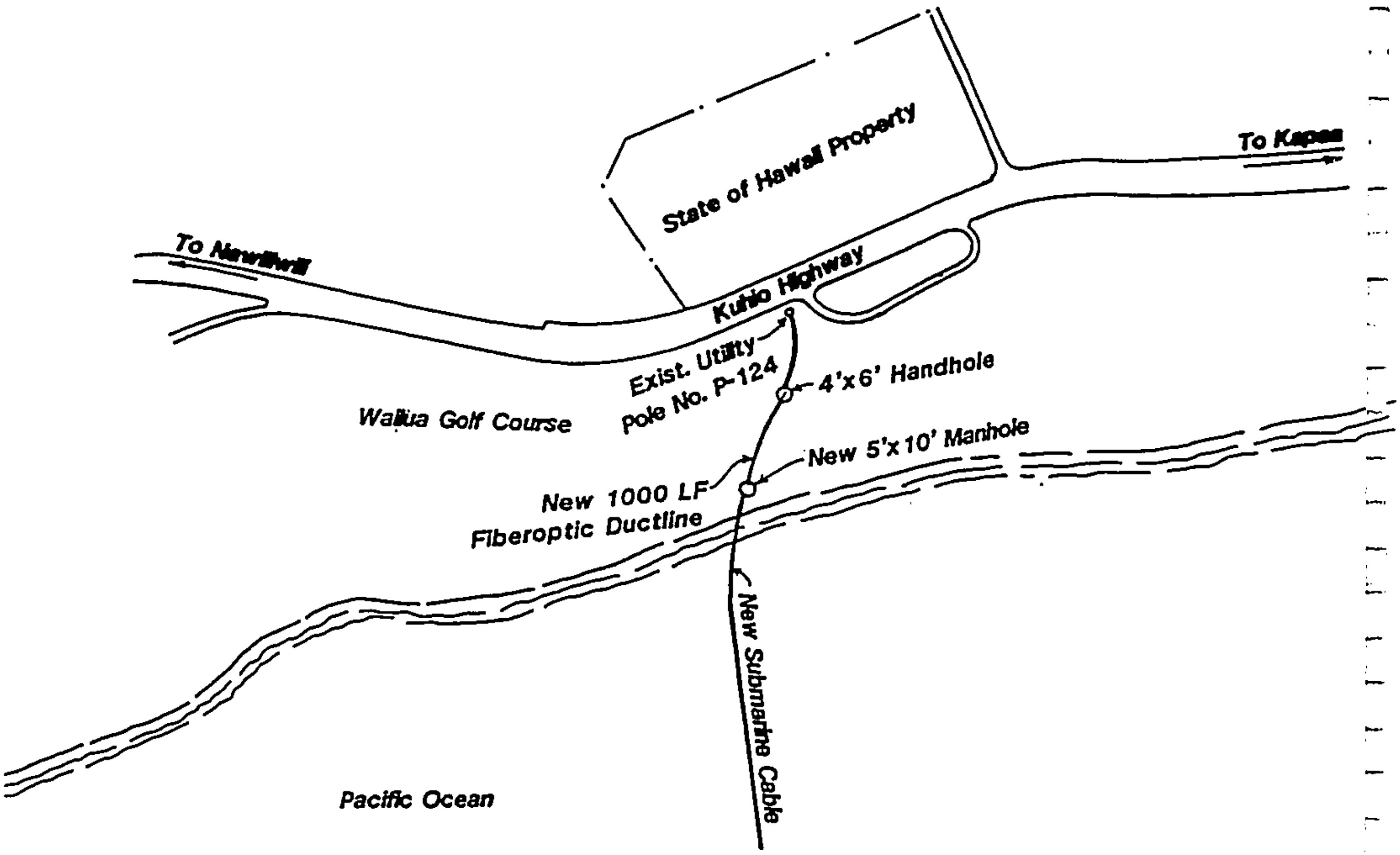

Figure 3-1
SITE PLAN • WAILUA

GTE Hawaiian Tel Interisland Fiber Optic Cable Project

Not to Scale

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FEBRUARY 1992

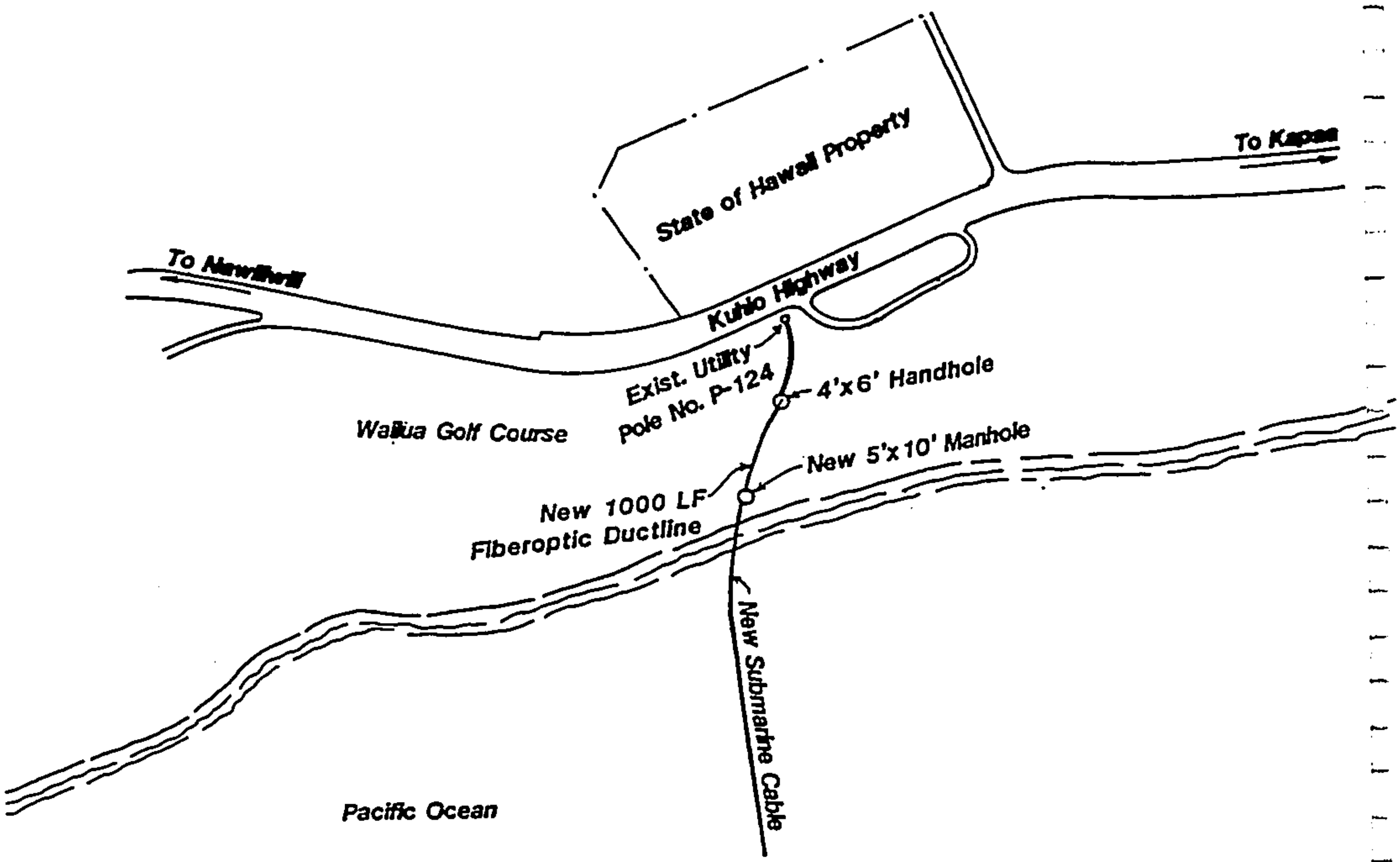

Figure 3-1
SITE PLAN • WAILUA

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

Not to Scale

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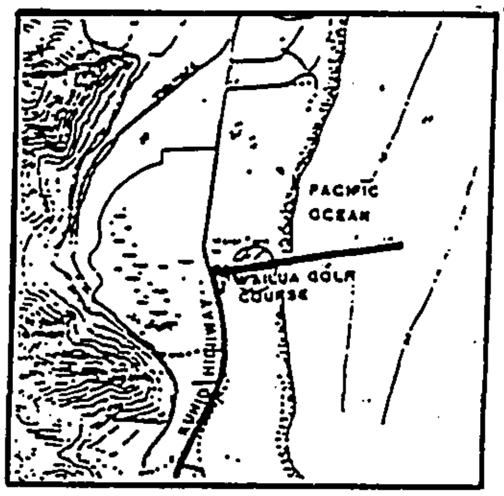
be installed within the Wailua Golf Course midway between the new manhole and Pole P-124. The PVC ducts will be encased in concrete and buried under 3 feet of earth cover (see Figure 3-2). Only one duct will be utilized while the others remain vacant and retained for future use. The trench will cut across the golf course driving range, but use of the golf course should not be affected during the trenching operations. Safety measures such as wooden barricades will be constructed around the excavation, and wooden walkways will be provided across the trenches for golfers. Traffic on Kuhio Highway will not be affected by the construction.

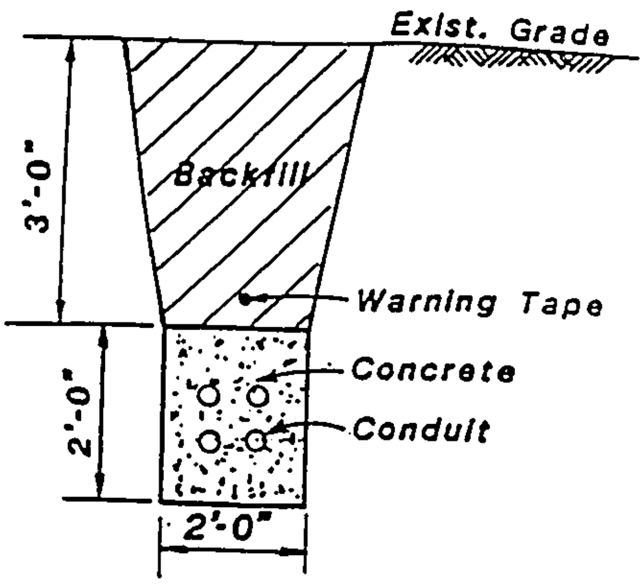
Kahe Point Beach Park, Oahu

The land-side construction activities involve the construction of a new manhole at Kahe Beach Park and approximately 350 feet of underground ducts and cable from the landing site to the new manhole to an existing manhole (No. 3455) located on the mauka side of Farrington Highway (see Figure 3-3). From Manhole No. 3455 the fiber optic cable will be pulled through 11,000 feet of existing underground ducts to connect to the GTE Hawaiian Tel Central Office (CO) at 92-1389 Aliinui Drive.

A new 5-foot x 10-foot x 6-foot deep reinforced concrete manhole will be constructed at Kahe Beach Park approximately 300 feet makai of Farrington Highway.

The new manhole will be the terminus of the land-side activities and it shall be constructed to accept the submarine cable. Seaward of the manhole, two six-inch diameter steel conduits encased in concrete will be embedded within the limestone cliff and rock outcropping fronting the ocean. Boring and trenching equipment will be utilized during the installation of the conduits. Landside of the manhole, four 4-inch diameter PVC ducts will be installed in a trench from the new manhole to Manhole 3455 located on the mauka shoulder of Farrington Highway. The duct lines will be encased in concrete and buried under 3 feet of earth cover. The trench will cut across the Kahe Beach Point Park Access Road, a railroad right-of-way, and Farrington Highway. Traffic will be detoured around the construction equipment during the trenching operations. Traffic control procedures such as rerouting the traffic onto the shoulder of the highway with the aid of necessary safety





NEW MANHOLE TO

EXIST.UTILITY POLE, NO.- P124

Figure 3-2
WAILUA BEACH PARK
TRENCH SECTIONS

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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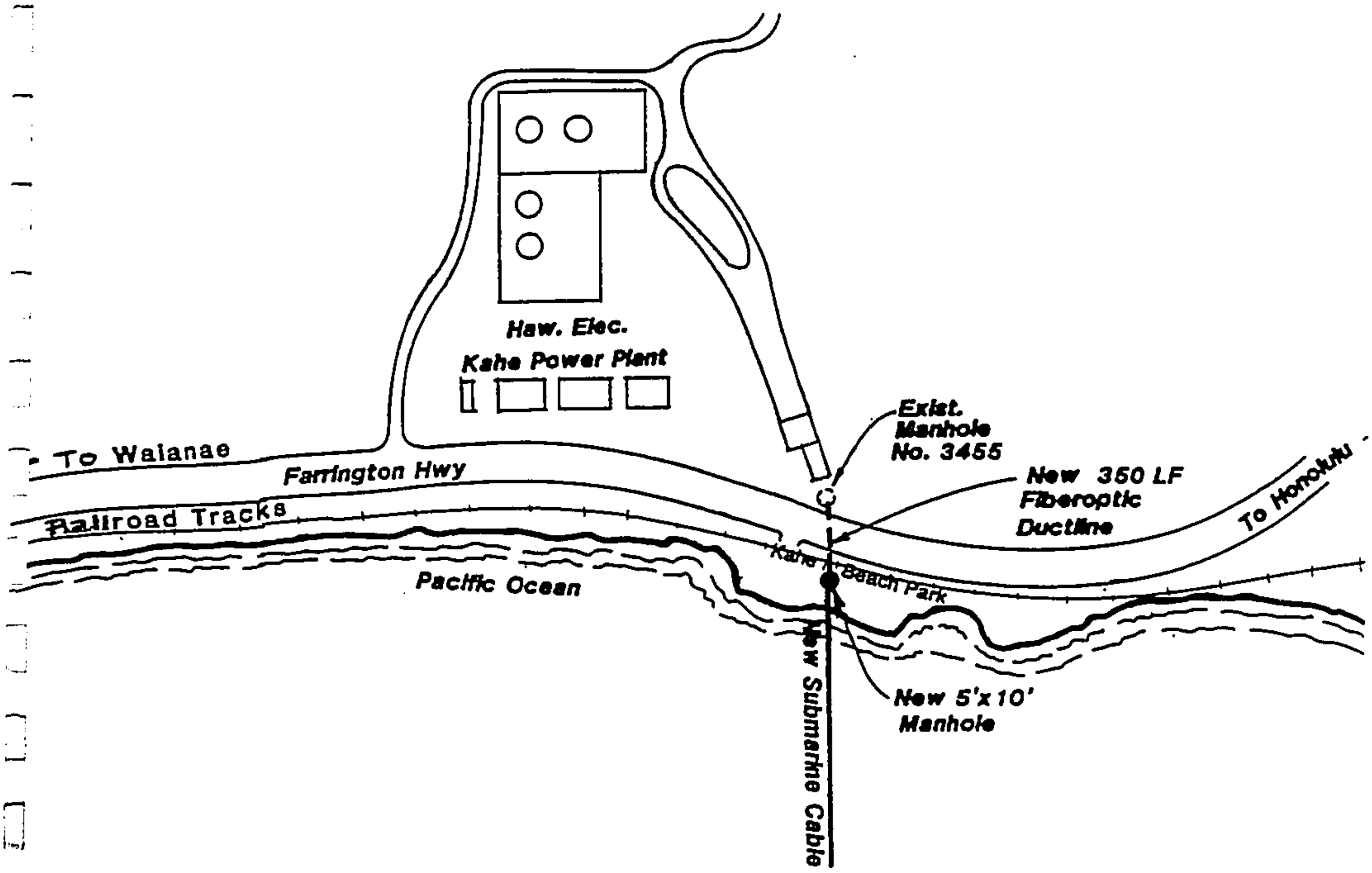

Figure 3-3
SITE PLAN•KAHE BEACH

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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measures such as temporary traffic control devices (cones) and/or use of flagmen to direct traffic will be implemented during work activity. Two-way traffic on Farrington Highway will be maintained at all times. Approximately two weeks will be required to complete the trenching work within the Farrington Highway right-of-way. The Kahe Point Beach Park Access Road may be partially closed to vehicular traffic during construction. The existing railroad tracks and ties removed during the trenching operations shall be restored after work within the railroad right-of-way is completed.

Sandy Beach Park, Oahu

The first phase involves land side construction which includes installation of a new manhole and approximately 1,500 feet of underground ducts and cable along Kalanianaole Highway to an existing manhole (No. 6207), located on the makai side of the intersection at Kalanianaole Highway and Kealahou Avenue (see Figure 3-4). From Manhole No. 6207, the fiber optic cable will be pulled through 9,650 feet of existing underground ducts to connect to the GTE Hawaiian Tel Central Office (CO) at 7664 Hawaii Kai Drive.

The new 5'x 5' x 10' deep reinforced concrete manhole will be constructed approximately 200 feet makai of Kalanianaole Highway adjacent to the Sandy Beach Park Access Road. The new manhole will be located approximately 5 feet from the edge of pavement (see Figure 3-4). Traffic on the Sandy Beach Park Access Road will not be affected except during the cable landing operations when the cable is pulled ashore from the cable laying ship (e.g. via a winch) which will be placed on the mauka side of the Park Road. This work will be accomplished in one or two days during which the eastern end of the park access road will be closed to traffic.

The terminus of the land side activities will be the manhole which will need to be constructed to accept the submarine cable. Four 4-inch diameter PVC ducts will be installed in a trench from the manhole along the makai shoulder of Kalanianaole Highway to existing Manhole 6207 (a permit to perform work upon a state highway will be sought for the proposed project). The PVC ducts will be located approximately 5 feet off the edge of the pavement. These PVC ducts will be encased in concrete and buried under 3 feet of

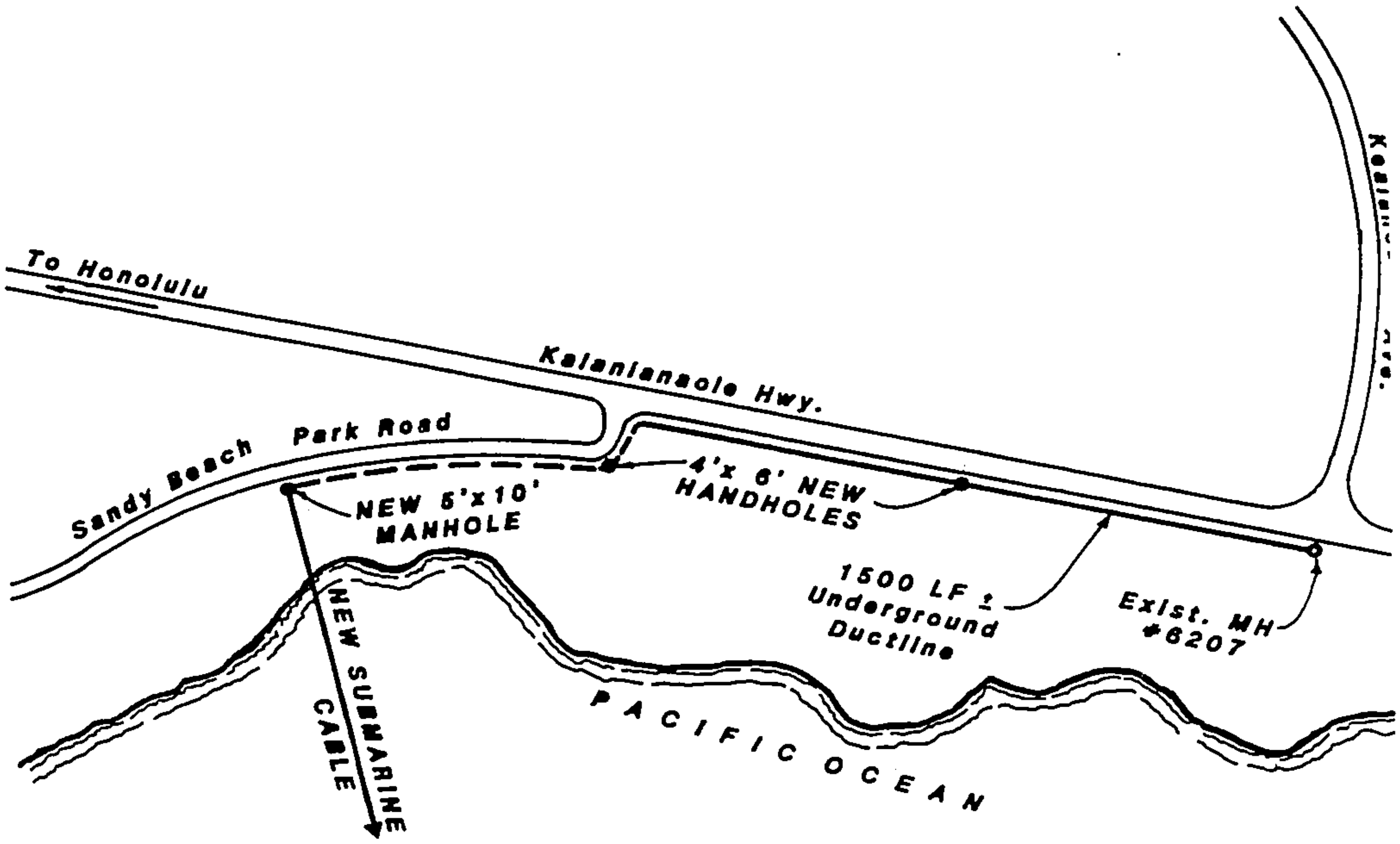

Figure 3-4
SITE PLAN • SANDY BEACH

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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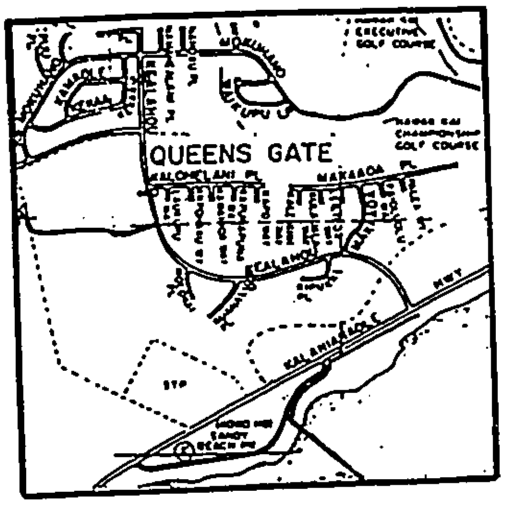
earth cover (See Figure 3-5). Only one duct will be utilized while the others remain vacant and retained for future use. Traffic in the makai lane of Kalanianaole Highway may be affected during trenching operations along the road shoulder and may need to be detoured around construction equipment. If necessary, traffic control safety measures to reroute traffic along the mauka shoulder of the highway will include use of temporary traffic control cones or use of flagmen during work activity. Two-way traffic on Kalanianaole Highway will be maintained at all times. Approximately 2 weeks will be required to excavate the trench, lay the ducts, place the concrete and backfill the trench.

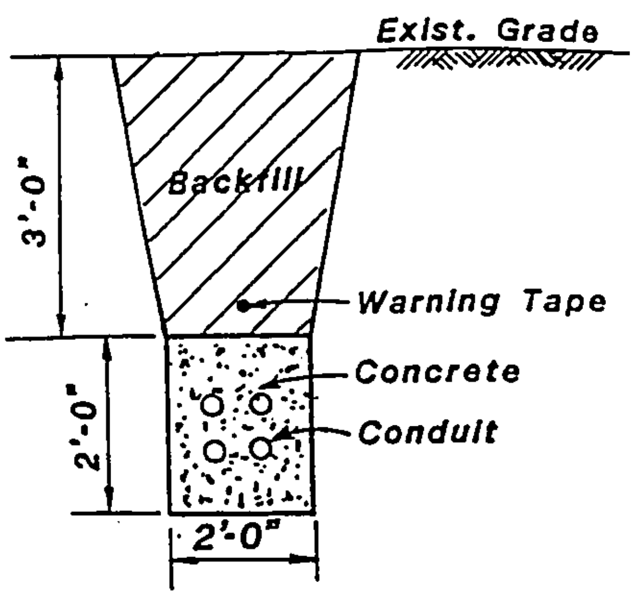
Mokapu Beach, Maui

The land-side construction activities involve the construction of: 1) a new 5 feet by 10 feet manhole at the Mokapu Beach landing site; 2) seven 4 feet by 6 feet handholes; and 3) the installation of approximately 3,100 feet of underground ducts and cable from the landing site to Manhole 100A at Okolani Drive (see Figure 3-6). Approximately 5,600 feet of cable will be pulled through existing underground ducts connecting Manhole 100A to Manhole 75 and installing 11,200 feet of overhead cable on existing utility poles from Manhole 75 to the central office located at 210 Halona Street.

A new 5'x 10'x 6' deep reinforced concrete manhole will be constructed within an easement near the southwestern corner of the Ten Wailea Beach resort property.

The new manhole will be terminus of the land-side activities and will be constructed to receive the submarine cable. Four 4-inch diameter PVC ducts will be installed in a trench from the new manhole along the southern boundary of the Ten Wailea Beach property, mauka toward and across Wailea Alanui Drive. After crossing Wailea Alanui Drive, the cables will be directed north toward Okolani Drive along the mauka shoulder of the highway adjacent to the golf course (Figure 3-6). The duct line will be located approximately 2-feet off the edge of the pavement and the conduits will be encased in concrete and buried under 3-feet of earth cover (see Figure 3-7).





NEW MANHOLE AT SANDY BEACH TO
EXISTING MANHOLE NO. 6207

Figure 3-5
SANDY BEACH PARK
TRENCH SECTIONS

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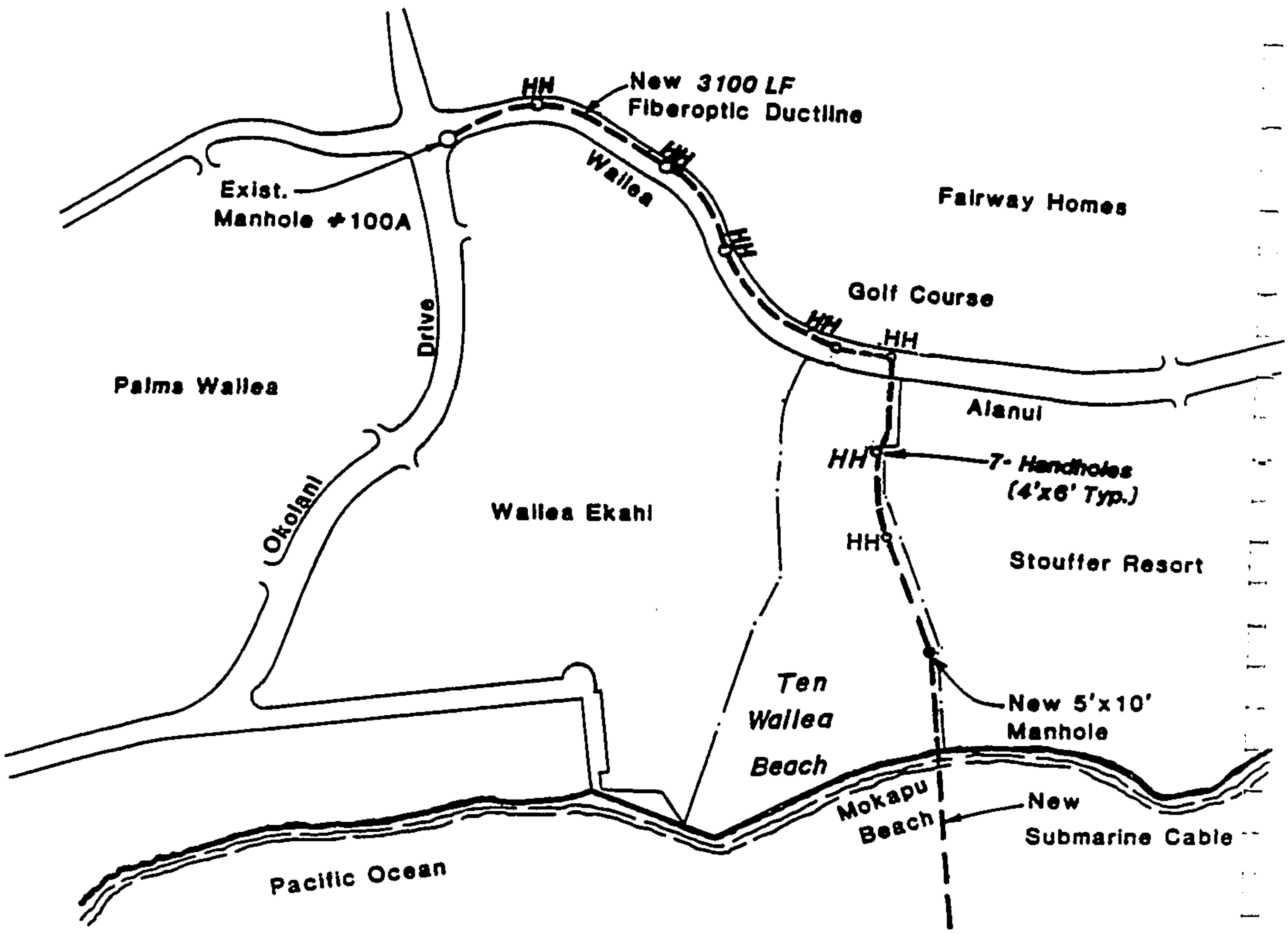

Figure 3-6
SITE PLAN • MOKAPU

GTE Hawaiian Tel Interisland Fiber Optic Cable Project

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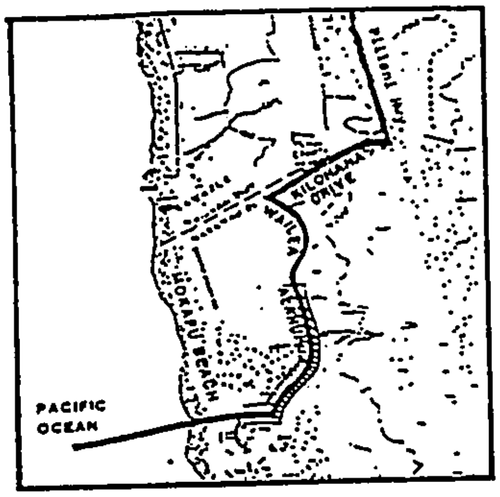

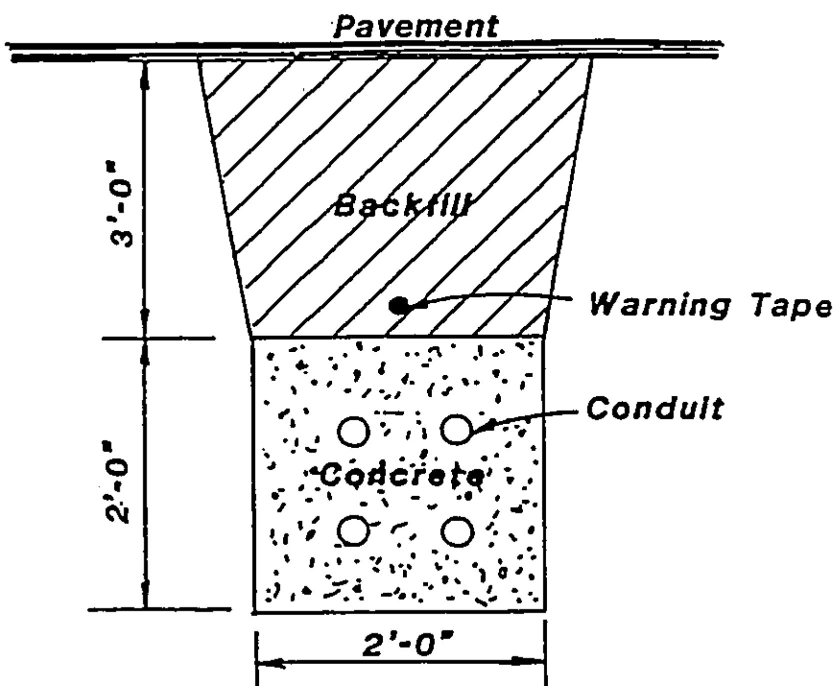

NEW MANHOLE TO EXIST.
MANHOLE NO. 100A

Figure 3-7
MOKAPU BEACH PARK
TRENCH SECTIONS

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Fiber Optic Cable Project

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Only two of the four PVC ducts will be utilized, with one duct receiving the Oahu end of the interisland cable, and one duct receiving the Big Island end of the interisland cable. The remaining two ducts will remain vacant and retained should their future use become necessary.

Approximately seven 4 feet by 6 feet concrete handholes will be constructed along the duct line about 500 feet apart. At the intersection of Okolani Drive, the ducts will be directed makai across Wailea Alanui Drive to an existing manhole (No. 100A). The cable will then be pulled through existing underground ducts connecting Manhole 100A to Manhole 75 at Kilohana Avenue. The cables will then be routed overhead onto existing utility poles along Kilohana Avenue and Piilani Highway to the central office at 210 Halona Street.

Spencer Beach Park, Hawaii

The land-side construction activities involve the construction of a new manhole and the installation of 2,300 lineal feet of underground cable and ducts to Akoni Pule Highway.

A new reinforced concrete manhole approximately 5'x10'x4' will be constructed on Spencer Beach Park (see Figure 3-8). The manhole will be the terminus of the land-side activities and shall be constructed to receive the submarine cable. Approximately 2,300 lineal feet of four, 4-inch diameter PVC ducts will be installed in a trench from the manhole to Spencer County Road and along the new proposed relocated Spencer Road to Akoni Pule Highway. The duct line will cut across the existing Spencer County Road and travel along the shoulder of the proposed relocated Spencer County Road until it reaches Akoni Pule Highway. Traffic will be affected during the trenching operations across Spencer County Road and may be detoured around the construction equipment. Traffic control procedures such as rerouting the traffic onto the shoulder of the road with the aid of necessary safety measures such as temporary traffic control devices (cones) and/or flagmen to direct traffic will be implemented.

The new underground ducts will be encased in a concrete jacket and buried under 3-4 feet of earth cover (see Figure 3-9). Only one duct will be utilized while the others remain vacant and retained should their future use be necessary. At Akoni Pule Highway the

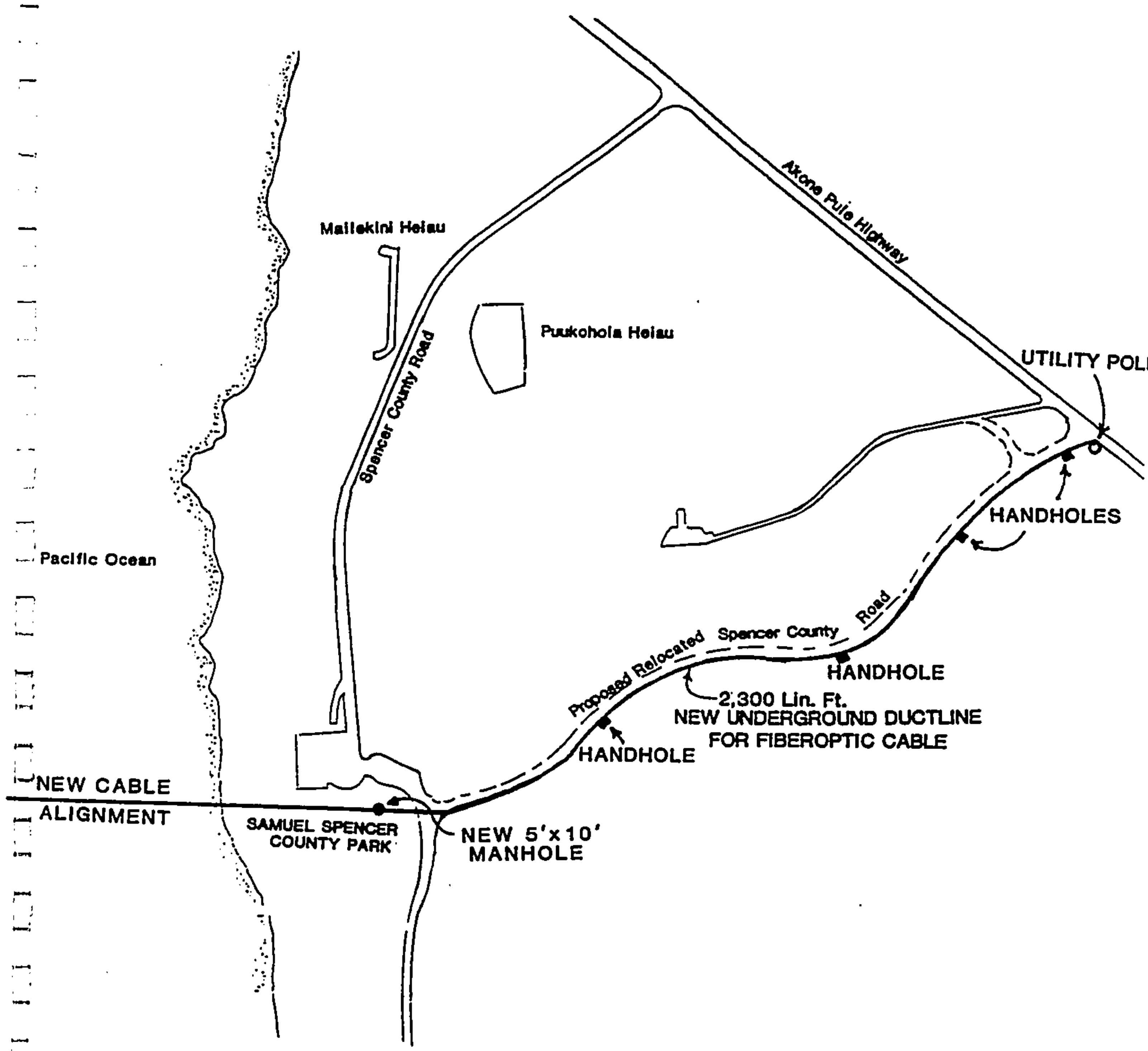

Figure 3-8
SITE PLAN•SPENCER BEACH

GTE Hawaiian Tel Interisland
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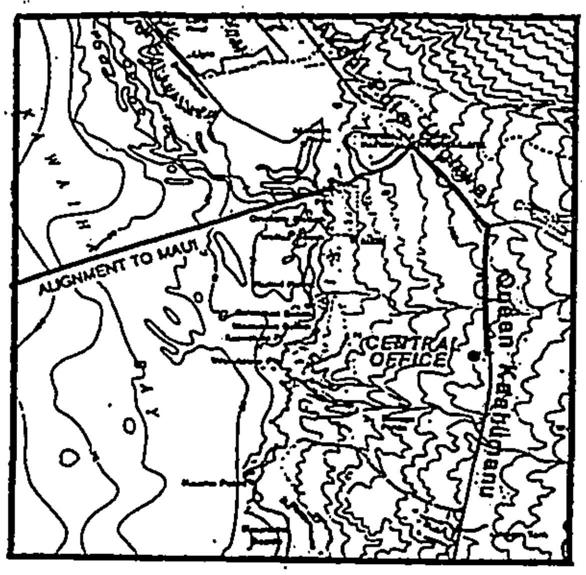

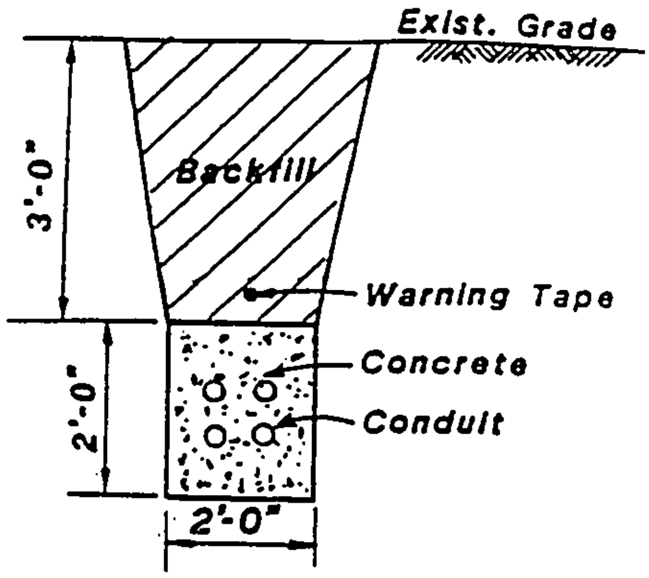

NEW MANHOLE AT SPENCER BEACH TO AKONE PULE HIGHWAY

Figure 3-9
SPENCER BEACH PARK TRENCH SECTIONS

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Kawaihae Golf Staff 3-6

underground cable will be diverted upwards onto a utility pole and carried overhead on existing utility polelines to the central office located nearby on Queen Kaahumanu Highway. Approximately four, 4'x6'x6' deep reinforced concrete handholes will also be constructed along the duct line at 500' intervals.

The area of Spencer Beach Park where the proposed trenching and underground duct line will traverse also has scattered trees. When sighting the trench and underground duct line alignment every effort will be made to try and avoid damaging the trees.

3.3 NEARSHORE ACTIVITY

The greatest danger to a cable system is the submarine portion of the route, and this necessitates more construction effort than the landside portion. Protection of the cable and public safety are the major factors for ensuring the fiber optic cable is covered or anchored in nearshore waters. Approximately 50 to 60 feet of water will be required before wave forces diminish to levels where wave action does not affect the cable. Until the cable reaches this depth it must be protected. Trenching is preferred, because it provides maximum protection against wave forces and is best for public safety. Public safety is at risk if the cable is left exposed along the nearshore, because someone could trip over it or hit their foot against it. Therefore, GTE Hawaiian Tel must do trenching or cable armoring in order for the cable and public safety to be protected.

Wailua Golf Course, Kauai

This second work phase involves landing the submarine fiber optic cable and establishing a connection to the new manhole at Wailua Beach. Wherever feasible, split pipe will be utilized to minimize turbidity and reduce potential for impacts to marine habitat. It should be noted that in utilizing both trenching and split pipe, that the operations will be short term, will be based on the need for public safety and protection or the cable, and will not constitute a long-term adverse impact.

There will be no permanent storage of any construction equipment on the beach. Equipment will only be on the beach during the beach construction phase, approximately 1-2 calendar days.

underground cable will be diverted upwards onto a utility pole and carried overhead on existing utility polelines to the central office located nearby on Queen Kaahumanu Highway. Approximately four, 4'x6'x6' deep reinforced concrete handholes will also be constructed along the duct line at 500' intervals.

The area of Spencer Beach Park where the proposed trenching and underground duct line will traverse also has scattered trees. When sighting the trench and underground duct line alignment every effort will be made to try and avoid damaging the trees.

3.3 NEARSHORE ACTIVITY

The greatest danger to a cable system is the submarine portion of the route, and this necessitates more construction effort than the landside portion. Protection of the cable and public safety are the major factors for ensuring the fiber optic cable is covered or anchored in nearshore waters. Approximately 50 to 60 feet of water will be required before wave forces diminish to levels where wave action does not affect the cable. Until the cable reaches this depth it must be protected. Trenching is preferred, because it provides maximum protection against wave forces and is best for public safety. Public safety is at risk if the cable is left exposed along the nearshore, because someone could trip over it or hit their foot against it. Therefore, GTE Hawaiian Tel must do trenching or cable armoring in order for the cable and public safety to be protected.

Wailua Golf Course, Kauai

This second work phase involves landing the submarine fiber optic cable and establishing a connection to the new manhole at Wailua Beach. Wherever feasible, split pipe will be utilized to minimize turbidity and reduce potential for impacts to marine habitat. It should be noted that in utilizing both trenching and split pipe, that the operations will be short term, will be based on the need for public safety and protection or the cable, and will not constitute a long-term adverse impact.

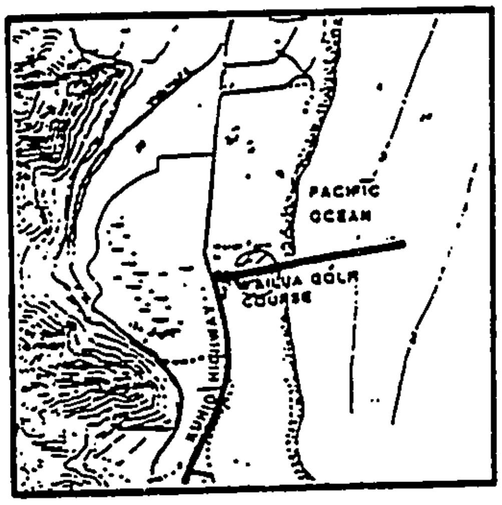
There will be no permanent storage of any construction equipment on the beach. Equipment will only be on the beach during the beach construction phase, approximately 1-2 calendar days.

A 300-foot long trapezoidal shaped trench as indicated in Figure 3-10 will be excavated between the new manhole and the mean low water mark and four 6-inch steel conduits encased in concrete installed within the trench. Only one conduit will be used while the others are plugged and retained should their future use be necessary. The trench will have a 2-foot base and will be approximately 6 feet deep, with a 1:1 side slopes. Approximately 580 cubic yards of sand and rubble excavated from the trench will be stored on the beach adjacent to the cable easement for later use as backfill. The trench will be backfilled after the concrete jacket has cured.

Sand and rubble covering the proposed cable segment may require removal below the level of the prevailing tides. For this process, a backhoe, shovels, or other mechanical means will be used to remove the upper layers. If necessary, sandbags will be used to prevent sand from reentering the open trench. Rock outcrops and other hard substrate which cannot be avoided will be also removed using a backhoe or other similar mechanical means. Below the waterline sand or rubble will be temporarily displaced using a hydro-jet.

To reduce potential for turbidity due to construction related work, silt screens or filters will be utilized. Upon completion of construction activities, the construction crew will return the ground to existing preconstruction contours through use of existing excavated materials for backfill. The quality of backfill at each level of excavation will be equal to or better than that of the abutting areas (in terms of sand-dirt-stone ratio).

A study of the ocean bottom along the proposed cable alignment indicates that no offshore cable protection, anchoring or trenching is anticipated. There are several small sand deposits on the reef flat off the central and north parts of the golf course, but most terminate on hard bottom or the 60-foot ledge, which parallels much of the windward coast off Kauai. The recommended route is located in the only sand channel found that bisects the ledge and the reef and extends into deeper water. The bottom is sand from the shoreline to at least the 120-foot depth, the seaward limit of the visual inspection. There is hard bottom, with the typical 60 foot ledge, both north and south of this sand channel. The 60-foot depth contour is located 2200 feet from shore. From that point seaward, the



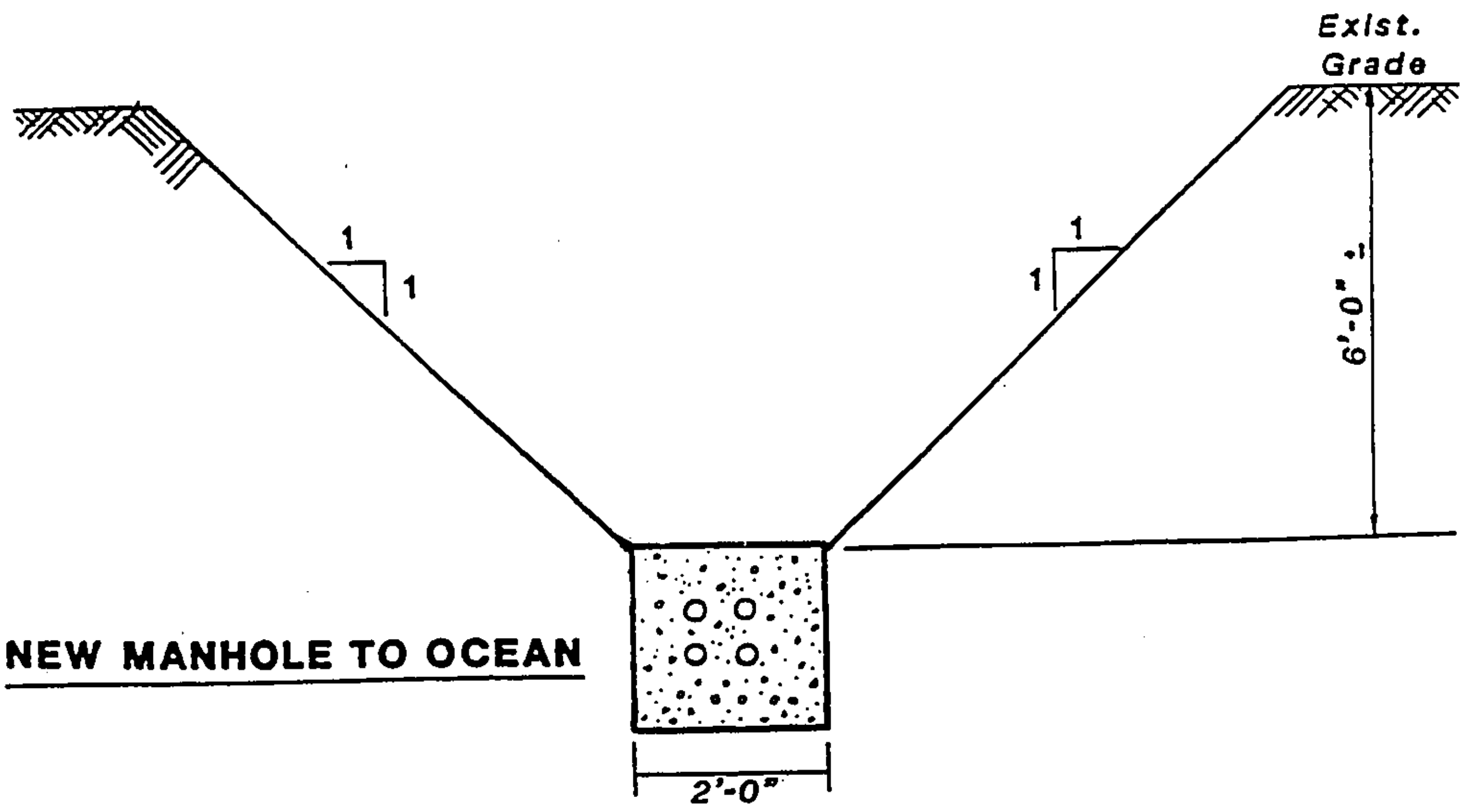


Figure 3-10
WAILUA BEACH PARK
TRENCH SECTIONS

GTE Hawaiian Tel Interisland
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bottom slope becomes steeper, and the 110 foot depth contour is located only 2600 feet offshore. The sand deposit was not probed, but it appears to be thick. The sand is medium to coarse grained, with pronounced sand waves in shallow water, due to wave action. There are no visible outcrops of coral or rock along the route. The flat and sandy ocean bottom provides an ideal landing condition as the cable will eventually be covered by sand providing protection from wave action.

Kahe Point Beach Park, Oahu

This second work phase involves landing the submarine fiber optic cable and establishing a connection to the new manhole at Kahe Point Beach. Again, the greatest danger to a cable system is the submarine portion of the route, which will require more construction effort than the landside portion. GTE Hawaiian Tel will utilize trenching or cable armoring as necessary at Kahe Point Beach, in order for the cable and public safety to be protected.

Wherever feasible, split pipe will be utilized to minimize turbidity and reduce potential for impacts to marine habitat. It should be noted that in utilizing both trenching and split pipe, that the operations will be short term, will be based on the need for public safety and protection of the cable, and will not constitute a long-term adverse impact.

There will be no permanent storage of any construction equipment at Kahe Point Beach Park. Equipment will only be in the park during the nearshore construction phase, approximately 1-2 calendar days.

To reduce potential for turbidity due to construction related work, silt screens or filters will be utilized. Upon completion of construction activities, the construction crew will return the ground to existing preconstruction contours through use of existing excavated materials for backfill. The quality of backfill at each level of excavation will be equal to or better than that of the abutting areas (in terms of sand-dirt-stone ratio).

A study of the ocean bottom along the proposed cable alignment at the landing site indicates the following characteristics:

Immediately offshore, there is a 380-foot wide band of hard bottom, consisting of alternative ridges and channels, with scattered boulders and coral with vertical relief of about 3 to 4 feet. The water depth at the seaward end of this band is approximately 15 feet. Seaward of this point, there is a 100-foot wide transition zone, with the bottom consisting of a flat sand bottom with interspersed limestone and coral outcrops. Vertical relief through this zone is 2 to 4 feet. The water depth at the seaward end of the transition zone is 18 to 20 feet. The percentage of sand in the transition zone increases proceeding seaward.

An extensive deposit of medium grained calcareous sand begins approximately 500 feet offshore and continues for approximately 2,200 feet to the 70-foot depth. There are no exposed outcrops of limestone or coral in the deposit. The ocean bottom from the 70-foot depth to the 100-foot depth comprises of limestone, scattered coral, and coral rubble with sand.

Depending on subsurface conditions, the cable may need to be curved around fixed underwater obstacles such as coral heads, finger coral, and rock outcrops. Coral, rock and other hard surfaces that cannot be avoided will have to be removed or circumvented using methods including:

1. Coral and limestone beds may need to be trenched to a width and depth of approximately 1 to 2 feet, or more, to accept the fiber optic cable. If necessary, tremie concrete can be poured into the trench where it can harden under water. The impacts can be minimized depending on the depth of trenching necessary to accommodate the relatively narrow diameter of the cable. If tremie concrete is used, it will provide a new surface for growth of coral and other marine organisms; or,

2. Shielded cable may be laid with split pipe fastened around the cable and then bolted to the hard rock or coral bed using pneumatic or mechanically driven bolts. This practice will result in minimal environmental impact since little or no coral will have to be displaced to site the cable.

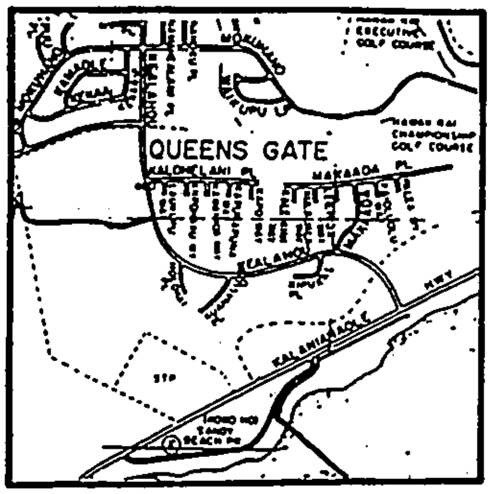
The cable will be anchored in shallow water with a hard rock or coral bottom to prevent abrasion resulting from wave action. Under this situation the cable will be exposed to abrasion from movement against hard surfaces caused by weather or geologically (tsunami) induced wave action. In deeper water, cable movement is significantly reduced and the need for wave related abrasion protection is less of a concern. According to Seafloor Surveys International, in deeper waters trenching is generally unnecessary since there are no man-made activities capable of dredging the cable off the ocean floor and damaging it (only commercial trawlers would pose this concern and none are located in Hawaiian waters in the vicinity of the proposed cable alignment).

Sandy Beach Park, Oahu

This second work phase involves landing the submarine fiber optic cable and establishing a connection to the new manhole at Sandy Beach. Where feasible, split pipe will be utilized to minimize turbidity and reduce potential for impacts to marine habitat. In utilizing both trenching and split pipe, the operations will be short term, will be based on the need for public safety and protection of the cable, and will not constitute a long-term adverse impact.

There will be no permanent storage of any construction equipment on the beach. Equipment will only be on the beach during the beach construction phase, approximately 1-2 calendar days.

A 200-foot long trapezoidal shaped trench as indicated in Figure 3-11 will be excavated between the new manhole and the mean low water mark and four 6-inch steel conduits encased in concrete installed within the trench. Only one conduit will be used while the others are plugged and retained should their future use be necessary. The trench will have a 2-foot base and will be approximately 6 feet deep, with a 1:1 side slopes. Approximately 385 cubic yards of sand and rubble excavated from the trench will be stored on the beach adjacent to the cable easement for later use as backfill. The trench will be backfilled after the concrete jacket has cured.



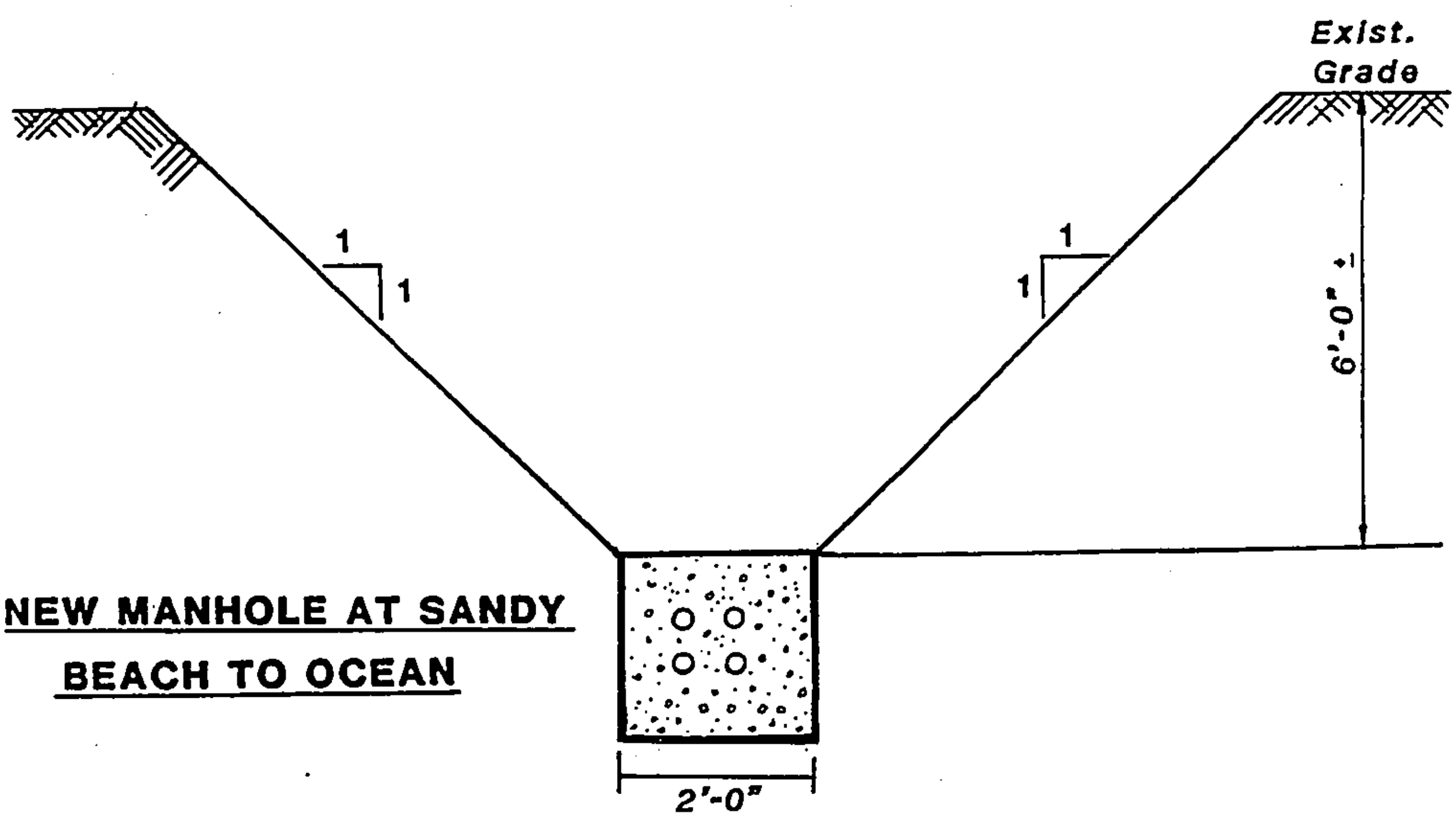


Figure 3-11
SANDY BEACH PARK
TRENCH SECTIONS

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

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DECEMBER 1992

Sand and rubble covering the proposed cable segment may require removal below the level of the prevailing tides. For this process, a backhoe, shovels, or other mechanical means will be used to remove the upper layers. If necessary, sandbags will be used to prevent sand from reentering the open trench. Rock outcrops and other hard substrate which cannot be avoided will be also removed using a backhoe or other similar mechanical means. Below the waterline sand or rubble will be temporarily displaced using a hydro-jet.

To reduce potential for turbidity due to construction related work, silt screens or filters will be utilized. Upon completion of construction activities, the construction crew will return the ground to existing preconstruction contours through use of existing excavated materials for backfill. The quality of backfill at each level of excavation will be equal to or better than that of the abutting areas (in terms of sand-dirt-stone ratio)

A study of the ocean bottom along the proposed cable alignment at the landing site indicates the following features:

The first 600 feet out from the shore is hard substrate, consisting of relatively flat limestone with numerous small to medium (1 to 2-foot diameter) boulders. There are some scattered larger (3 to 4-foot diameter) boulders, particularly in the shallower water. The water depth at the seaward end of this zone is 20 feet. At the seaward limit of this inshore zone, there is a 100 to 150-foot wide band of ledges and other irregularities, with vertical relief on the order of 3 to 7 feet.

Seaward of the ledges, there is a 350-foot wide band of exposed limestone, with scattered coral heads and some sand. The water depth at the seaward end of this band, 950 feet from shore, is 32 feet. From this point to the 70-foot depth contour, located 2,500 feet offshore, the bottom is primarily sand. Because the sand deposit is irregular, the cable will cross two limestone spurs in this area, with a total width of approximately 250 feet. Again, the limestone is relatively flat, with scattered coral heads. Vertical relief is on the order of 1 to 2 feet.

Seaward of the 70-foot depth, the bottom consists of coral rubble, scattered sand, and some scattered limestone mounds and ledges. The coral rubble areas are flat, and the relief of the mounds and ledges is typically 3 feet.

The cable will be protected with cable armoring for the first 950 feet offshore, through the zone of hard substrate. Although the sand deposit appears to be relatively thin, it is extensive enough so that the cable will eventually be covered and protected against wave forces. Depending upon the selected cable vendor and the extent of cable armoring, protection may or may not be required where it crosses the two limestone spurs between the 32 and 70-foot depths. Protection will probably not be required beyond the 70-foot depth.

Depending on subsurface conditions, the cable may need to be curved around fixed underwater obstacles such as coral heads, finger coral, and rock outcrops. Coral, rock and other hard surfaces that cannot be avoided will have to be removed using various means including:

1. Coral and limestone beds may need to be trenched to a width and depth of approximately 1 to 2 feet, or more, to accept the fiber optic cable. If necessary, tremie concrete can be poured into the trench where it can harden under water. The impacts can be minimized depending on the depth of trenching necessary to accommodate the relatively narrow diameter of the cable. If tremie concrete is used, it will provide a new surface for growth of coral and other marine organisms; or,

2. Shielded cable may be laid with split pipe fastened around the cable and then bolted to the hard rock or coral bed using pneumatic or mechanically driven bolts. This practice will result in minimal environmental impact since little or no coral will have to be displaced to site the cable.

The cable will be anchored in shallow water having a hard rock or coral bottom to prevent abrasion resulting from wave action. Under this situation without anchoring the cable would be exposed to abrasion from movement against hard surfaces caused by weather or geologically (tsunami) induced wave action. In deeper water, cable movement is significantly reduced and the need for wave related abrasion protection is less of a concern. According to Seafloor Surveys International, in deeper waters trenching is generally unnecessary since there are no man-made activities capable of dredging the cable off the ocean floor and damaging it (only commercial trawlers would pose this concern and none are located in Hawaiian waters in the vicinity of the proposed cable alignment).

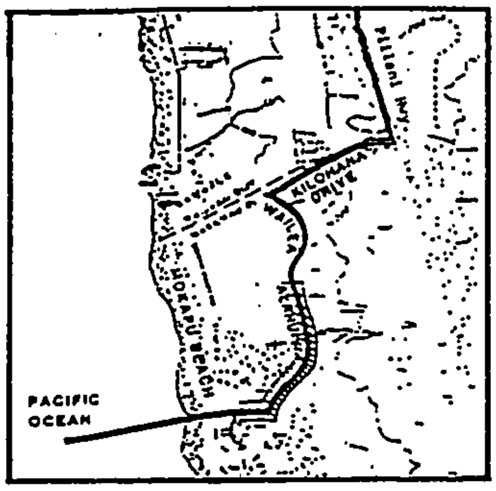
Mokapu Beach, Maui

This second work phase involves landing the submarine fiber optic cable and establishing a connection to the new manhole at Mokapu Beach. Wherever feasible, split pipe will be utilized to minimize turbidity and reduce potential for impacts to marine habitat. The operations will be short term, will be based on the need for public safety and protection of the cable, and will not constitute a long-term adverse impact.

There will be no permanent storage of any construction equipment on the beach. Equipment will only be on the beach during the beach construction phase, approximately 1-2 calendar days.

A 200-foot long trapezoidal shaped trench as indicated in Figure 3-12 will be excavated between the new manhole and the mean low water mark and four 6-inch steel conduits encased in concrete installed within the trench. Only one conduit will be used while the others are plugged and retained should their future use be necessary. The trench will have a 2-foot base and will be approximately 6 feet deep, with a 1:1 side slopes. Approximately 385 cubic yards of sand and rubble excavated from the trench will be stored on the beach adjacent to the cable easement for later use as backfill. The trench will be backfilled after the concrete jacket has cured.

Sand and rubble covering the proposed cable segment may require removal below the level of the prevailing tides. For this process, a backhoe, shovels, or other mechanical means will be used to remove the upper layers. If necessary, sandbags will be used to prevent sand



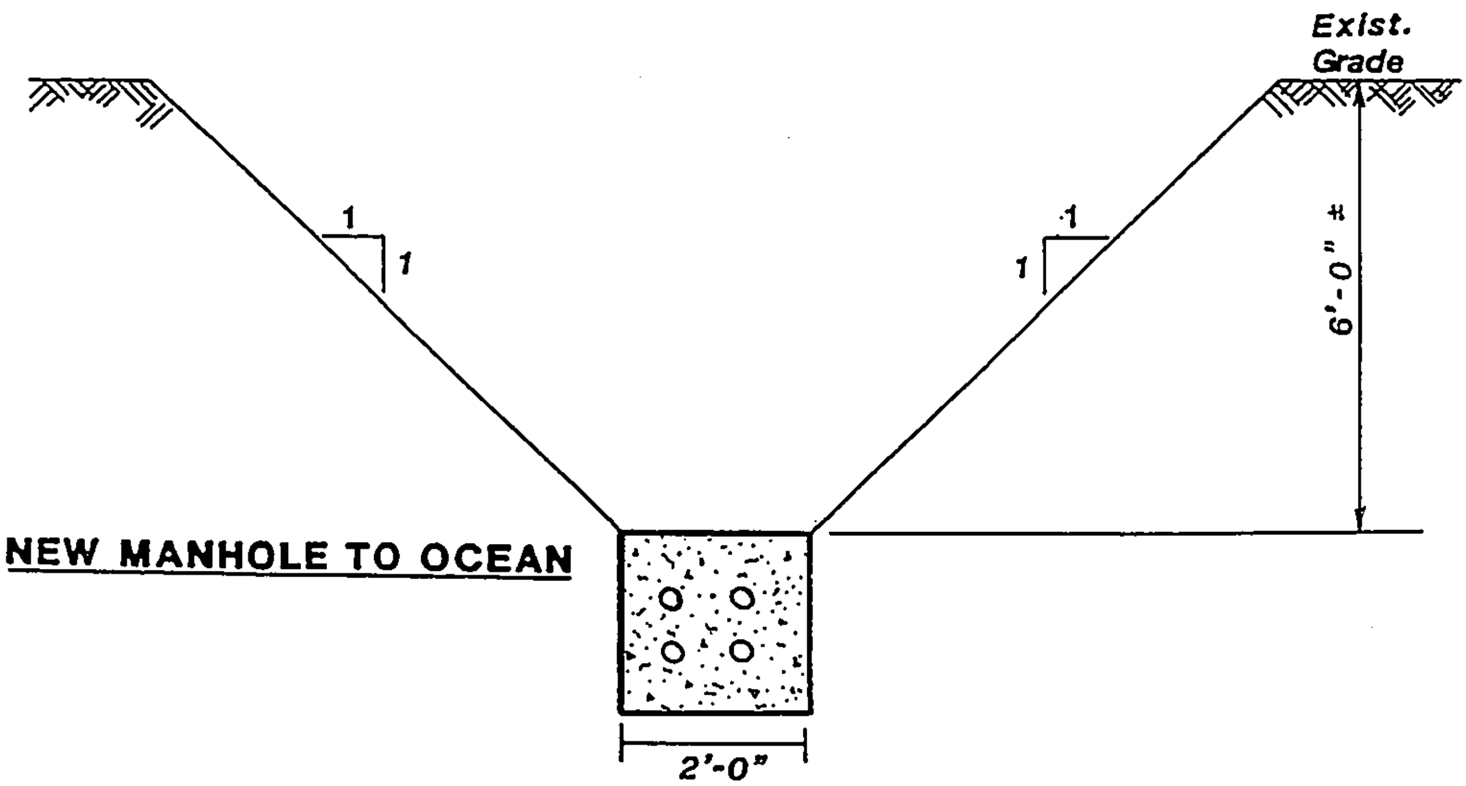


Figure 3-12
MOKAPU BEACH PARK
TRENCH SECTIONS

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from reentering the open trench. Rock outcrops and other hard substrate which cannot be avoided will be also removed using a backhoe or other similar mechanical means. Below the waterline sand or rubble will be temporarily displaced using a hydro-jet.

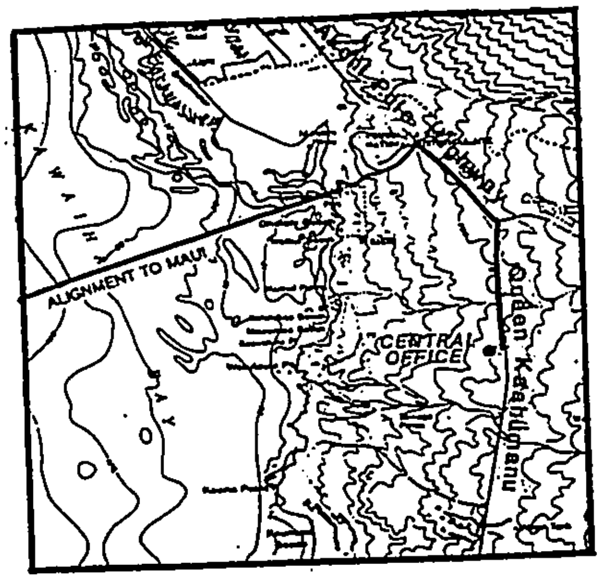
To reduce potential for turbidity due to construction related work, silt screens or filters will be utilized. Upon completion of construction activities, the construction crew will return the ground to existing preconstruction contours through use of existing excavated materials for backfill. The quality of backfill at each level of excavation will be equal to or better than that of the abutting areas (in terms of sand-dirt-stone ratio).

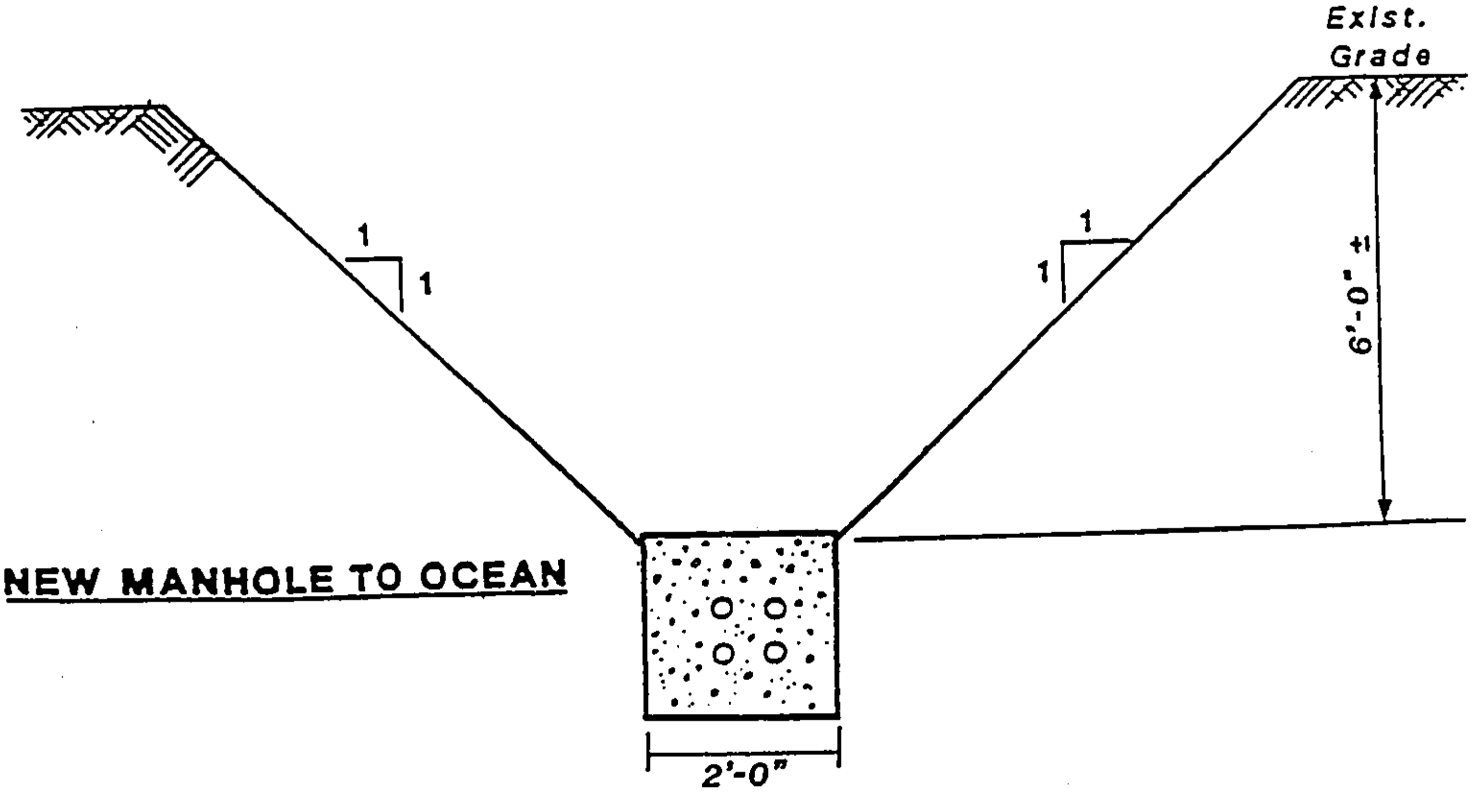
Spencer Beach Park, Hawaii

This second work phase involves landing the submarine fiber optic cable and establishing a connection to the new manhole at Spencer Beach. Wherever feasible, split pipe will be utilized to minimize turbidity and reduce potential for impacts to marine habitat. It should be noted that in utilizing both trenching and split pipe, that the operations will be short term, will be based on the need for public safety and protection of the cable, and will not constitute a long-term adverse impact.

There will be no permanent storage of any construction equipment on the beach. Equipment will only be on the beach during the beach construction phase, approximately 1-2 calendar days.

A 200-foot long trapezoidal shaped trench as indicated in Figure 3-13 will be excavated between the new manhole and the mean low water mark and four 6-inch steel conduits encased in concrete installed within the trench. Only one conduit will be used while the others are plugged and retained should their future use be necessary. The trench will have a 2-foot base and will be approximately 6 feet deep, with a 1:1 side slopes. Approximately 385 cubic yards of sand and rubble excavated from the trench will be stored on the beach adjacent to the cable easement for later use as backfill. The trench will be backfilled after the concrete jacket has cured.





NEW MANHOLE TO OCEAN

Figure 3-13
SPENCER BEACH PARK
TRENCH SECTIONS

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Sand and rubble covering the proposed cable segment may require removal below the level of the prevailing tides. For this process, a backhoe, shovels, or other mechanical means will be used to remove the upper layers. Below the waterline sand or rubble will be temporarily displaced using a hydro-jet. If necessary, sandbags will be used to prevent sand from reentering the open trench. Rock outcrops and other hard substrate which cannot be avoided will be also removed using a backhoe or other similar mechanical means.

To reduce potential for turbidity due to construction related work, silt screens or filters will be utilized. Upon completion of construction activities, the construction crew will return the ground to existing preconstruction contours through use of existing excavated materials for backfill. The quality of backfill at each level of excavation will be equal to or better than that of the abutting areas (in terms of sand-dirt-stone ratio).

The proposed cable alignment at the landing site will be directed through a sand channel, which connects the beach to a large offshore sand deposit. The water depth in the sand channel is typically 10 to 15 feet and there are many large coral formations within the channel which rise vertically up from the channel bottom to within a few feet of the surface.

The sand, both in the inner channel and the offshore deposit, is relatively fine and has a high silt content. Besides the coral outcrops in the sand channel, there is also a 50-foot wide basalt shelf at the toe of the beach.

A straight line route was selected to avoid much of the coral formations in the channel. Most of the coral outcrops can be avoided by carefully maneuvering the cable between the formations. During the cable landing, the floats will be successively cut from the cable and allowed to sink. Several small boats may be used during the landing process to weave the cable into place between the coral formations prior to cutting the floats. All bends will be relatively gentle and well within the bending radius of the cable.

Coral, rock and other hard surfaces that cannot be avoided will have to removed or circumvented by various means including:

1. Coral beds may need to be trenched to a width and depth of approximately 1 to 2 feet, or more, to accept the fiber optic cable. If necessary, tremie concrete can be poured into the trench where it can harden under water.

   If tremie concrete is used, it will provide a new surface for growth of coral and other marine organisms; or,

2. Shielded cable may be laid with split pipe fastened around the cable and then bolted to the hard rock or coral bed using pneumatic or mechanically driven bolts. This practice will result in minimal environmental impact since little or no coral will have to be displaced to site the cable.

In the area of the basaltic shelf, the cable will probably be pinned to the bottom, or trenched into the shelf. The water at the seaward boundary of the shelf is only about 3 feet deep.

3.4 CABLE LANDING PROCESS

Two range targets (alignment guide) will be placed on land just prior to the landing of the cables to aid in the cable laying process. The range targets will be placed on temporary structures and will be removed following the cable landing. The range targets will not disrupt traffic movements along Spencer Road.

A cable laying ship provided by the cable vendor will serve as the primary means of laying the fiber optic cable. The following procedures describe the activities involved during the cable landing operations.

The ship's captain will approach the landing site using the range target to align the ship as it approaches the shore. The range targets will be placed by a cable receiving party according to previously surveyed coordinates. Once the ship approaches the shore landing to the minimum depth allowable, it will fix its position relative to the landing site using anchoring, tugboats, side-thrusters or other means. As the ship fixes its position, it will begin laying out cable.

The ship will lay cable while its personnel attach suspension floats at regular intervals to the cable. As the cable is lowered to the water, it will float, allowing it to be pulled toward shore using a winch, small motor boat, or other mechanical means.

The shore landing will be specially prepared to accept the cable. As the cable nears the shore, it will be fed into the steel conduit previously buried in the sand and the cable will be pulled to the new manhole. When the cable is secured in the manhole, it will be temporarily anchored while the divers readjust the suspension floats in the water to obtain a proper nearshore to shoreline alignment.

Once the cable is aligned, it will be permanently installed in the manhole and the divers will cut the remaining floats away, allowing the rest of the cable to sink to the ocean bottom.

Following this action, the cable ship will commence with cable laying operations to the next landing site. The ship will follow a prescribed survey route until it reaches the other landing site where the end of the cable can be similarly connected.

3.5 SAFETY CONSIDERATIONS

During the construction phase on the beach (approximately 30-45 calendar days, May-June 1993), the portion of the beach which contains the open trench will be barricaded from public entry. During the construction period, a security guard may be required at night and weekends to ensure public safety and integrity of the job site.

During the cable laying process (approximately 2 days depending on the weather conditions), the nearshore waters will be closed to ocean activities (surfing, diving, boating, swimming) to ensure the safety of ocean users. The area that will be closed will be approximately 100 to 150 feet wide and 1,000 to 2,000 feet long. The actual area may be more or less depending on the tides. The period when the waters will be closed is not expected to be more than two days, weather permitting. This short-term "closure" of nearshore water areas will be achieved by publishing a notice to advise mariners to avoid the area. Further, during the cable laying process, project personnel will advise beach users to avoid the project site both on land and in the water via small powered water crafts.

To ensure the protection of the cable and public safety the fiber optic cable will be covered and anchored in nearshore waters. Makai of the beach manhole the trench will be a minimum of 6 feet deep. Historically, the proposed project site's beach has been relatively stable (see page 29). The cable is not expected to be exposed unless there is a severe storm. If there is a severe storm the entire beach would erode, so there would be no trench. If the cable is exposed at any of the sites GTE will take immediate action to protect the cable and ensure public safety.

All work shall be performed in conformance to all prevailing County, State, and Federal regulations regarding noise and dust control, the disposal of dirty or polluted water and construction debris and other environmental issues which may arise. No oil and/or grease from machinery shall be released into the ocean from the proposed project. All work shall be performed in conformance to the Department of Health Section 401 Water Quality Certification. The "discharge" associated with the construction of the submarine fiber optic cable is expected to be primarily from minor excavation and trenching in the nearshore waters. Materials to be "discharged" would consist of sand and rock. All discharges will be biological, the principle elements of which will be salt water, sand and dirt.

3.6 SCHEDULE AND ESTIMATED COST

Wailua Golf Course, Kauai

The first phase (land-side activities) of the project is scheduled tentatively for March and April 1993. The second phase (installation of interisland cable and cable landing operations) is scheduled tentatively for May and June 1993. Construction cost for the first phase is estimated at $461,000.00.

Kahe Point Beach Park, Oahu

The first phase (land-side activities) of the project is scheduled tentatively for March and April 1993. The second phase (installation of interisland cable and cable landing operations) is scheduled tentatively for May and June 1993. Construction cost for the first phase is estimated at $243,550.

Mokapu Beach, Maui

The first phase (land-side activities) of the project is scheduled tentatively for February and March 1993. The second phase (installation of interisland cable and cable landing operations) is scheduled tentatively for April and May 1993. Construction cost for the first phase is estimated at $655,000.

Sandy Beach Park

The first phase (land-side activities) of the project is scheduled tentatively for March and April 1993. The second phase (installation of interisland cable and cable landing operations) is scheduled tentatively for May and June 1993. Construction cost for the first phase is estimated at $512,000.00.

Spencer Beach Park, Hawaii

The first phase (land-side activities) of the project is scheduled tentatively for February and March 1993. The second phase (installation of interisland cable and cable landing operations) is scheduled tentatively for April and May 1993. Construction cost for the first phase is estimated at $440,000.

SECTION 4

DESCRIPTION OF THE AFFECTED ENVIRONMENT

4.1 PHYSICAL ENVIRONMENT

4.1.1 Climate

Wailua Golf Course, Kauai

The project site and surrounding area is located on the eastern side of Kauai which is generally warm and moist. The mean annual temperature is between 70 and 82 degrees Fahrenheit and the annual rainfall is between 60 to 96 inches, most of it occurring during winter months (Atlas of Hawaii, 1983).

As with most windward facing coastal areas of the Hawaiian Islands, conditions are generally windy and with frequent rainfall.

Impacts

The proposed project is not expected to impact the local climate of the project area and vicinity.

Kahe Point Beach Park, Oahu

The project site and surrounding area is located on the south-western side of Oahu which is generally warm and dry. The mean annual temperature is between 72 and 79 degrees Fahrenheit and the annual rainfall is about 20 inches, most of it occurring during winter months. The prevailing winds are tradewinds blowing from a northeasterly direction. Winds from a southeasterly direction (Kona winds) may be expected 5-8 percent of the time (Atlas of Hawaii, 1983).

Impacts

The proposed project is not expected to impact the local climate of the project area and vicinity.

Sandy Beach Park, Oahu

The project site and surrounding area is located on the southeastern side of Oahu which is generally warm and dry. The mean annual temperature is between 72 and 75 degrees Fahrenheit and the annual rainfall is between 15 and 25 inches, most of it occurring during winter months (Atlas of Hawaii, 1983).

Impacts

The proposed project is not expected to impact the local climate of the project area and vicinity.

Mokapu Beach, Maui

The project site is located on the leeward side of Maui which is typically hot, dry and sunny. The mean annual temperature is between 71.5 and 78 degrees Fahrenheit. The area averages 15 inches of rain annually. August and September are normally the hottest and driest months and January through March are the coolest and wettest.

Winds are generally from the northeast except during the winter months when storms are usually accompanied by south winds. The Kihei-Makena shoreline areas are also subject to unpredictable local winds from Kalama Park to Cape Kinau. These winds are created as the trades increase in velocity as they travel between the West Maui Mountains and Haleakala and meet the eddy current of the trades deflected along the southeast slopes of Haleakala (Atlas of Hawaii, 1983).

Impacts

The proposed project is not expected to impact the local climate of the project area and vicinity.

Spencer Beach Park, Hawaii

The project site and surrounding area is located on the lee side of the island and is generally warm and dry. The mean annual temperature is between 74 and 77 degrees Fahrenheit and the annual rainfall is between five and twenty inches, most of it occurring during winter months.

Impacts

The proposed project is not expected to impact the local climate of the project area and vicinity.

4.1.2 Topography, Geology, Soils

Wailua Golf Course, Kauai

The project area lies at the base of a single shield volcano which was eroded and layered by other volcanic activity. The Koloa volcanic series covers about half of the eastern section of Kauai and the Waimea volcanic series covers the balance. The property's elevation ranges from sea level to only less than 20 feet above sea level. The predominant underlying soil type for the affected area, as described in the August 1972 U.S. Department of Agriculture, Soil Conservation Service publication, "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," consists of the Mokuleia Series particularly Mokuleia fine sandy loam (Mr), dune land (DL) and beach sand land types (BS). The representative profile of Mokuleia fine sandy loam is very dark grayish-brown clay loam about 16 inches thick. The next layer, 34 to more than 48 inches thick, is dark-brown and light-gray, single-grain sand and loamy sand. The surface layer is neutral in reaction, and the underlying material is moderately alkaline. Permeability is moderately rapid in the surface layer and rapid in the subsoil. Runoff is very slow and the erosion hazard is slight.

Soils at the landing site consist of beach sand which is typically made of white sand and gravel or coral material. However, coastal turbidity primarily from runoff associated with agricultural activity have discolored the sand.

Dune land consists of hills and ridges of sand-size particles drifted and piled by wind. The sand is predominantly from coral and sea shells. Dune lands consist of the majority soil type of the cable route.

Most if not all of the above soil types have been covered by golf course turf grass and accessory uses such as paved areas or other types of vegetation used primarily for windbreak.

Impacts

No long term or adverse surface impacts are anticipated since the project involves only temporary excavation and filling with the same material. This will only apply to the segment of the cable to be installed subsurface. The excavated portions will be returned to existing preconstruction contours and turf grass removed by trenching, will be retained and replanted upon completion of construction activities. Any remaining areas not adequately grassed will be replanted with additional turf grass so as to minimize impacts to golf play.

Kahe Point Beach Park, Oahu

The project area lies at the base of the Waianae mountain range. The predominant soil type for the area excluding the landing site, as described in the August 1972 U.S. Department of Agriculture, Soil Conservation Service publication, "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," consists of the Lualualei Series particularly Lualualei extremely stony clay, 3 to 35 percent slopes. There are many stones on the surface and in the profile. It is impractical to cultivate this soil unless the stones are removed. Runoff is medium to rapid, and the erosion hazard is moderate to severe.

Soils at the landing site consist of rock land. Rock land (rRk) is made up of areas where exposed rock covers 25 to 90 percent of the surface. The rock outcrops and very shallow soils are the main characteristics.

Impacts

With respect to the segment of the cable to be installed subsurface, no long term or adverse surface impacts are anticipated since the project involves temporary excavation and filling with the same material. The excavated portions will be returned to its present status by reusing soil excavated for fill.

Sandy Beach Park, Oahu

The project area lies at the base of two geologic formations, the Koolau Mountains and Koolau Volcano. The predominant soil type for the area excluding the landing site, as described in the August 1972 U.S. Department of Agriculture, Soil Conservation Service publication, "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," consists of the Koko Series particularly Koko silt loam, 2 to 6 percent slopes (KsB). The surface layer is a dark reddish-brown silt loam about 16 inches thick. The subsoil, about 32 inches thick, is dark reddish-brown or dark - brown soil loam, loam, or clay loam that has subangular blocky structure. Permeability is moderate, runoff is slow and the erosion hazard is slight.

Soils at the landing site consist of rock land. Rock land (rRk) is made up of areas where exposed rock covers 25 to 90 percent of the surface. The rock outcrops and very shallow soils are the main characteristics.

Impacts

With respect to the segment of the cable to be installed subsurface, no long term or adverse surface impacts are anticipated since the project involves temporary excavation and filling with the same material. The excavated portions will be returned to its present status by reusing soil excavated for fill.

Mokapu Beach, Maui

Geologically, the area is described as the coastal flank of the western slope of the massive, but extinct, volcano, Haleakala. The underlying structure of the land form is rock formed by the cooling of lava flows down the slope from the crater when active. The most recent flows (last eruption recorded in 1790), range from a few inches to a few feet in thickness at variable depths below the soil mantle (Makena Series) which has built up over the ages by alluvial action.

The project area has sedimentary rocks which consist of alluvium, dune sand, colluvium, mudflow deposits, and lagoonal deposits. The predominant soil type for the area excluding the landing site consists of the Makena Series particularly Makena loam, stony complex, 3 to 15 percent slopes (MXC). In a representative profile the surface layer, about 4 inches thick, is very dark brown loam that has platy structure. The subsoil, about 19 inches thick, is very dark grayish-brown and dark yellowish-brown silt loam that has prismatic structure. The substratum is dark yellowish-brown cobbly silt loam. The soil is mildly alkaline in the surface layer and subsoil. On the Makena part of the complex, permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.8 inches per foot of soil. On the Stony land part, permeability is very rapid and there is no erosion hazard.

Soils at the landing site are classified as Beaches. Beaches (BS) occur as sandy, gravelly, or cobbly areas. They are washed and rewashed by ocean waves. The beaches consist mainly of light-colored sands derived from coral and seashells.

Impacts

With respect to the segment of the cable to be installed subsurface, no long term or adverse surface impacts are anticipated since the project involves temporary excavation and filling with the same material. All reasonable efforts will be taken to ensure that excavated portions are returned to present preconstruction contours by reusing soil excavated for fill.

Spencer Beach Park, Hawaii

The project area lies at the base of two geologic formations, the Kohala Mountains and Mauna Kea Volcano. The predominant soil type for the area excluding the landing site consists of the Kawaihae Series particularly Kawaihae extremely stony very fine sandy loam, 6 to 12 percent slopes (KNC). The surface layer is dark reddish-brown extremely stony very fine sandy loam about two inches deep with hard pahoehoe lava bedrock beneath. Permeability is moderate, runoff is medium and erosion hazard is moderate (U.S. Department of Agriculture, Soil Conservation Service and University of Hawaii Agricultural Experiment Station, August 1972).

Soils at the landing site consist of beach land type made of sand and gravel.

Impacts

With respect to the segment of the cable to be installed subsurface, no long term or adverse surface impacts are anticipated since the project involves temporary excavation and filling with the same material. The excavated portions will be returned to its present status by reusing soil excavated for fill.

4.1.3 Hydrology

Wailua Golf Course, Kauai

There are no perennial streams in the subject area. The major drainage feature for the area is an unnamed wetland to the west and Wailua River to the north. A portion of the wetland area has been developed by the State for a prison facility.

Groundwater for the area is basal and is not a source for domestic use (Atlas of Hawaii, 1983).

Impacts

No adverse impacts are anticipated on surface water or groundwater since the project will not alter existing drainage patterns or have any long term water requirements. No impacts are anticipated on the adjacent wetland since the cable route will be on existing utility poles in the area which are makai of Kuhio Highway.

Kahe Point Beach Park, Oahu

There are no perennial streams in the subject area. The major drainage features for the area are Waimanalo Gulch to the east, Keaneoio Gulch to the north and Makaiwa Gulch to the south all of which are dry except for the rainy season.

Groundwater for the area is brackish and is not a source for domestic use (Atlas of Hawaii, 1983).

Impacts

No adverse impacts are anticipated on surface water or groundwater since the project will not alter existing drainage patterns or have any long term water requirements.

Sandy Beach Park, Oahu

There are no perennial streams in the subject area. The major drainage feature for the area is an unnamed gulch to the north which is dry except for the rainy season.

Groundwater for the area is basal in sediments and is not a source for domestic use (Atlas of Hawaii, 1983).

Impacts

No adverse impacts are anticipated on surface water or groundwater since the project will not alter existing drainage patterns or have any long term water requirements.

Mokapu Beach, Maui

There are no perennial streams in the subject area. The major drainage features for the area are two unnamed gulches to the north, both of which are dry except for the rainy season.

Groundwater for the area is basal water floating on salt water.

Impacts

No adverse impacts are anticipated on surface water or groundwater since the project will not alter existing drainage patterns or have any long term water requirements.

Spencer Beach Park, Hawaii

There are no perennial streams for the area. The major drainage features for the area is Makeahua Gulch to the north and an unnamed gulch approximately 2,000 feet to the south both of which are dry except for the rainy season.

Groundwater for the area is brackish and is not a source for domestic use.

Impacts

No adverse impacts are anticipated on surface water or groundwater since the project will not alter existing drainage patterns or have any long term water requirements. The project proposes the installation of a cable line within the shoreline area and does not affect any potable groundwater source.

It is anticipated that nearshore waters may become clouded during the trench excavation and backfilling operations. Silt or other types of filter screens to lessen turbidity effects may be erected to minimize this impact. Water collected during the dewatering process will be discharged on the beach adjacent to the work area.

4.1.4 Terrestrial Flora/Fauna

Wailua Golf Course, Kauai

The area is developed with a golf course and related accessory uses (i.e., driving range). Any naturally occurring flora have long since been removed during the development of the course. No rare or endangered species of plants are known to inhabit the site.

Concerning fauna, no rare or endangered animals are known to inhabit the site or the surrounding area.

Impacts

Because the project area is not known to contain any rare plants or animals, adverse impacts are not anticipated. As part of the proposed development the exposed areas within the cable easement will be replanted with the same types of vegetation as found on site.

Kahe Point Beach Park, Oahu

The area's flora is classified as lowland dry shrub and typically contain species such as kiawe, koa haole, bristly foxtail, uhaloa, milo, and fingergrass. Homesites, military installations, and pastures are the most common uses for this type of plant environment.

No rare or endangered species of plants are known to inhabit the site.

With respect to animal wildlife for the area, no rare or endangered animals are known to inhabit the site. The area has a dry climate and sparse vegetation does not provide good habitats for rare animals.

Impacts

Because the project area is not known to contain any rare plants or animals, adverse impacts are not anticipated. As part of the proposed development the exposed areas within the cable easement will be replanted.

Sandy Beach Park, Oahu

The area's flora is classified as lowland dry shrub and typically contain plant species such as kiawe, naupaka, klu, koa haole, gingergrass, and bristly foxtail. Homesites, pasture, and truck crops are the most common uses for this type of plant environment. No rare or endangered species of plants are known to inhabit the site. Existing flora and fauna of the project site consists mainly of introduced species.

With respect to animal wildlife for the area, no rare or endangered animals are known to inhabit the site. The area has a dry climate and sparse vegetation and does not provide good habitats for rare animals.

Impacts

Because the project area is not known to contain any rare plants or animals, adverse impacts are not anticipated. As part of the proposed development the exposed areas within the cable easement will be replanted.

Mokapu Beach, Maui

The Makena Series of soils are used for pasture and wildlife habitat. Vegetation at the project site consists of bristly foxtail, haole koa, feather fingergrass, ilima, and kiawe. No rare or endangered species of plants were found on the site. The majority of the existing flora and fauna of the project site consists mainly of introduced species.

With respect to animal wildlife for the area, no rare or endangered animals are known to inhabit the site. The area has a hot, dry climate and sparse vegetation and does not provide good habitats for rare animals.

Impacts

Because the project area is not known to contain any rare plants or animals, adverse impacts are not anticipated. As part of the proposed development the exposed areas within the cable easement will be replanted.

Spencer Beach Park, Hawaii

The area's flora is classified as lowland dry shrubland and typically contain plant species such as kiawe, piligrass, ilima, and fingergrass. Cattle pasture is the most common use for this type of plant environment. No rare or endangered species of plants are known to inhabit the site.

With respect to animal wildlife for the area, no rare or endangered animals are known to inhabit the site. Although a single siting of the hoary bat has been recorded at Spencer Beach Park, the area is a dry climate and sparse in vegetation and does not provide good habitats for rare animals known to exist in the area.

Impacts

Because the project area is not known to contain any rare plants or animals, adverse impacts are not anticipated. As part of the proposed development the exposed areas within the cable easement will be replanted.

4.1.5 Marine Flora and Fauna

Wailua Golf Course, Kauai

Sea Engineering conducted a qualitative reconnaissance of the waters fronting the Wailua County Golf Course in June 1991 (see marine Environmental Analysis of Selected Landing Sites, Sea Engineering, Inc., and Environmental Assessment Company., January 1992). To obtain an overall perspective on the extent of the major communities occurring in the study area, divers were towed slowly behind a skiff over most the study site from shore seaward to at least the 60-80 contour. Examination of other nearshore and deeper water characteristics were conducted using SCUBA. "Because the substratum of the entire corridor was found to be sand, no quantitative sampling of the marine communities was carried out at this site. The qualitative survey extended from shore to about the 100 foot isobath approximately 2,800 feet from shore. In this area only one zone or biotope was defined, the biotope of sand."

"The biotope of sand lies covers the entire project site. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Other species will swim above the substratum (e.g., fish) to avoid abrasion. Thus many species in the sand biotope are either cryptic and difficult to see or will just pass through sand environments well off the bottom; among the cryptic species are many of the molluscs and crustaceans such as the Kona crab (Ranina serrata). Hence, without considerable time spent searching, many species in the sand habitat will not be seen. The fauna of the biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant.

Benthic communities on sand substrates usually have their greatest development at depths below which wave impact occurs (below 100 feet). Because of constraints with bottom time at these depths and the general lack of meaningful results from quantitative surveys in shallower water over sand, only a qualitative survey was done. Species commonly seen in the deeper regions of the biotope of sand include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), the Kona crab (Rania serrata), opelu or mackerel scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), uku or snapper (Aprion virescens), hihimanu or sting ray (Dasyatis hawaiiensis) and the weke or white goatfish (Mulloides flavolineatus). In our qualitative reconnaissance, the only species seen in water of less than 30 feet in depth was a school of newly settled juvenile gobies of a species not determined. These fishes were transparent with only the eyes apparent and were about 18-20mm in length. These fishes were seen at a depth of about 8 feet near the shoreline of the proposed cable site. Undoubtedly, with greater searching, many more fish species would be encountered in this biotope. Most of these species become less evident in the shallower portions of this biotope.

The intertidal region at this proposed cable landing site is sand; a short inspection of the beach noted ghost crab holes (Ocypode ceratophthalma) and several sand crabs (Emerita pacifica).

No green turtles (Chelonia mydas) were seen during our survey work in the waters fronting the Wailua County Golf Course. Additionally, we found no macroalgae in the vicinity of the cable alignment or shelter that may be appropriate as green turtle resting sites. The lack of these components is due to a lack of hard substratum. We have found no information to suggest that nesting of sea turtles in the vicinity of the Wailua County Golf Course has occurred in historical times.

The biological survey of the proposed cable alignment at offshore of Wailua County Golf Course did not find any rare or unusual species or communities. Another protected species, the humpback whale (Megaptera novaeangliae), was not seen offshore of the study area during the period of our field effort, but whales are known to be seasonally present along the windward coast of Kauai."

Impacts

"The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment passes through the biotope of sand prior to landfall. As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom (e.g.,corals and many of the associated invertebrates). Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever-changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur in low abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since many of these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will "sink into" the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

It is expected that the cable will be buried in the sand at the shoreline. This will probably entail a combination of trenching across the backshore of the beach and water jetting the cable to grade in the vicinity of the water line. This will temporarily generate some level of turbidity that could impact hard substratum communities if in close proximity to the proposed project site. However, we are not aware of any well developed hard bottom communities close to the proposed cable alignment.

With any construction is the concern over possible impact to corals due to their sessile nature and usual slow growth characteristics. Because there is no hard substratum in the alignment path (or near it) in shallow water, we do not expect that corals will be directly impacted by this activity. Additionally, the small scale of this project suggests that the turbidity levels generated will be considerable less than the those caused by two natural occurrences: 1) turbidity input from the Wailua River that empties into the ocean about 7,000 feet to the north, particularly following heavy rainfall, and 2) turbidity due to resuspension of sand in the Wailua area due to the frequently rough sea conditions. The episodic input of stormwater runoff has probably been an important parameter in structuring benthic communities in this area; this coupled with storm surf and the movement of sand that scours the bottom will retard benthic community development.

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales (Megaptera novaeangliae). As far as the impact to humpback whales is concerned, if construction activities are restricted to the period between April through October, there would be no impacts because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when the whales are present in Hawaiian waters, it is anticipated that the impacts would be minimal. The cable laying ship should not be on site more than one or two days. The most probable source of impact to whales would be noise generation by the cable ship, the support tugs and the small boats used for the cable landing. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981; Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if extensive turbidity is generated and if turtles are present in the area. However, the generation of fine particulate material from dredging did not appear to hinder the green turtle in one Hawaiian study; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about one 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and the generation of turbid water.

The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles)."

Kahe Point Beach Park, Oahu

Sea Engineering carried out a qualitative reconnaissance of the Kahe Point Beach Park cable route on 21 June 1991 and a quantitative sampling of this site was done on 6 December 1991 (see Marine Environmental Analysis of Selected Landing Sites, Sea Engineering, Inc., and Environmental Assessment Co., Jan. 1992). To obtain an overall perspective on the extent of the major communities occurring in the study area divers were slowly towed behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. During the course of the field work notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near to the study area.

Benthic communities in the vicinity of the project site are situated on hard shore substratum. "Coral coverage may locally (over areas up to $10m^2$) exceed 75 percent; mean coverage is about 15 percent (Sea Engineering, January 1992). Diversity and abundance of fish in the area is high due to the plentitude of coral and the warm water outfall from the Hawaiian Electric Power Plant. Invertebrate species richness and abundance is similarly high. The intertidal bench supports normal tidal zone marine life, including starfish, crabs, small fishes, algae, and sea urchins.

"The biological survey did not find any rare or unusual species or communities. There were no sightings of green sea turtles in the area. "To the south of the beach park (i.e., offshore of Paradise Cove and West Beach) are known concentrations of green sea turtles. Some shelter (caves, ledges and undercuts) at sizes and scales appropriate for green sea turtle resting areas were seen in the region adjacent to shore and macroalgal species were encountered both subtidally and intertidally which are known forage for green turtles. No information was discovered to suggest that nesting of sea turtles in the vicinity of Kahe Point

Beach Park has occurred in historical times. Another protected species, the humpback whale, also was not seen offshore of the study area" (Sea Engineering, January 1992). As noted by Herman (1979), humpback whales tend to be found in regions remote from human activities and the proposed Kahe Point cable alignment is in relatively close proximity to the Barbers Point Harbor which is becoming an important commercial port for Oahu.

Impacts

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. "From the sea the proposed cable alignment enters the shallows through a substrate of sand, where most of the organisms are mobile. Since these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably just move out of the way as the cable was deployed. Additionally since the substratum shifts, it is probable that the deployed cable will sink into the substrate" (Sea Engineering, January 1992).

"In the shallower areas along the route, there are areas where the cable will cross hard substratum and there is a greater possibility of impact to benthic and fish communities. Impacts associated with these construction activities primarily include removal of benthic communities in the cable path, and the generation of turbidity which may impact surrounding communities. The small scale of the proposed activities that would be necessary to protect the cable in shallow water would produce little sediment, and over a relatively short period of time. Turbidity from the construction will be a minor impact" (Sea Engineering, January 1992).

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales. As far as the impact to humpback whales is concerned, if construction activities are restricted to the period between April through October, there would be no impacts because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when the whales are present in Hawaiian waters, it is anticipated that the impacts would be minimal. The cable laying ship should not be on site more than one or two days.

The most probable source of local impact to whales would be noise generation by the cable laying ship, the support tugs and the small boats. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981, Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area. The potential impacts also need to be evaluated in light of the proximity of the site to the Barbers Point Harbor which is becoming an important commercial port for Oahu.

Sea turtles are permanent residents in inshore Hawaiian habitats. Although the potential exists for problems during the construction phase if it entails dredging, the generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1991a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Sandy Beach Park, Oahu

Sea Engineering carried out a qualitative reconnaissance of the Sandy Beach cable route on 19 June 1991 and a quantitative sampling of this site was done on 7 January 1992 (see

Marine Environmental Analysis of Selected Landing Sites, Sea Engineering, Inc., and Environmental Assessment Co., Jan. 1992). To obtain an overall perspective on the extent of the major communities occurring in the study area, divers were towed slowly behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. During the course of the field work notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near to the study area.

"Benthic communities in the vicinity of the project site are situated on a hard substratum of basalt rock. The mean coral coverage is 20 percent and it decreases near shore (i.e., the inner 300 feet) to 0.2 percent" (Sea Engineering, January 1992). Diversity and abundance of fish in the area is high due to the plentitude of coral. Invertebrate species richness and abundance is similarly high. The rocky cobble shoreline supports normal tidal zone marine life, including sea urchins, sea cucumbers, algae, crabs and small fishes. The intertidal region fronting the proposed cable landing site is subjected to occasional high energy conditions (waves) which keeps the diversity low.

"The biological survey did not find any rare or unusual species or communities other than a single threatened green sea turtle. It appears that the shallow area is not heavily used by green turtles" (Sea Engineering, January 1992). There has been no evidence to suggest that nesting of sea turtles on Sandy Beach has occurred. Another protected species, the humpback whale was not seen offshore of the study area. As noted by Herman (1979), humpback whales tend to be found in regions remote from human activities, thus relatively fewer numbers of whales are seen around Oahu as compared to other islands.

Impacts

"From the sea the proposed cable alignment enters the shallows through a substrate of sand, where most of the organisms are mobile. Since these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably just move out of the way as the cable was deployed. Additionally since the substratum shifts, it is probable that the deployed cable will sink into the substrate" (Sea Engineering, January 1992).

"In the shallower areas along the route, there are areas where the cable will cross hard substratum and there is a greater possibility of impact to benthic and fish communities. Impacts associated with these construction activities primarily include removal of benthic communities in the cable path, and the generation of turbidity which may impact surrounding communities. The small scale of the proposed activities that would be necessary to protect the cable in shallow water would produce little sediment, and over a relatively short period of time. Turbidity from the construction will be a minor impact, especially when viewed in light of the nearby chronic disturbance to these benthic communities of sewage input that has occurred since the early 1970's" (Sea Engineering, January 1992).

Another concern may be with disturbance to threatened or endangered species. If construction activities are restricted to the period between April through October, the endangered humpback whale (Megaptera novaeangliae) would not be impacted because it is only in Hawaiian waters on a seasonal basis (November through March).

Assuming that deployment of the cable occurs during the period of time that humpback whales are in island waters, it is anticipated that the impacts to whales would be minimal. The deployment of the cable from shallow water (i.e., the 60 foot isobath) to shore should not take longer than one day. In general, this deployment is done by bringing the cable laying ship into about the 60 foot isobath; from this point to shore the cable is buoyed up using floats and small craft are used to maneuver the cable into the appropriate alignment and into shore.

The probable source of local impact to whales would be the production of noise by the cable laying ship and smaller vessels used to bring it ashore. There are variable and conflicting reports as to the impact of vessel traffic on whales. Evidence from the northwest Atlantic and northeast Pacific suggest behavioral changes by whales in response to vessels, but they may show considerable fidelity to specific areas despite vessel traffic (major shipping, trawler activity, etc.; Brodie 1981, Matkin and Matkin 1981, Hall 1982, Mayo 1982). In contrast Jurasz and Jurasz (1980) found a sharp decline in humpback whale numbers in Glacier Bay, Alaska with increases in vessel activity. In a short term study, Bauer (1986) found no correlation between vessel and whale numbers as well as no net movement offshore at Olowalu, Maui in 1983-84. However, a six year study suggested a major offshore movement of mother-calf pods off Maui with increased vessel traffic (Glockner-Ferrari and Ferrari 1985, 1987). This study alone cannot be used to determine whether the observed reductions in sighting around Maui is correlated with vessel traffic; there is no consistent baseline information or comparative studies on humpback whale habitat utilization around Maui which may corroborate the trends reported by Glockner-Ferrari and Ferrari (Tinney 1988).

With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman 1986). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the cable deployment. However as noted above the impacts (here noise) are not expected to last for more than one day, and all activities will be concentrated in a very small area.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if it entails dredging. The generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, green turtles moved from an offshore diurnal resting site about one kilometer offshore to a point about 200m from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Any construction activity that generates fine particulate material will lower light levels and in the extreme, bury benthic communities. Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light level resulting in a lowering of primary productivity. When light levels are sufficiently decreased, hermatypic corals (i.e., the majority of the corals found on coral reefs) will eject their symbiotic unicellular algae (zooxanthallae) on which they depend as source of nutrition. However, in nature corals will eject their zooxanthallae and survive (by later acquiring more zooxanthallae) if the stress is not a chronic (long-term) perturbation.

Mokapu Beach, Maui

A qualitative reconnaissance of Mokapu Beach was carried out on 26 June 1991 and a quantitative sampling conducted on 4 December 1991. The findings are summarized here with the complete study appended to this document. The qualitative survey extended from shore to about the 90 foot isobath approximately 2,800 feet from shore. In this area three major zones or biotopes were defined as follows: sand and Halimeda beds, biotope of sand, and the biotope of basalt rock and corals. In general, the biotopes parallel the shore, but along the proposed cable alignment, the biotope of sand extends shoreward from the deeper offshore biotope of sand and Halimeda beds. Thus the biotope of sand bisects the nearshore biotope of basalt rock and corals. Figure 4-1 shows the boundaries of the biotopes as well as the quantitative transect stations. The biotope of sand and Halimeda beds is at depths in excess of 80 feet (about 2,600 feet from shore) and continues seaward to well outside of the study area. To both the east and west of the proposed cable alignment are basalt rock headlands. Between these is an 325 foot sand shoreline that is the central part of Mokapu Beach. Offshore and subtidally of these rock headlands is the biotope of basalt rock and coral. On the western side this biotope extends more than 400 feet offshore and on the eastern side in excess of 550 feet seaward.

LEGEND

A Biotope of Sand and Halimeda Beds

B Biotope of Sand

C Biotope of Basalt Rock and Corals

1 **2** Quantative Transect Stations

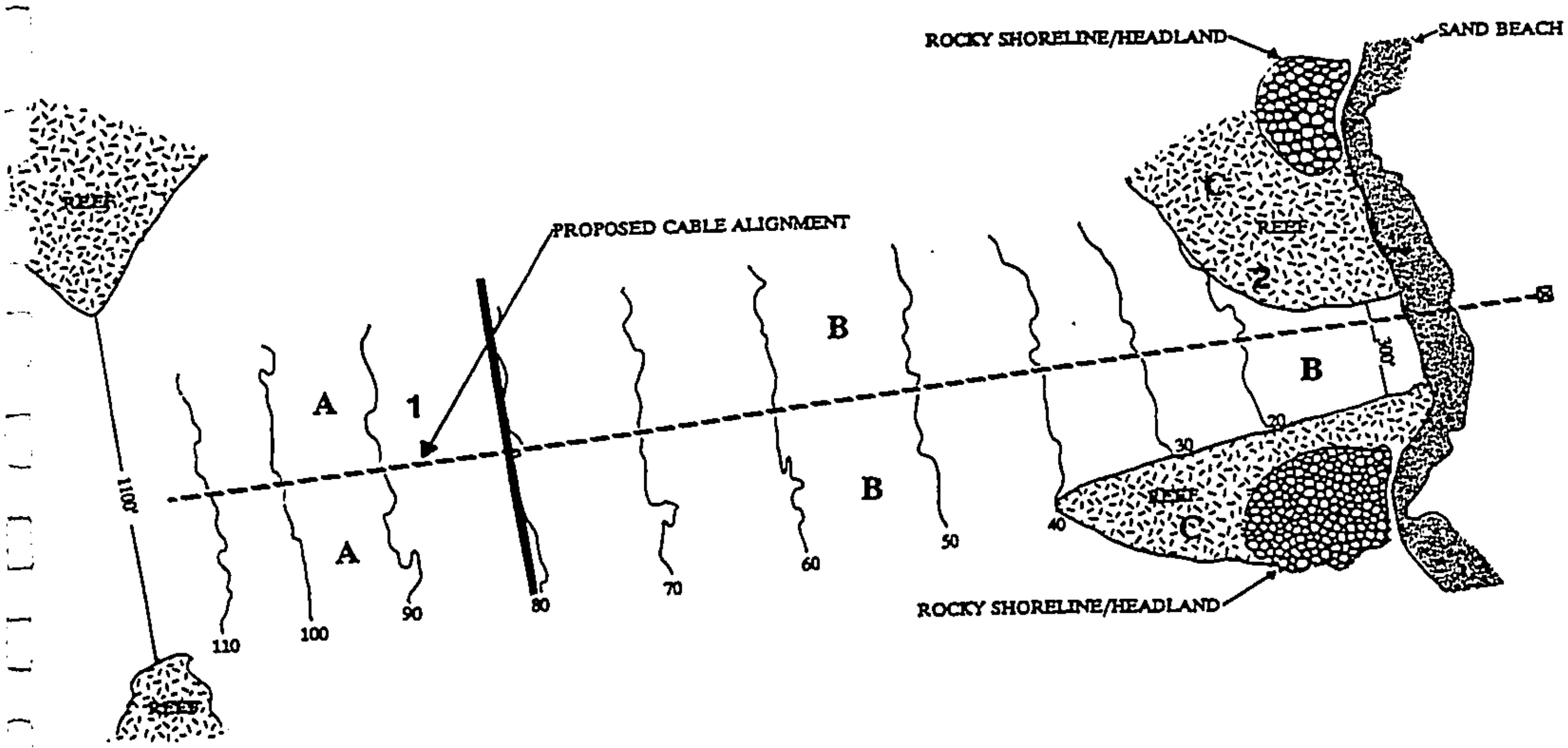

Figure 4-1 **MOKAPU BEACH**
BIOTOPES ALONG SELECTED CABLE ALIGNMENT

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The biotope of sand and Halimeda beds is found at depths greater than 80 feet. This biotope may be characterized by a relatively flat sand substratum with little rubble present. A dominant feature of this biotope is the presence of beds of the alga, Halimeda opuntia. These beds range in size from 6 to 25 feet in width, 3 to 30 feet in length and rise no more than 6 inches from the substratum. These Halimeda patches are spaced from 5 to over 50 feet apart. In the area examined, the sand has a large number of fragments of the bivalve, Pinna muricata suggesting that somewhere in the near vicinity is probably a large "bed" of this species. Pinna muricata is usually found forming large beds that may cover hundreds of square meters of sand bottom in deeper water (Kay 1979, Brock and Chamberlain 1968).

The results of the fish census are presented in the Appendix; only five species (11 individuals) were encountered in the census area having an estimated biomass of $2g/m^2$. The most common fishes were the alo'ilo'i or whitespot damselfish (Dascyllus albisella) and the serranid (Anthias thompsoni). Other than a small piece of metal, there was very little local shelter for fishes at this station.

The biotope of sand lies shoreward of the biotope of sand and Halimeda beds and it extends uninterrupted to the beach in the area of the proposed cable alignment. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Thus many species in the sand biotope are cryptic and difficult to see; among those are many of the molluscs and crustaceans such as the kona crab (Ranina serrata). Hence, without considerable time spent searching in the sand, many species in the sand habitat will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant.

Because of the dispersed and cryptic nature of many of the species resident to the biotope of sand we did not quantitatively sample this biotope but rather carried out a qualitative reconnaissance of the habitat in waters from 30 to 80 feet in depth. Species noted in this overview of the biotope include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), opelu or mackeral scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), the lizard fish or 'ulae (Synodus binotatus), the flatfish or paki'i (Bothus mancus), uku or snapper (Aprion virescens), goatfish or malu (Parupeneus pleurostigma) and the weke or white goatfish (Mulloides flavolineatus).

A short survey was made of the sand beach at the point of the proposed cable landing; no macrofauna was seen although one ghost crab hole (probably Ocypode ceratophthalmus) was present on the beach. A short visual appraisal was made of the rocky intertidal that lies to the east and west of the proposed alignment. The substratum of the rocky intertidal is primarily a pahoehoe (basalt) bench with scattered basalt boulders. On the emergent rocks were seen the grey littorine snail (Littorina pintado) and the prosobranch mollusc, Siphonaria normalis; slightly lower down on the rocks are the black snail or pipipi (Nerita picea). Algae seen include limu hulu'ilio (Giffordia breviarticulata) and the encrusting coralline alga (Porolithon onkodes). Also present are a number of unidentified microalgal species that form a fine "turf". We noted the black rock crab or ama'ama (Grapsus grapsus) on the basalt boulders and the small hermit crabs (Calcinus herbstii and C. elegans) in the shallows.

The biotope of basalt rocks and corals is not in the path of the proposed cable alignment but at the closest point, lies within 80 feet of it. The substratum of this biotope is primarily basalt rock with corals on it. There is a small amount of sand present in this biotope and as the waves pass, the sand roils and must scour the substratum. Much of the basalt is in the form of boulders with a mean diameter of about 2 feet. Many of the corals are found on the boulders up away from the depressions with sand. Common species on the boulders include the coral Pocillopora meandrina, sea urchins, wrasses, surgeon fishes and damselfishes.

No green sea turtles were seen during this survey of Mokapu Beach. There was little algae present that could serve as appropriate forage for green turtles although several sites were seen in the biotope of basalt rocks and corals that could serve as resting sites. We have found no information to suggest that nesting of sea turtles on Mokapu Beach has occurred in historical times.

The biological survey of the proposed cable alignment at Mokapu Beach did not find any rare or unusual species or communities. Another protected species, the humpback whale (Megapteranovaeangliae) was not seen offshore of the study area during the period of our field effort.

Impacts

Potential impacts are summarized below. The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment enters the shallows through the biotope of sand and Halimeda beds. The cable will have little negative impact to the communities in the biotope of sand and Halimeda beds because the majority of the substratum is sand. It is expected that a cable deployed over a Halimeda bed would probably sink into the substratum between the individual algal fronds and present little impact.

A major consideration in the selection of the route is the presence of sand because deployment through sand offers little chance of negative impact to benthic communities relative to the impact that could occur to benthic communities situated on hard substratum. The proposed cable alignment at Mokapu Beach is through a sand channel to the shoreline. Little impact to surrounding marine communities would result if this proposed route is utilized.

Another concern may be with disturbance to threatened or endangered species. If construction activities are restricted to the period between April through October, the endangered humpback whale (Megaptera novaeangliae) would not be impacted because it is only in Hawaiian waters on a seasonal basis (November through March).

Assuming that deployment of the cable occurs during the period of time that humpback whales are in island waters, it is anticipated that the impacts to whales would be minimal. The deployment of the cable from shallow water (i.e., the 60 foot isobath) to shore should not take longer than one day. In general, this deployment is done by bringing the cable laying ship into about the 60 foot isobath; from this point to shore the cable is buoyed up using floats and small craft are used to maneuver the cable into the appropriate alignment and into shore.

The probable source of local impact to whales would be the production of noise by the cable laying ship and smaller vessels used to bring it ashore. There are variable and conflicting reports as to the impact of vessel traffic on whales. Evidence from the northwest Atlantic and northeast Pacific suggest behavioral changes by whales in response to vessels, but they may show considerable fidelity to specific areas despite vessel traffic (major shipping, trawler activity, etc.; Brodie 1981, Matkin and Matkin 1981, Hall 1982, Mayo 1982). In contrast Jurasz and Jurasz (1980) found a sharp decline in humpback whale numbers in Glacier Bay, Alaska with increases in vessel activity. In a short term study, Bauer (1986) found no correlation between vessel and whale numbers as well as no net movement offshore at Olowalu, Maui in 1983-84. However, a six year study suggested a major offshore movement of mother-calf pods off Maui with increased vessel traffic (Glockner-Ferrari and Ferrari 1985, 1987). This study alone cannot be used to determine whether the observed reductions in sighting around Maui is correlated with vessel traffic; there is no consistent baseline information or comparative studies on humpback whale habitat utilization around Maui which may corroborate the trends reported by Glockner-Ferrari and Ferrari (Tinney 1988).

With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman 1986). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the cable deployment. However as noted above the impacts (here noise) are not expected to last for more than one day, and all activities will be concentrated in a very small area.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if it entails dredging. The generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, green turtles moved from an offshore diurnal resting site about one kilometer offshore to a point about 200m from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Any construction activity that generates fine particulate material will lower light levels and in the extreme, bury benthic communities. Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light level resulting in a lowering of primary productivity. When light levels are sufficiently decreased, hermatypic corals (i.e., the majority of the corals found on coral reefs) will eject their symbiotic unicellular algae (zooxanthallae) on which they depend as source of nutrition. However, in nature corals will eject their zooxanthallae and survive (by later acquiring more zooxanthallae) if the stress is not a chronic (long-term) perturbation.

Perhaps a greater threat would be the simple burial of benthic communities that may occur with high sediment loading and concurrent low water movement. Many benthic species including corals are capable of removing sediment settling on them by ciliary action and the production of mucous, but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual becomes buried. However, the impact of sedimentation on Hawaiian reefs may be overstated. Sedimentation from land derived sources (usually the most massive source) is a natural event usually associated with high rainfall events. Dollar and Grigg (1981) studied the fate of benthic communities at French Frigate Shoals in the Northwest Hawaiian Islands following the accidental spill of 2200 mt of kaolin clay. These authors found that after two weeks there was no damage to the reef corals and associated communities except where the organisms were actually buried by the clay deposits for a period of more than two weeks.

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This may occur through natural events such as storm surf resuspending fine material that had previously come into the area through natural events and settled or by human activities including the directing of storm water runoff into the ocean or by underwater construction activities. Underwater construction (principally dredging) will generate fine particulate material that could impact corals. The generation of fine sedimentary material could have a negative impact to corals and other benthic forms if it occurs in sufficient quantity over sufficient time. Studies (e.g., Dollar and Grigg 1981 noted above) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the construction activities that would be necessary to protect the cable in shallow water would probably produce little sediment. This statement is supported by the fact that trenching would probably be confined to an area directly adjacent to the shoreline and through it, and would be carried out in a sand substratum. The small scale and anticipated short duration of the project suggest a minimal impact.

High water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats thus assisting in the advection of this material out of these areas (less than 100m in depth) where corals are found.

Turbidity is a an optical property that is related to the scattering of light by the suspended particles in the water column. The finer the particles, the longer they may remain in suspension (Ekern 1976) and if fine materials are associated with much water motion (waves, currents) the actual deposition rates in these turbid waters may be quite low. However, if the amount of suspended particles (i.e., turbidity) is great enough to reduce light levels, some impact to corals may occur.

These data suggest that if needed as a means for protecting the proposed fiber optic cable in shallow water, the short term disturbance (probably less than two weeks) created by small-scale trenching will be a minor impact.

In addition, through the use of silt curtains at the cable manhole, adverse effects due to turbidity can be minimized by leaving a barrier of sand in place at the water's edge until the day of the cable pull.

Spencer Beach Park, Hawaii

Sea Engineering conducted a qualitative marine biological reconnaissance of Spencer Beach Park on 17 July 1991 and a quantitative sampling on 16 January 1992 (see Marine Environmental Analysis of Selected Landing Sites, Sea Engineering, Inc., and Environmental Assessment Co. Jan. 1992). The qualitative survey extended from shore to about the 90 foot isobath approximately 3,900 feet from shore. In this area three major zones or biotopes were defined. In general, the biotopes parallel the shore but in the proposed cable alignment, the most seaward biotope (the biotope of sand) extends into shallow water towards the beach. The presence of sand was an important factor in the selection of the proposed route. The biotopes recognized in the vicinity of the proposed cable alignment at Spencer Beach Park are: 1) the biotope of sand; 2) the biotope of emergent hard substratum and corals, and 3) the biotope of scattered corals. The biotope of emergent hard substratum and corals lies to the north and south of the proposed cable alignment. The biotope of sand is situated primarily seaward of the project area but encroaches as a 160 to 325 foot wide channel well into the study site to within 1400 feet of shore. Shoreward of the biotope of sand is the elongate biotope of scattered corals which is restricted to a sand channel that is oriented perpendicular to shore and cuts through the biotope of emergent hard substratum and corals. Inshore of the biotope of scattered corals on the proposed cable alignment is an area of sand that extends to the shoreline with a small area of scoured emergent hard substratum just seaward of the beach.

The biotope of sand lies principally seaward of the project site. It occurs as a "pie-shaped wedge" towards the shoreline in the area proposed for the cable alignment. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Thus many species in the sand biotope are cryptic and difficult to see; among those are many of the molluscs and crustaceans such as the kona crab (Ranina serrata). Hence, without considerable time spent searching in the sand many species in the sand habitat will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant. Therefore, the inshore boundary of this biotope is arbitrarily shown well offshore (see Figure 4-2) despite the presence of considerable sand shoreward of this point.

Because of constraints with bottom time at the depth of which the biotope of sand is found as well as very poor water clarity on 16 January 1992, we did not quantitatively sample this biotope but rather utilized the data gathered in our qualitative reconnaissance of the habitat on 17 July 1991 in waters from 80 to 90 feet in depth. Species frequently seen in the biotope of sand include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia

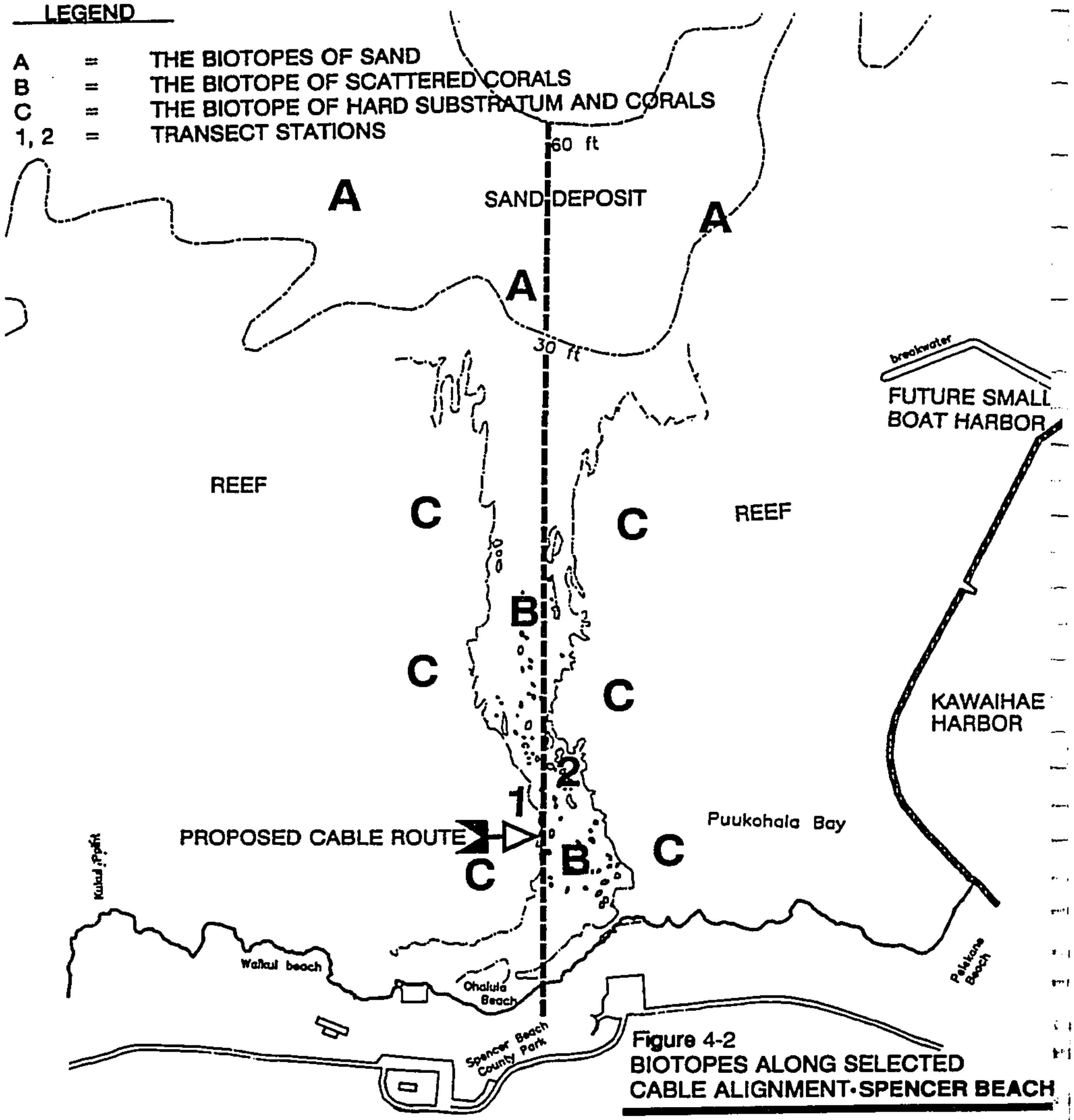

Figure 4-2
BIOTOPES ALONG SELECTED CABLE ALIGNMENT-SPENCER BEACH

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FEBRUARY 1992

bradleyi), brown sea cucumber (Bohadschia vitiensis), opelu or mackeral scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), uku or snapper (Aprion virescens), hihimanu or sting ray (Dasyatis hawaiiensis) and the weke or white goatfish (Mulloides flavolineatus). Undoubtedly, with greater searching, many more fish species would be encountered in this biotope.

Both to the north and south of the channel alignment is the biotope of emergent hard substratum and corals. This biotope may characterized as a hard substratum reef flat that is quite shallow, ranging from about 3 to 8 feet in depth. The biotope extends for a considerable distance both north and south of the study area. Although the proposed cable alignment does not cross this biotope, we sampled the biotope because of its proximity to the proposed alignment.

The substratum in the biotope of emergent hard substratum and corals is comprised of both basalt rock (pahoehoe) and limestone as well as corals. There are scattered depressions and small channels on this substratum; the depressions are from 3x3 feet to about 12x30 feet in dimensions and are up to 2 feet in depth. These depressions are spaced from 8 to 30 feet apart and between them are small channels no more than 4 feet in width, up to 15 feet in length and to about 1 foot in depth. The small channels have a general orientation approximately perpendicular to shore. The channels, depressions and corals provide ample cover for fishes and invertebrates yet, as noted in the Appendix, few organisms were seen in the quantitative survey.

The proposed cable alignment passes through the biotope of scattered corals. This biotope may be described as occurring in a sand channel that has an orientation perpendicular to shore. The dominant substratum in this biotope is sand; spaced from 2 to 75 feet apart are areas of corals. These coral "mounds" range in size from about 3x3 feet to 20x50 feet and are up to 8 feet in height. Common coral species seen in this biotope include Porites lobata, Porites compressa and Montipora verrucosa. Few macroinvertebrates are seen on the sand substratum but there are a number of burrows or holes created by a number of species including the commensal goby-shrimp, unidentified crustaceans, echinoderms, etc.

A survey station was established approximately 40 feet north of the proposed alignment in water about 15 feet in depth. The transect at this station sampled both the hard substratum with corals as well as the open sand substratum. The sand at this station had a surface layer of very fine sedimentary material over it; below this 0.25 inch layer was the usual coarser beach sand. Water visibility at the time of censuring was about 6 feet.

The results of the quantitative survey are provided in the Appendix. Common species included coral species (Porites lobata, Porites compressa and Montipora verrucosa), one macroinvertebrate species, the Hawaiian rock oyster (Spondylus tenebrosus), commensal gobies and shrimps, and other small unidentified burrows. The fish census noted four species, the most common of which were the alo'ilo'i or whitespot damselfish (Dascyllus albisella) and the small eleotrid (Asterropteryx semipunctatus).

In the vicinity of the survey station were seen the algae or limu (Desmia hornemannii and Cladymenia pacifica), corals (Porites evermanni, Leptastrea purpurea and Pocillopora meandrina), the christmas-tree worm (Spirobranchus gigantea), oak cone (Conus quin), the butterfly fish or kikakapu (Chaetodon auriga), lizard fish or 'ulae (Synodus binotatus), the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus) and goldring surgeonfish or kole (Ctenochaetus strigosus).

Inshore of the biotope of scattered corals (commencing 325 feet offshore) is an area of sand that extends from that point to within 80 feet of the shoreline. Inspection of this area on the 16 January 1992 survey noted no macrofauna present. Undoubtedly, with enough search time one would note fishes crossing this sand area such as juvenile jacks or papio (family Carangidae) as well as other species. Between the sand area and the shore in the vicinity of the proposed cable alignment is a small "finger" of emergent basalt (pahoehoe). This hard bottom commences about 15 feet offshore of the sand beach (about 3 feet deep) and continues seaward to a maximum extent of about 80 feet offshore in 8 feet of water. Most of this hard substratum was partially covered with a veneer of sand at the time of sampling and appeared to be quite scoured with no obvious macrobiota present in the area of the proposed alignment. However about 50 feet to the north the hard substratum rises further from the sand (i.e., is shallower) and has a veneer of microalgal species. In a short inspection of this area, the alga (Microdictyon setchellianum) was seen as well as the green sea urchin (Echinometra mathaei), the boring urchin (Echinostrephus aciculatum), the long spined urchin or wana (Echinothrix diadema), green wrasse or 'omaka (Stethojulis balteata) and the saddleback wrasse or hinalea lauwili (Thalassoma duperrey). Also noted were broken live loose fragments of the corals Porites lobata and Pocillopora meandrina.

The intertidal region at this proposed cable landing site is a sand beach. We did not encounter any fauna or flora on this beach.

Only one small green sea turtle (Chelonia mydas) was seen in the biotope of scattered corals about 900 feet from shore in about 15 feet of water during the 16 January 1992 survey. This turtle was estimated to be about 55cm in straight line carapace length. We were unable to determine if this turtle bore any unusual features (i.e., tumors, tags or deformities). Offshore of Spencer Beach Park appears to have appropriate shelter for green turtles (i.e., undercuts, ledges and caves) at a size and scale appropriate for green turtle resting areas. However we noted little macroalgae present in the area that could be utilized as forage (Balazs, 1980, Balazs et al. 1987). We saw no other turtles in the vicinity of the proposed cable landing site but one individual (Mr. Patrick Cunningham) familiar with the area noted that about one-quarter mile to the south small green turtles are frequently seen in the nearshore waters. We have found no information to suggest that nesting of sea turtles at Spencer Beach Park has occurred in historical times.

The biological survey of the proposed cable alignment at Spencer Beach Park did not find any rare or unusual species or communities other than the single threatened green sea turtle noted above. Another protected species, the humpback whale (Megaptera novaeangliae), was not seen offshore of the study area during the period of our field effort. As noted by Herman (1979), humpback whales tend to be found in regions remote from human activities and the proposed Spencer Beach Park cable alignment is in relatively close proximity to Kawaihae Harbor which has been the major commercial port serving West Hawaii for many years.

Impacts

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment enters the shallows through the biotope of sand. As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom (e.g.,corals and many of the associated invertebrates). Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever-changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur in low abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will "sink into" the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

As the cable enters the shallows offshore of Spencer Beach Park, there are areas where the scattered coral mounds will lie in the direct path of the cable. Cutting or trenching through these mounds, which are up to 8 feet above the surrounding bottom, would be difficult and would result in loss of the benthic community in the alignment path. Other impacts would be those associated with the generation of turbidity during the trenching process.

Spencer Beach Park was selected as the cable landing site based upon the assumption that the fiber optic cable would be routed as necessary to avoid the scattered coral mounds. The anticipated placement method was discussed in an earlier section of this chapter. At most, it is anticipated that trenching will only have to be undertaken in shallow water across approximately 50 feet of scoured pahoehoe adjacent to the beach. Since this scoured substratum supports few, if any, benthic organisms in the proposed path, there should be little or no impact to marine organisms.

Other construction methods to protect the cable in shallow water range from just laying the cable directly on the basalt shelf without any specific attachment, to placing it inside of a protective pipe that is bolted to the shelf. This strategy has been used at the Natural Energy Laboratory of Hawaii facility at Keahole Point, Hawaii to secure pipes coming ashore through a subtidal region that is frequently subjected to extreme high energy conditions. Bolting a pipe to the substratum significantly reduces the impact to surrounding benthic communities over the alternative of trenching and backfilling. This alternative may provide low impact to marine communities but it will have an obvious visual impact to any underwater observer. If the trenching and back- filling strategy is used, the tremie concrete cap will probably be colonized by corals, algae and other benthic forms. Studies on substrate selection in Hawaiian coral larvae have shown concrete to be second only to limestone/coral as an appropriate substratum for settlement (Fitzhardinge and Bailey-Brock 1989). Laying the cable directly on the basalt without attachment may result in cable abrasion, and is not an acceptable alternative.

Our 16 January 1992 survey noted considerable turbidity in the region of the proposed cable alignment. Offshore in the biotope of sand, visibility was less than 1 foot at the 80 foot depth. Inshore in the biotope of scattered corals, visibility was about 6 feet. For two days preceding the survey, considerable rainfall had occurred on the West Hawaii coast (Mr. Patrick Cunningham, personal communication). Our inspection of the mouth of Waimea Stream (which is intermittent in its lower reaches) revealed a large amount of water had reached the sea bringing a considerable amount of terrigeneous material with it. Waimea Stream is south of the project site but it is surmised that the stream was the source of much of the turbid water encountered in the study area because of the brown (possibly terrigeneous) color. The second source of turbidity was from surf on the reef. During the month of January 1992 there was a near-continuous westerly swell impacting this coastline. The high surf resuspends fine sediments making the water turbid. These occasional natural inputs of turbidity serve to reduce light levels and potentially impact benthic communities. The communities present in the vicinity of the proposed alignment have evolved under this occasional impact. Construction activities related to the cable landing probably would not begin to match the level of turbidity both in terms of scale or intensity that we encountered on our 16 January 1992 field effort.

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales (Megaptera novaeangliae). As far as the impact to humpback whales is concerned, if construction activities are restricted to the period between April through October, there would be no impacts because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when the whales are present in Hawaiian waters, it is anticipated that the impacts would be minimal. The cable laying ship should not be on site more than one or two days.

The most probable source of local impact to whales would be noise generation by the cable laying ship, the support tugs and the small boats. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981; Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area. The potential impacts also need to be evaluated in light of the proximity of the site to Kawaihae Deep Draft Harbor, the second largest harbor on the island.

Sea turtles are permanent residents in inshore Hawaiian habitats. Although the potential exists for problems during the construction phase if it entails dredging, the generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Fishery Considerations. Access to the shoreline at Spencer Beach Park is excellent and has probably been since prehistoric times; the Kawaihae area was an important center in the Hawaiian culture. The beach at Spencer is heavily used by people interested in beach going and probably fishing. Fishermen catch fish both from shore as well as offshore from small boats. In all probability, some commercial fishing occurs offshore of the proposed cable alignment. We are unaware of any individuals that specifically and exclusively use Spencer Beach Park area for subsistence fisheries. Probably most of the fishing activity in and around Spencer Beach Park is by recreational fishermen. With most Hawaiian recreational fisheries, species targeted include papio and ulua (family Carangidae), o'io or bonefish (Abula vulpes), moi (Polydactylus sexfilis), goatfishes (family Mullidae), snappers (family Lutjanidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and a host of smaller species such as the aholehole (Kuhlia sandvicensis), aweoweo (Priacanthus cruentatus) and menpachi (Myripristes amaenus). Fishing methods used include nets, spears, traps as well as hook and line.

This survey noted a paucity of fishes or invertebrates. One reason for this may be related to the high turbidity present at the time of sampling. Turbidity may temporarily cause motile species to leave; when conditions improve, they may return. Some comparative information for the Spencer Beach area is available from a study carried out by Brock (1991) where three stations were established seaward of Kawaihae Small Boat Harbor in May 1991. The closest station to the proposed cable alignment is approximately 1,000 feet to the north in water 8 to 12 feet deep. A fish census at this station resulted in 26 species and 231 individuals encountered. The census methods were identical to those used here.

The standing crop of fishes on coral reefs is usually in the range of 2 to 200g/m^2 (Brock 1954, Goldman and Talbot 1975, Brock et al. 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, the variation in standing crop appears to be related to the variation in local topographical complexity of the substratum. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fish (2 to 20g/m^2). Goldman and Talbot (1975) note that the upper limit to fish biomass on coral reefs is about 200g/m^2. The present study found extremely low estimated standing crops at both stations especially when viewed with respect to the availability of shelter space. It is probable that both fishing pressure as well as high turbidity have played a role in the low estimated biomass at these stations.

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This may occur through natural events such as storm surf resuspending fine material that had previously come into the area through natural events and settled, or by human activities including the directing of storm water runoff into the ocean or by underwater construction activities. Underwater construction may generate fine particulate material that could impact corals. The generation of fine sedimentary material could have a negative impact to corals and other benthic forms if it occurs in sufficient quantity over sufficient time. Studies (e.g., Dollar and Grigg 1981 noted above) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the trenching activities that would be necessary to protect the cable in shallow water (if used) would probably produce little sediment. This statement is supported by the fact that only 50 lineal feet of hard substratum would be disturbed. The small scale and anticipated short duration of the project suggest a minimal impact. High water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats thus assisting in the advection of this material out of these areas (less than 100m in depth) where corals are found.

The turbidity generated by the construction activity will be short in duration and relatively small in quantity. Numerous studies have provided observations showing the relationship between increased suspended or deposited sediment with reduced coral growth rates, cover and species diversity (Roy and Smith 1971, Maragos 1972, Loya 1976, Bak 1978, Randall and Birkeland 1978, Cortes and Risk 1985, Grigg 1985, Hubbard and Scaturo 1985, Kuhlman 1985, Muzik 1985, Hubbard 1987). In contrast, Glynn and Stewart (1973) found no correlation between these parameters on reefs off the Pacific side of Panama.

Turbidity is a an optical property that is related to the scattering of light by the suspended particles in the water column. The finer the particles, the longer they may remain in suspension (Ekern 1976) and if fine materials are associated with much water motion (waves, currents) the actual deposition rates in these turbid waters may be quite low. However, if the suspended particles (i.e., turbidity) is great enough to reduce light levels, impacts to corals may be low.

The deposition of sediment on coral reefs has been measured and correlated with the "condition" of the reef corals. Loya (1976) defined a "high" sedimentation rate as $15 mg/cm^2/day$ and a "low" rate as $3 mg/cm^2/day$ for Puerto Rican reefs. Low cover and species diversity were associated with reefs exposed to "high" sediment deposition rates. In contrast, "high" sediment deposit- ion rates on Guamian reefs was defined in the range of 160- 200mg/cm^2/day and this rate of deposition limited coral cover and diversity (here less than 10 species and 2% cover; Randall and Birkeland 1978). A "low" rate was defined as 32mg/cm^2/day and was associated with rich coral communities (more than 100 species and 12%+ coral cover). These comparisons demonstrate the relative nature of sedimentation rates; the rate considered to be low in Guam is more than twice the high rate from Puerto Rico. Reasons for this disparity relate to differences in how rates are measured (i.e., lack of a standardized methodology) as well as difficulty in relating environmental factors such as water motion and sediment deposition in sediment traps. Water motion may mitigate or enhance the deleterious effects of sedimentation on the diversity and cover of corals in a given area. Hopley and Woesik (1988) note a chronic sedimentation rate of 129mg/cm^2/day (7 month mean) did not negatively impact an Australian coral reef with high cover and species diversity.

These data suggest that if there is need to protect the proposed fiber optic cable in shallow water by small-scale trenching, the short term disturbance (probably less than two weeks) will be a minor impact.

4.1.6 Scenic and Visual Resources

Wailua Golf Course, Kauai

The area is developed with a golf course and provides open space views to the ocean and to the mountains. The site contains a clubhouse, golf proshop, restaurant, and parking with necessary roads and utility facilities.

Impacts

No long term adverse impacts are anticipated on the beach or the golf course since the proposed cable wiil be located below surface until beyond the golf course. From there the cable will be routed to the nearest existing telephone pole near the vicinity of the loop road for further routing towards the central office in the Lihue Shopping Center.

For seven to ten days there will be a temporary impact on the coastal views from construction activities. During the construction period, the beach portion of the project site will have construction equipment and a mound of sand from the excavated trench.

The beach will be returned to its existing condition at the conclusion of the cable installation. Excess material not utilized for fill will be removed.

With respect to construction activity on the golf course, a similar trench will be prepared to accept the cable facility. Any turf grass removed will be retained for replanting upon completion. In addition, any irrigation facilities affected by the trenching will be repaired or rerouted as required by the County Department of Parks and Recreation. Therefore, after the cable is installed no long-term impacts are anticipated.

Kahe Point Beach Park, Oahu

Kahe Point Beach Park has the Hawaiian Electric Power Plant to the north end and the rest of the area is generally void of man-made structures. Except for light poles along Farrington Highway, the beach park has amenities such as two comfort stations, a pavilion, camping and picnic equipment, and fourteen marked camping sites with parking.

Impacts

No long term adverse impacts are anticipated on the beach park since the proposed cable will be located below surface. From there the cable will be routed by duct lines under Farrington Highway to connect to the GTE Hawaiian Tel Central Office (CO) at 92-1389 Aliinui Drive.

For two to seven days there will be a temporary impact on the coastal views from construction activities. During the construction period, the beach portion of the project site will have construction equipment and a mound of sand from the excavated trench.

The beach will be returned to its existing condition at the conclusion of the cable installation. Excess material not utilized for fill will be removed.

Therefore, after the cable is installed no long-term impact is anticipated.

<u>Sandy Beach Park, Oahu</u>

The area is generally void of man-made structures except for light poles along Kalanianaole Highway and the park access road, and beach park amenities such as showers and toilet facilities.

<u>Impacts</u>

No adverse impacts are anticipated on the beach park since the proposed cable will be located below surface until beyond the park. From there the cable will be routed by duct lines under Kalanianaole Highway until it reaches the intersection of Kealahou Avenue and connects to the nearest existing telephone pole for further routing towards the central office on Hawaii Kai drive.

For seven to ten days there will be a temporary impact on the coastal views from construction activities. During the construction period, the beach portion of the project site will have construction equipment and a mound of sand from the excavated trench.

The beach will be returned to its existing condition at the conclusion of the cable installation. Excess material not utilized for fill will be removed.

Therefore, after the cable is installed no long-term impact is anticipated.

Mokapu Beach, Maui

Mokapu Beach has a hotel on the south end and the rest of the area is generally void of man-made structures. Views out of the site will remain unchanged, and Haleakala will be visible and views of the ocean from the site will be retained.

Impacts

No adverse impacts are anticipated on the beach since the proposed cable will be located entirely below surface. From there the cable will be routed through duct lines located alongside Wailea Alanui Road until it reaches the intersection of Kilohana Avenue and connects to the nearest existing telephone pole for further routing towards the Central Office (CO) on Halona Street.

For seven to ten days there will be a temporary impact on the coastal views from construction activities. During the construction period, the beach portion of the project site will have construction equipment and a mound of sand from the excavated trench. Following the installation of the duct line, the ground surface will be restored to its original condition. The beach will be returned to its existing condition at the conclusion of the cable installation.

Therefore, after the cable is installed no long-term visual impacts are anticipated.

Spencer Beach Park, Hawaii

The area is generally void of man-made structures except for telephone poles along main roads and beach park amenities such as toilet facilities. The Kawaihae Harbor and related shoreside facilities are visible towards the north and the two heiaus along the park access road. Views at the shoreline are towards mauka and along the shoreline north and south.

Impacts

No adverse impacts are anticipated on the beach park since the proposed cable will be located below surface until the Akoni Pule Highway, where it will be routed overhead on existing utility lines for routing towards the central office on Queen Kaahumanu Highway.

For seven to ten days there will be a temporary impact on the coastal views from construction activities. During the construction period, the beach portion of the project site will have construction equipment and a mound of sand from the excavated trench.

The beach will be returned to its existing condition at the conclusion of the cable installation. Excess material not utilized for fill will be removed. Therefore, after the cable is installed no long-term impact is anticipated.

4.1.7 Historic/Archaeological Resources

Wailua Golf Course, Kauai

Cultural Surveys Hawaii conducted an archaeological assessment of the Wailua Golf Course cable landing site on 13 March 1992 (see Archaeological Assessment of the Proposed Fiber Optic Cable Landing for Wailua, Kauai, Cultural Surveys Hawaii, March 1992). The work at the proposed landing site consisted of the following:

A. A field check of the cable landing and a corridor - up to a few hundred feet wide - to Kuhio Highway, including a stratigraphic profile visible in the wave cut bank along the shoreline;

B. Interviews with two individuals familiar with events and discoveries of Hawaiian remains in the area during the period from 1946 to the present;

C. Field check of two burial sites discovered in the vicinity of the fiber optic cable corridor; and

D. Limited historical research on Wailua ahupua'a.

The archaeological study found, "No archaeological sites or buried cultural remains except for human burials to be known to exist within or in close proximity to the present study area" (Cultural Surveys Hawaii, March 1992).

Impacts

Due to potential for presence of archaeological sites, Cultural Surveys Hawaii, recommends a test trench following the exact cable alignment be carried out prior to construction activities. Any historic sites issues will be addressed through appropriate mitigative measures such as further surveys involving recovery or avoidance in coordination with the State DLNR, Historic Preservation Office. According to Cultural Surveys, continuous on-site monitoring by archaeologists is also recommended during all excavation work in undisturbed beach and dune sand deposits between the wave cut bank at the shoreline and Kuhio Highway. An archaeologist should be on-site during excavation to insure that any remains uncovered will be treated in accordance with current regulations governing cultural deposits.

Kahe Point Beach Park, Oahu

Cultural Surveys Hawaii conducted an archaeological assessment of the Kahe Point Beach Park cable landing site on February 1992 (see Archaeological Assessment of the Proposed Fiber Optic Cable Landing for Wailua, Kauai, Cultural Surveys Hawaii, Feb. 1992). "The scope of work included inspection of the proposed landing site (Kahe Point Beach Park) and the proposed duct line along Farrington Highway. The landing and duct line corridor were inspected for any surface sites. Two areas of interest were noted within the Beach Park portion but none along the proposed duct line. The two areas within the Beach Park include a sea cave and associated crevices, and an extant section of fairly well preserved Oahu Railway and Land Company (O.R. & L.) tracks.

No subsurface testing was undertaken in association with this assessment. This was due to a number of facts which include: (1) The sea cave and crevices in the park can easily be avoided; (2) The O.R. & L. right-of-way is listed as a national registered site (50-80-9714) and a mitigation plan to get by it must be approved by the Historic Sites Division of the Department of Land and Natural Resources (DLNR); (3) Sub-surface testing along the approximately 2,500 feet long duct line within Farrington Highway is not only beyond the scope of this assessment, but based on the observed degree of land alteration associated with the highway's construction (massive cut and fill), it would appear that no archaeological resources of significance remain within the actual right-of-way itself" (Cultural Surveys Hawaii, Feb. 1992).

Impacts

"Only two areas of interest would be impacted by the proposed route, the rail line and the sea cave and fissures. If the cable is routed to the south of the sea cave then no impact is foreseen for the cave and fissures. However, if the proposed cable route will impact the cave and fissures then an archaeological survey, including sub-surface examinations, should be conducted prior to construction. It is recommended that DLNR be consulted to assess if any impact can be made on this section of rail line. If impact is allowed on the rail line an archaeologist should be present during excavation" (Cultural Surveys Hawaii, Feb. 1992).

"The proposed underground duct line within Farrington Highway (right-of-way) from Kahe Point to Ko'olina Resort, appears to contain no significant archaeological resources. However, once the actual route with a surveyed and staked centerline is chosen, it is recommended that if portions of the duct line are outside of the highway right-of-way, a survey be conducted to properly assess the staked route" (Cultural Surveys Hawaii, Feb. 1992).

Sandy Beach Park, Oahu

There are no known features of historic or archaeological significance in the vicinity of Sandy Beach Park (Atlas of Hawaii, 1983). Due to the site's popularity as a recreational destination, any visible remains would have been recovered or destroyed during the development of the park.

Impacts

No short or long term impacts are expected from the development of the proposed project. However, should any unidentified cultural remains be uncovered during cable installation, work in the immediate area will cease and the appropriate government agencies will be contacted for further instructions.

Mokapu Beach, Maui

There are no known features of historic or archaeological significance in the vicinity of Mokapu Beach (Atlas of Hawaii, 1983). Due to the extensive explosives detonated during combat demolition exercises during World War II any visible remains would have been destroyed.

Impacts

No short or long term impacts are expected from the development of the proposed project. However, should any unidentified cultural remains be uncovered during cable installation, work in the immediate area will cease and the appropriate government agencies contacted for further instructions.

Spencer Beach Park, Hawaii

Cultural Surveys Hawaii conducted an archaeological assessment of the Spencer Beach Park cable landing site and the proposed duct line on January 1992 (see Archaeological Assessment of the Proposed Fiber Optic Cable Landing for Spencer Beach Park, Island of Hawaii, Cultural Surveys Hawaii, January 1992). The scope of work at the Spencer Beach Park landing site included sub-surface testing, survey, and review of pertinent literature.

"No significant archaeological resources were observed within the proposed fiber optic cable landing corridor in Spencer Beach Park. The corridor (actually the entire beach) was inspected for any surface sites, of which none exist. Testing of the beach deposits was accomplished by excavation of five test units. The test units were hand dug and the excavated material was screened through 1/4-inch mesh screen. Samples were collected of the cultural material present (midden and artifacts). Representative soil profiles and photographs were taken, after which the test units were backfilled" (Cultural Surveys, Jan. 1992).

"With respect to the proposed underground fiber optic cable duct line at Spencer Beach Park, no impact to archaeological resources is expected. The proposed duct line will traverse through heavily graded portions of Spencer Beach Park and new access road. Archaeological surveys has identified six sites within the new access road right-of-way" (Cultural Surveys Hawaii, Jan. 1992). These six sites were the subject of archaeological test excavations in February 1989 (Carter 1989).

"The results of Carter's test excavations demonstrated that only four of the sites were important for their informational content. In the process of determining that the four sites were likely to yield information important in prehistory or history, however, that potential was realized and the information was adequately recorded. Therefore, they are no longer significant" (Carter 1989).

In July 1992, following minor modification to the landside cable alignment, Cultural Surveys, again visited the site to assess potential for archaeological significance (see Figure 8). According to Cultural Surveys, "We do not anticipate any significant sub-surface cultural remains to be impacted by the newly proposed Fiber Optic Cable landing and duct line. The relocation of the landing area and park associated duct line, some forty feet north of the present original corridor, would appear to place them in areas even more disturbed than the original corridor. The cable landing area, within the beach, is closer to the existing bath house and its associated features (i.e., waterlines, sidewalk, and rock wall). The proposed duct line in the grassy lawn is also closer to the existing underground utility lines (i.e., sewer and electricity) and where the duct line exits the park, there is a cut and filled embankment with a storm drain outlet associated with the newly constructed access road. However no testing has taken place within the new corridor, either within the sandy beach area or on the grassy lawn portion of the park" (Cultural Surveys, July 19, 1992).

Impacts

No impacts are anticipated based on heavy disturbance of the beach park site which would have already destroyed any remains of significance. However, given that no subsurface testing has been undertaken along the new alignment segment, from above the beach landing towards Spencer County Road, it is recommended that after a staked alignment is identified, that subsurface testing be undertaken to accurately assess sub-surface conditions.

Subsurface testing will be undertaken in coordination with DLNR, Historic Preservation Division. Should any significant cultural remains be discovered, work in the immediate area will cease and the appropriate government agencies will be contacted.

4.1.8 Beach Erosion and Sand Transport

Wailua Golf Course, Kauai

The beach fronting Wailua Golf Course is approximately 175 feet wide and stretches from beyond Kawailoa in the south to Lydgate State Park and Wailua River to the north. The beach along the southern half of the golf course has undergone significant erosion in the last 40 years. The vegetation line has eroded over 50 feet since 1950 along segments of the beach. A 3500-foot long revetment was constructed between 1987 and 1988 to protect this portion of the golf course. The beach area in front of the club house has since been relatively stable, while to the north the beach has accreted up to 60 feet since 1950. Since then, the portion makai of the golf course has not exhibited significant aversion nor accretion in the last 10 years and is not expected to vary in the near future. No offshore structures that affect sand transport are proposed.

Impacts

The proposed project is not expected to impact beach processes. Upon completion of construction activities, the construction crew will make every reasonable effort to return the ground to existing preconstruction contours through use of existing graded materials for backfill. The existing basal shelf which has kept the beach relatively stable will not be destroyed and any part of it which is removed will be reconstructed. If necessary, additional boulders similar to those utilized to stabilize the stabilize the existing shelf may be employed.

Kahe Point Beach Park, Oahu

"The shoreline in this area is rocky, consisting primarily of low limestone sea cliffs approximately 15 to 20 feet high and is not subject to the typical processes of coastal erosion and accretion. The shoreline therefore has been stable in recent history. The cliff appears to be erodible, and there are large pieces of fallen limestone at the base of the cliffs. Also at the foot of the cliffs, at the waterline, there is a narrow limestone bench that terminates in a drop into 3 to 5 feet of water. The nearshore bottom off Kahe Point Beach Park is irregular with areas of hard rock bottom, alternating with patches of sand. Further offshore, a sandy bottom predominates" (Sea Engineering, January 1990).

Impacts

The proposed project is not expected to impact beach processes. Upon completion of construction activities, the construction crew will make every reasonable effort to return the ground to existing preconstruction contours through use of existing excavated materials for backfill.

Sandy Beach Park, Oahu

Sandy Beach is about 1200 feet long and is fairly wide with a sloping foreshore. The bottom immediately offshore, a mixture of patches of sand, lava, and reef, drops off abruptly to an average depth of eight to ten feet. This quick change in depth creates the very steep and hard-breaking waves that pound in Sandy's shorebreak. On a big day the surf erodes the sand to form a steep foreshore, which in turn produces a strong, forceful backwash.

Sandy Beach, as described in July 1981 by Dennis Hwang, "Beach Changes on Oahu as Revealed by Aerial Photographs," has historically been an unstable beach system. Sandy Beach may have an annual variation in width of at least 25 feet. However the beach at the project area has remained relatively stable because it lies landward of a basalt lava shelf located at the water line. The lava shelf shelters the sandy areas from typical coastal processes that cause accretion and erosion.

Impacts

The proposed project is not expected to impact beach processes. Upon completion of construction activities, the construction crew will make every reasonable effort to return the ground to existing preconstruction contours through use of existing graded materials for backfill. The existing basal shelf which has kept the beach relatively stable will not be destroyed.

Mokapu Beach, Maui

Mokapu Beach is crescent-shaped, approximately 800 feet long and 85 feet wide. The inshore bottom is gently sloping and extends into deeper water offshore. There are reefs extending seaward from both the headlands.

Mokapu Beach, as described in 1991 by Makai Ocean Engineering and Sea Engineering, has undergone net erosion over the past 42 years. Between 1949 and 1988 the east end of the beach eroded 40 feet and the west end eroded 85 feet. Mokapu Beach is subject to extensive damage due to severe Kona Storms and the passage of hurricanes to the south. The erosion at Mokapu Beach is not chronic and occurs only during severe storms. The beach is currently undergoing the slow process of recovery.

Impacts

The proposed project is not expected to impact beach processes. Upon completion of construction activities, the construction crew will make every reasonable effort to return the ground to existing preconstruction contours through use of existing graded materials or concrete for backfill.

Spencer Beach Park, Hawaii

Spencer Beach Park is located immediately south of the Kawaihae Deep Draft Harbor and encloses one of the typical small pocket beaches along this coast. The beach within the park is Ohaiula Beach, and is approximately 400 feet long. Ohaiula Beach has been stable over the past 30 years and the vegetation line has experienced little erosion or accretion. Oceanward of the beach, a shallow, fringing reef extends offshore, and shelters the shoreline from waves. A narrow sand channel extends through the reef at the northern end of the beach and will serve as the nearshore route for the proposed fiber optic cable.

The nearshore fringing reef extends 2500 feet from the shore. The fringing reef is cut by a sand channel, which connects the beach to a large offshore sand deposit. The water depth at the seaward limit of the reef is approximately 20 feet. The water depth in the sand channel is typically 10 to 15 feet, and much of the reef is within a few feet of the surface. There are many large coral formations within the channel. The coral formations rise vertically up from the channel bottom to within a few feet of the surface.

Seaward of the fringing reef the bottom is entirely sand, out to at least the 100 foot depth, the limit of the visual survey. A prior R. M. Towill Corporation bathymetric survey shows a large reef formation south of the cable route, in water depths of 35 to 110 feet. The route was selected to avoid this formation, and the closest point of approach is 100 feet. The sand, both in the inner channel and the offshore deposit, is relatively fine and has a high silt content.

Impacts

The proposed project is not expected to negatively impact beach processes. The proposed cable route will seek to utilize the sand channel which passes through the shallow fringing reef, and therefore will not impair the ability of the reef from continuing to protect Ohaiula Beach. Seaward of the fringing reef it is expected that after laying the fiber optic cable that it will soon settle into the sand. Because of the small surface area of the cable and this settling action, no adverse impacts are anticipated. At the landing site, once all construction activities are completed, the work crew will make every reasonable effort to return the ground to existing preconstruction contours through use of excavated materials for backfill.

4.1.9 Noise From Construction Activity

During the construction phase of the project, excavation work and cable laying equipment and machinery will be used which will be sources of noise.

Impacts

Noise generated from machinery can be mitigated to some degree by requiring contractors to adhere to State and County noise regulations. This includes ensuring that machinery are properly muffled. Some work at night may be required. Night activities include cable splicing, cable pulling, operation of machinery, etc.

Boats (tugs and a small craft) that are used during the construction period will also be a source of noise. The impact of noise from these vessels cannot be mitigated. The noise impact will be temporary in nature and will not continue beyond the construction and cable laying period.

4.1.10 Air Quality

Air quality of the proposed project areas is good due to low emission levels and the almost continual presence of tradewinds or on-shore breezes. The major factor affecting air quality in the areas is vehicular traffic.

Impacts

During the excavation process, loose sand and dirt may be cast into the air by wind. The release of sand into the air can be prevented by requiring the contractor to periodically wet down the work area. The areas that are used for the placement of the range targets will also be exposed during the construction period. The target sites should be similarly wetted to control fugitive dust. The work sites will be returned to their original states after the cable laying process is completed.

Operation of construction vehicles is expected to temporarily contribute carbon monoxide pollutants in the project vicinities.

4.1.11 Water Quality

Wailua Golf Course, Kauai

Nearshore waters are rated Class "A" by the State Department of Health. Shallow waters experience considerable turbidity even when surf is minimal. Offshore waters generally have good underwater visibility during low turbidity conditions. However, frequent rains tend to increase runoff with sediments from mauka agricultural activities to the area from Wailua River causing extended periods of low underwater clarity.

Impacts

It is anticipated that the nearshore waters may be clouded during the trench excavation and backfilling operations. A screen to lessen turbidity effects will be erected as needed to minimize this impact.

Kahe Point Beach Park, Oahu

Nearshore waters are rated Class "A" by the State Department of Health. Offshore waters are very clear with excellent underwater visibility over reef slopes. Water temperature and salinity are normal for ocean water with evidence of fresh water inflow along the shore.

Impacts

It is anticipated that the nearshore waters may be clouded during the trench excavation and backfilling operations. Silt screens may be erected by the construction crew to lessen and minimize effects of turbidity.

Sandy Beach Park, Oahu

Nearshore waters are rated Class "A" by the State Department of Health. Shallow waters experience considerable turbidity even when surf is minimal. Offshore waters are very clear with excellent underwater visibility over reef slopes. Water temperature and salinity are normal for ocean water with evidence of fresh water inflow along the shore.

Impacts

It is anticipated that the nearshore waters may be clouded during the trench excavation and backfilling operations. Silt screens may be erected by the construction crew to lessen and minimize effects of turbidity.

Mokapu Beach, Maui

Nearshore waters are rated Class "A" by the State Department of Health. Shallow waters experience considerable turbidity even when surf is minimal. Offshore waters are very clear with excellent underwater visibility over reef slopes. Water temperature and salinity are normal for ocean water with evidence of fresh water inflow along the shore.

Impacts

It is anticipated that the nearshore waters may be clouded during the trench excavation and backfilling operations. Silt screens to lessen turbidity effects will be erected to minimize this impact. Adverse effects due to turbidity can be minimized by leaving a barrier of sand in place at the water's edge until the day of the cable pull. Turbidity is typically only generated on one or two days on a cable pull into a sandy beach.

Spencer Beach Park, Hawaii

Nearshore waters are rated Class "A" by the State Department of Health.

Impacts

No adverse impacts will occur on surface or ground water since the project will not significantly alter existing drainage patterns or have any long term water requirements. The project proposes the installation of a cable line within the shoreline area and does not affect any potable groundwater sources.

4.2 SOCIO-ECONOMIC ENVIRONMENT

4.2.1 Population

Wailua Golf Course, Kauai

Although the population within the Island of Kauai was approximately 54,100 in 1990, the population is projected to increase to 84,600 by 2010 (The State of Hawaii Data Book, 1990). This projected population increase of 56 percent over 1990 population requires that the County's communication system be upgraded and expanded to meet future communication needs.

Impacts

No adverse impact on existing resident and worker populations of Kauai are expected.

Kahe Point Beach Park, Oahu

Although the population within the Waianae area numbers 10,246, the population of Honolulu County as of 1989 was 841,600, and is projected to increase to 999,500 by 2010 (The State of Hawaii Data Book, 1990). This projected population increase of 157,900 over the 1989 level requires that the County's communication system be upgraded and expanded to meet future communication needs.

Impacts

No adverse impact on existing resident and worker populations of Waianae are expected.

Sandy Beach Park, Oahu

Although the population within the Hawaii Kai area numbers 28,636, the population of Honolulu County as of 1989 was 841,600 and is projected to increase to 999,500 by 2010 (The State of Hawaii Data Book, 1990). This projected population increase of 157,900 over the 1989 level requires that the County's communication system be upgraded and expanded to meet future communication needs.

Impacts

No adverse impact on existing resident and worker populations of Hawaii Kai is expected.

Mokapu Beach, Maui

Although the population within the Wailea area number 1,124, the population of Maui County as of 1989 was 122,300 and is projected to increase to 206,100 by 2010 (The State of Hawaii Data Book, 1990). This projected population increase of 83,800 over the 1989 level requires that the County's communication system be upgraded and expanded to meet future communication needs.

Impacts

No adverse impact on existing resident and worker populations of Wailea are expected.

Spencer Beach Park, Hawaii

Although the population within the Kawaihae area numbers 150, the population of Hawaii County as of 1989 was 122,300 and is projected to increase to 206,100 by 2010. In addition, telephone access lines connected for all islands, except Oahu, from 1981 to 1989 indicate an increase of 37% for business and residential connections or an average annual increase of 4.5%. This projected population increase of approximately 69% over the 1989 level and the growth in access line connections over the last eight years require that the County's communication system be upgraded and expanded to meet the future communication needs.

Impacts

No adverse impact on existing resident and worker populations of Kawaihae are expected.

4.2.2 Surrounding Land Use

Wailua Golf Course, Kauai

Wailua Golf Course is owned and managed by the County of Kauai. Lands mauka of the golf course are used by the State for a correctional facility with surrounding vacant agricultural land. Lands to the north before Wailua River is also used for public purposes and contains the Lydgate State Park. Lands to the south at Kawailoa are in resort use. Along the shoreline are recreational uses associated with marine recreation such as fishing, swimming, diving and walking along the shore.

Impacts

No long term impacts are expected from development of the proposed project. The cable route will be subsurface from before the shoreline to existing utility poles and will be carried overhead within street rights-of-ways and will not adversely impact surrounding uses. The only permanent structures proposed are two manholes which will be virtually unnoticed and therefore, unobtrusive to golf course users.

Short term impacts will include a temporary 7 to 10 day period of construction which would require the minimal blockage of specified areas due to safety considerations. This includes temporary closure of limited nearshore areas to prevent injury to recreational users. Public access will still be provided laterally in designated areas.

Kahe Point Beach Park, Oahu

Kahe Point Beach Park is owned by the City and County of Honolulu and is primarily in recreational use. The Hawaiian Electric Power Plant is located mauka of Kahe Point Beach Park, across Farrington Highway, and its outfall pipes are located just north of the Park. Barbers Point is located five miles south of Kahe Point Beach Park.

Impacts

No short or long term impacts are expected from the development of the proposed project. The proposed cable will be routed by duct lines subsurface and will not adversely impact surrounding uses.

Sandy Beach Park, Oahu

Sandy Beach Park and the surrounding coastal land to the west, which is owned by the City and County of Honolulu, is primarily in recreational use. Queens Beach which is located east of Sandy Beach Park is privately owned. Lands mauka of the coastal beach areas are generally vacant. The Hawaii Kai Golf Course is located mauka of Sandy Beach Park, across the Kalanianaole Highway. The Hawaii Kai Sewage Treatment Center is located 2,000 feet to the west.

Impacts

No short or long term impacts are expected from the development of the proposed project. The cable route will be on vacant land when subsurface and be carried overhead within street rights-of-ways and will not adversely impact surrounding uses.

Mokapu Beach, Maui

The Ten Wailea property occupies the northern end of Mokapu Beach and is privately owned by McCormack Properties. The site is proposed for future condominium development although it is currently vacant except for two storage buildings. The coastal properties south of this site include the Stouffer Wailea Resort. To the north of this site are multi-family and single family homes. Lands mauka of the coastal beach areas are generally developed with single family homes and a golf course.

Impacts

Short term impacts in the form of construction activity for the installation of the duct lines and the laying of the fiber optic cable are anticipated for 7 to 10 days. Following the installation of the duct lines and the installation of the fiber optic cable, the ground will be restored. No long term impacts are expected from the proposed project. The cable route will be subsurface on vacant land and overhead within street right-of-ways and will not adversely impact surrounding uses.

Spencer Beach Park, Hawaii

Spencer Beach Park and the surrounding coastal land, which is owned by the Queen Emma Foundation, is primarily in recreational use. Lands mauka of the coastal beach areas are generally vacant. The Mauna Kea Resort is located about one mile to the south. The Puukohola National Historic Site is adjacent to the north of Spencer Beach Park. Kawaihae Harbor is less than 2,000 feet beyond the historic site.

Impacts

No major short- or long-term impacts are expected from the development of the proposed project. The cable route will be on vacant land when subsurface and be carried overhead within street rights-of-ways and will not adversely impact surrounding uses.

4.3 PUBLIC FACILITIES AND SERVICES

4.3.1 Transportation Facilities

Wailua Golf Course, Kauai

The project site is served by Kuhio Highway which connects to Lihue Shopping Center. No roadway improvements are anticipated since the cable will utilize existing utility poles for routing into Lihue. Kuhio Highway has sufficient width and shoulders to accommodate cable line installation equipment without interrupting traffic flow. The applicant will coordinate installation activities with the responsible county agencies prior to construction to mitigate any traffic concerns.

Impacts

The proposed project is expected to have no impact on the existing traffic or bus services, after completion of construction activities. Construction will take seven to ten days.

Kahe Point Beach Park, Oahu

The project site is served by Kahe Point Beach Park Access Road. Trenching through the roadway and Farrington Highway will involve excavation of the pavement and subsurface, placement of the conduits within the exposed trench, and restoring the roadway and Farrington Highway to their original condition after installation of the cables.

The construction of the trench across Kahe Point Beach Park Access Road and Farrington Highway will affect traffic. Traffic may be detoured around the construction equipment. Traffic control procedures such as rerouting the traffic onto the shoulder of the highway with the aid of necessary safety measures such as temporary traffic control devices (cones) and/or use of flagmen to direct traffic will be implemented during work activity. Two-way traffic on Farrington Highway will be maintained at all times. Approximately two weeks will be required to complete the trenching work within the Farrington Highway right-of-way.

The Kahe Park Access Road may be partially closed to vehicular traffic during construction. The City and County of Honolulu, Department of Transportation Services, operates The Bus on a supply and demand basis, subject to availability of resources. Existing public transit service to the vicinity is provided by the City, with Route 51 between Honolulu and Makaha passing on Farrington Highway fronting the project area.

Impacts

The proposed project is expected to have no impact on the existing traffic or bus services, after completion of construction activities. Construction will take approximately two to seven days.

Sandy Beach Park, Oahu

The project site is served by Sandy Beach Park Access Road. Construction within the roadway right-of-way will involve excavation of the pavement and subsurface within the 10-foot easement, placement of the conduits within the exposed trench, and restoring the roadway to its original condition.

From the Sandy Beach Park Access Road the cable will follow an existing subground duct line of Kalanianaole Highway. The cable will be installed at the intersection of Kalanianaole Highway and Kealahou Avenue within the right-of-ways to the applicants central office located at 7664 Hawaii Kai Drive.

The principal bus stop that will be affected by the construction of the proposed project is located at the intersection of Kalanianaole Highway and Kealahou Avenue (see Figure 4-3).

Impacts

The proposed project is expected to have no impact on the existing traffic or bus services, after completion of construction activities. Construction will take seven to ten days.

Mokapu Beach, Maui

The project site is served by Wailea Alanui Road. The cable will follow an existing subground duct line along Wailea Alanui Road to an existing manhole (No. 100A). The cable will then be pulled through existing underground ducts connecting Manhole 100A to Manhole 75 at Kilohana Avenue. The cables will then be routed overhead onto existing utility poles along Kilohana Avenue and Piilani Highway to the Central Office (CO) at 210 Halona Street.

Impacts

The proposed project is expected to have no major impact on existing traffic. Construction will take seven to ten days during which equipment will be placed along side Wailea Alanui Road. Sufficient space is available so that an adequate thoroughfare can be maintained.

Spencer Beach Park, Hawaii

The project site is accessible by the new Spencer County Road, which is owned by the United States of America. The new Spencer road connects to Akoni Pule Highway, a major thoroughfare which connects to Queen Kaahumanu Highway.

Impacts

No impacts on transportation facilities are anticipated.

With respect to construction within the Akoni Pule Highway and the Queen Kaahumanu Highway, all cable lines will be located within existing rights-of-way. These rights-of-way have sufficient width to permit unimpeded traffic flow during construction. Some coning of traffic may be necessary due to limited sight distance, but should not result in any major impacts on existing traffic flows.

4.3.2 Recreational Facilities

Wailua Golf Course, Kauai

The principal recreational facility in the vicinity of the project site is Wailua Golf Course and the shore side beach area. The beach is used occasionally for swimming, diving, fishing, and walking. Wailua Golf Course is an 18-hole course with a driving range, clubhouse, restaurant, parking and related accessory uses (see Figure 4-3).

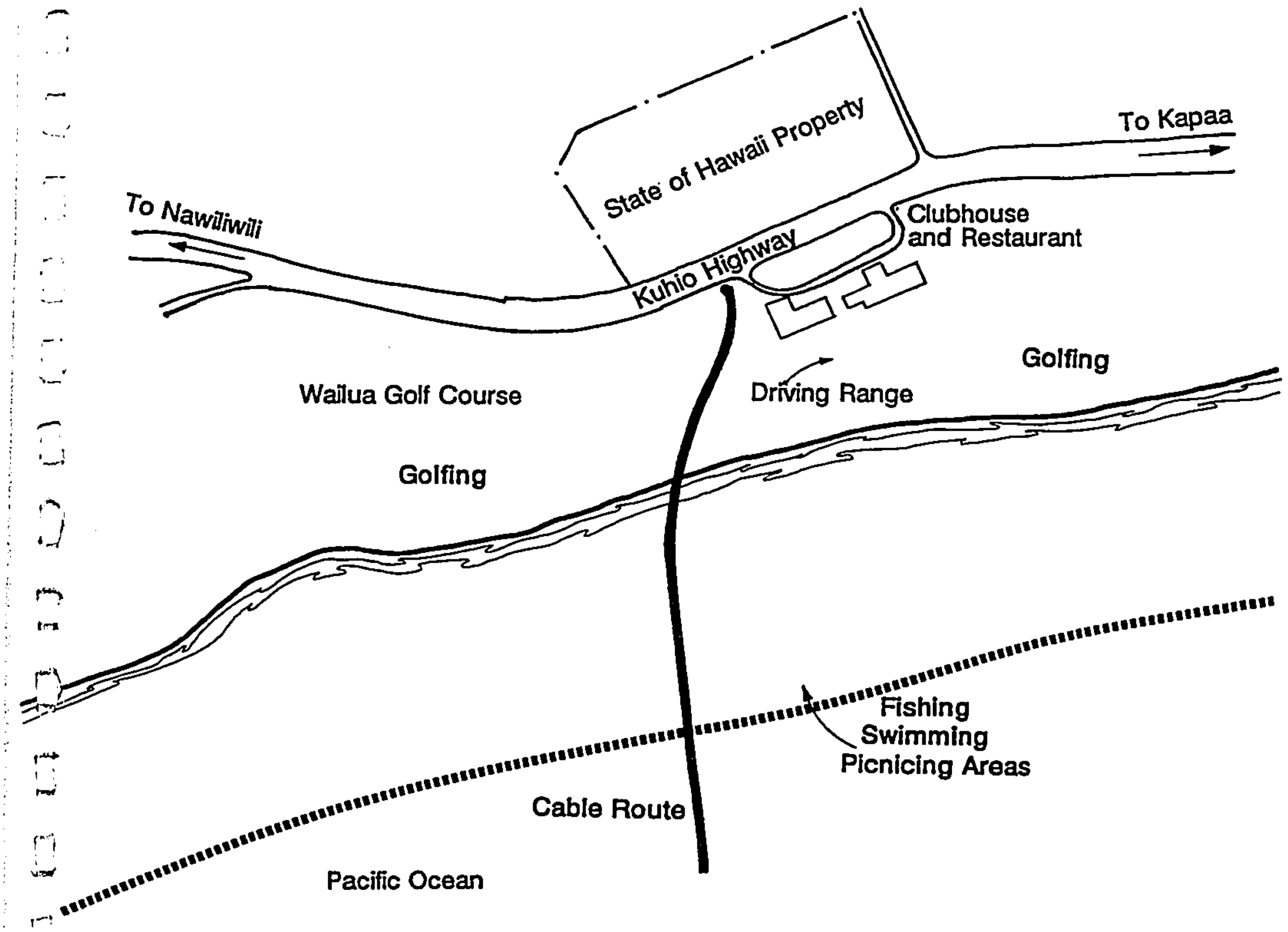

Figure 4-3
PUBLIC USES • WAILUA

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

Not to Scale

R. M. TOWILL CORPORATION
MARCH 1992

Impacts

No long term impacts are expected from the development of the proposed project. However, development will temporarily impact land and shore side recreational uses. During construction the portions of the shore side area will have to be closed for safety reasons. Lateral access will be provided in designated areas. With respect to the golf course, minimal inconvenience is anticipated to golfers using the 18-hole course in that the route proposed through the course will not cross any greens or fairways. Crossings over any golf cart paths would result in temporarily relocating paths to designated areas. Steel plates covering open trenches would allow for continued cart access between the front nine and the back nine holes.

Since the cable route would cross the existing driving range, use of the range will be halted until that section of the construction activity has been completed. To mitigate this loss of practice time, the construction activity will be completed in as little time as possible by excavating this section last.

Kahe Point Beach Park, Oahu

Although the landing site is located within an existing recreational facility, the installation and maintenance of the cable will not restrict recreational use of the park other than in the immediate area of construction and only during installation or repair.

Impacts

Construction will take approximately two to seven days during which time the immediate area surrounding the cable landing site will have to be cordoned off to the public for safety reasons. The major portion of the park will not have to be closed and will continue to be accessible to the public. Upon completion of the installation, the park grounds will be restored to its original condition. No impacts on the cable are expected from park users since the cable will be buried in sufficient depth and encased in concrete.

Sandy Beach Park, Oahu

The principal recreational facility in the vicinity of the project site is Sandy Beach Park. The beach park is used for swimming, sunbathing, surfing, bodysurfing, diving, fishing, kiting, and picnicking. The western side of Sandy Beach Park has the widest area of sand beach, and is more heavily used than the eastern side (see Figure 4-4).

Sandy Beach Park has become very popular among users since it was made accessible by automobile in October 1931. Visitor counts taken for The State of Hawaii Data Book (1990) revealed that approximately 2,815,288 people used the park facilities during that year. This public usage lies in between Waikiki's high usage of 11,173,540 and Kualoa low usage of 71,406.

Impacts

No long term impacts are expected from the development of the proposed project. However, development will temporarily impact land recreation uses on the eastern part of Sandy Beach Park. During construction the eastern part of the park will have to be closed for safety reasons. Construction will take seven to ten days. However the majority of recreational activities occur on the western part of Sandy Beach Park. This impact will be short term, lasting only until construction is completed.

Mokapu Beach, Maui

The principal recreational amenity in the vicinity of the project site is Mokapu Beach. The beach is used for swimming, sunbathing, bodysurfing, surfing, snorkeling, and picnicking (see Figure 4-5).

Impacts

No long term impacts are expected from the development of the proposed project. However, development will temporarily impact land and water recreation uses on the northern part of Mokapu Beach. During construction the northern part of the site will have to be closed to the public for safety reasons. Construction will take seven to ten days. This impact will be short term, lasting only until construction is completed.

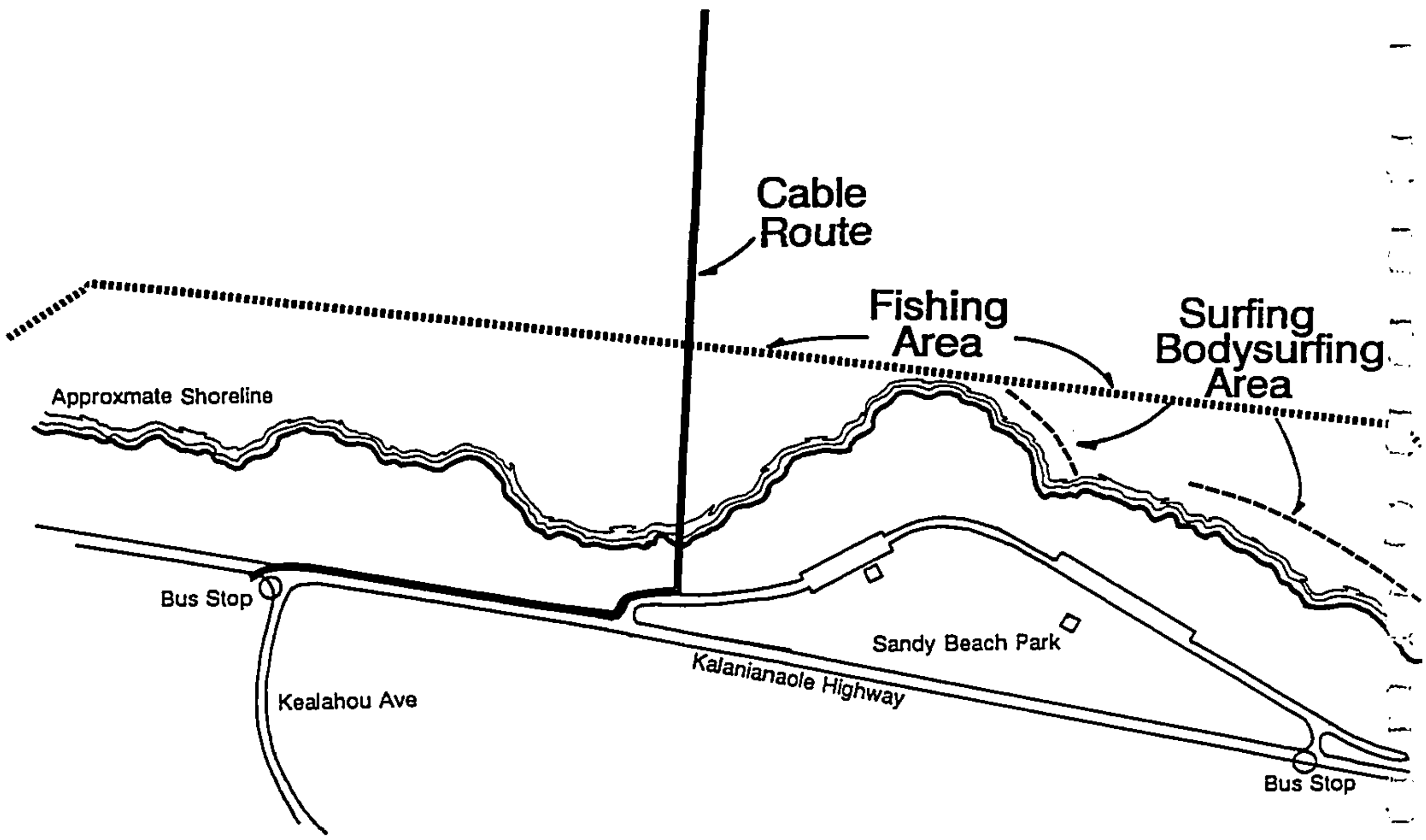

Figure 4-4
PUBLIC USES•SANDY BEACH

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Fiber Optic Cable Project

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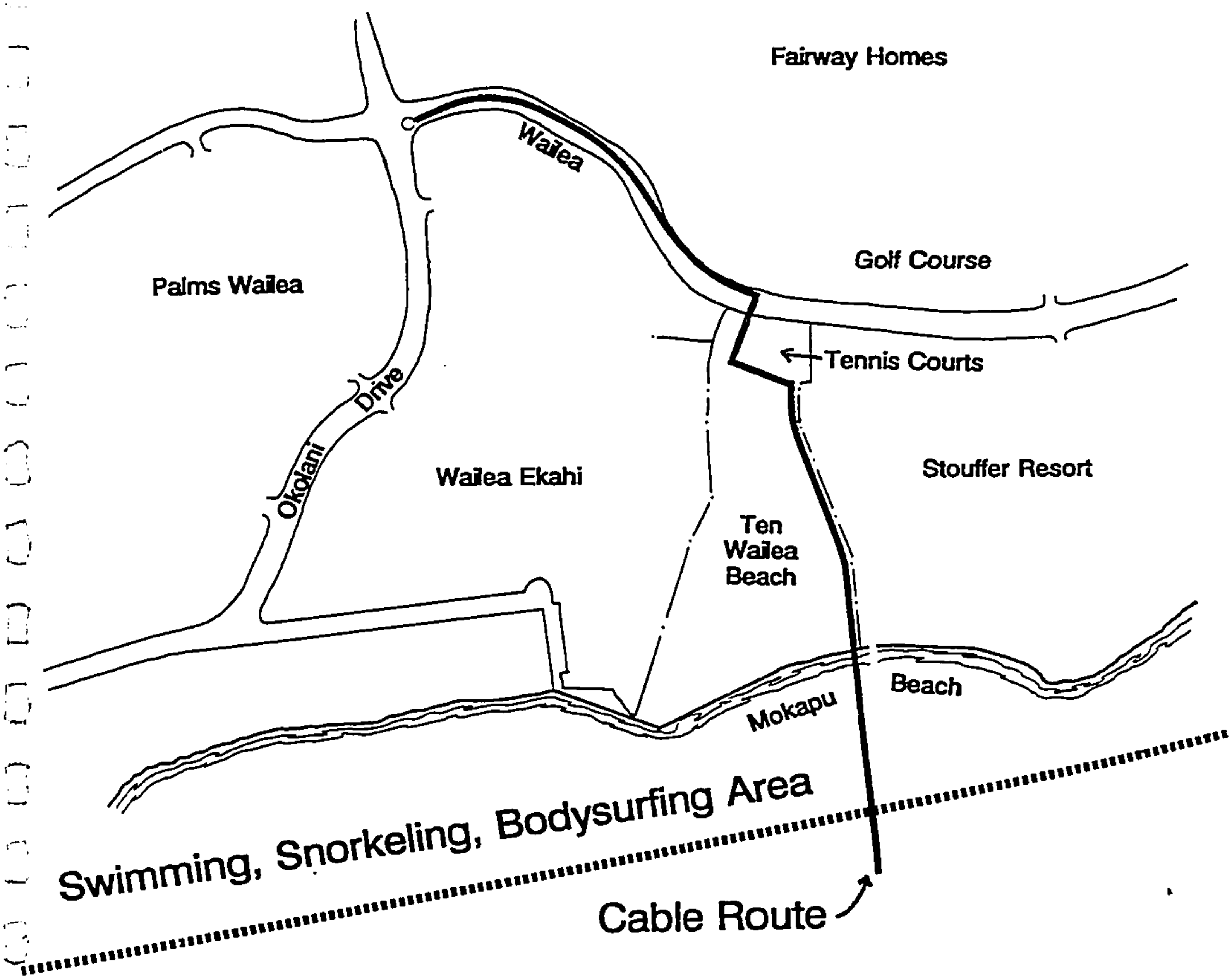

Figure 4-5
PUBLIC USES·MOKAPU

GTE Hawaiian Tel Interisland Fiber Optic Cable Project

Not to Scale

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JANUARY 1992

Spencer Beach Park, Hawaii

Although the landing site is located within an existing recreational facility, the installation and maintenance of the cable will not restrict recreational use of the park other than in the immediate area of construction and only during installation or repair.

Impacts

Construction will take approximately 7 to 10 days during which time the immediate area surrounding the cable landing site will have to be cordoned off to the public for safety reasons. The major portion of the park will not have to be closed and will continue to be accessible to the public. Upon completion of the installation, the park grounds will be restored to its original condition. No impacts on the cable are expected from park users since the cable will be buried in sufficient depth and encased in concrete.

<u>SECTION 5</u>

RELATIONSHIP TO STATE AND COUNTY LAND USE PLANS AND POLICIES

5.1 THE HAWAII STATE PLAN

The Hawaii State Plan (Chapter 226, Hawaii Revised Statutes) provides a guide for the future of Hawaii by setting forth a broad range of goals, objectives, and policies to serve as guidelines for growth and development of the State. The proposed project is generally consistent with the Hawaii State Plan. The following objectives of the State Plan are relevant to the proposed project:

<u>Section 226-10.5</u>: Economy - Information Industry
The proposed project serves to assist in the State's objective of positioning Hawaii as the leader in information services in the Pacific Rim. The proposed project will continue development and expansion of Hawaii's telecommunications infrastructure and will help to accommodate future growth in the information industry.

<u>Section 226-14</u> Facility Systems - In General
The proposed project supports the State's goals for achieving telecommunications systems necessary for Statewide social, economic, and physical objectives.

<u>Section 226-18</u>: Facility System - Energy/Telecommunications
The proposed project will help to ensure adequate and dependable telecommunication services for Hawaii by promoting efficient management and use of existing and proposed facilities and by promoting installation of new telecommunications cables.

5.2 STATE FUNCTIONAL PLANS

The Hawaii State Functional Plan (Chapter 226) provides a management program that allows judicious use of the State's natural resources to improve current conditions and attend to various societal issues and trends. The proposed project is generally consistent with the State Functional Plans. The following objectives of the State Functional Plans are relevant to the proposed project:

Education Implementing Action A(4)(c):
The proposed project will help to ensure adequate telecommunication services necessary for Hawaii's schools objectives.

Education Implementing Action B(3)(d):
The proposed project serves to promote and expand the appropriate use of telecommunications to deliver distance education as well as enhance the learning process and communication competencies of students.

Education Implementing Action(3)(e):
The proposed project enables school library media centers to effectively manage and provide access to information and knowledge through telecommunications.

5.3 STATE LAND USE LAW

Wailua Golf Course, Kauai

The State of Hawaii Land Use District classification designates Wailua Golf Course and the adjacent shoreline area within the Conservation District. The project site is designated by the State Department of Land and Natural Resources as being within the Limited Subzone (see Figure 5-1). A Conservation District Use Permit will be applied for as part of this project. A State Land Use District Boundary Amendment will not be required.

Kahe Point Beach Park, Oahu

The State of Hawaii Land Use District classifications designate Kahe Point Beach Park as "Urban", and the surrounding areas as "Urban" and "Agriculture" (see Figure 5-2). The "Urban" classification is defined as "areas characterized by city-like concentration of people, structures, streets and other related uses." The purpose of the agriculture district is to maintain a strong agricultural economic base and to prevent unnecessary conflicts among incompatible uses." The proposed project does not require any amendments in the current State Land Use classification.

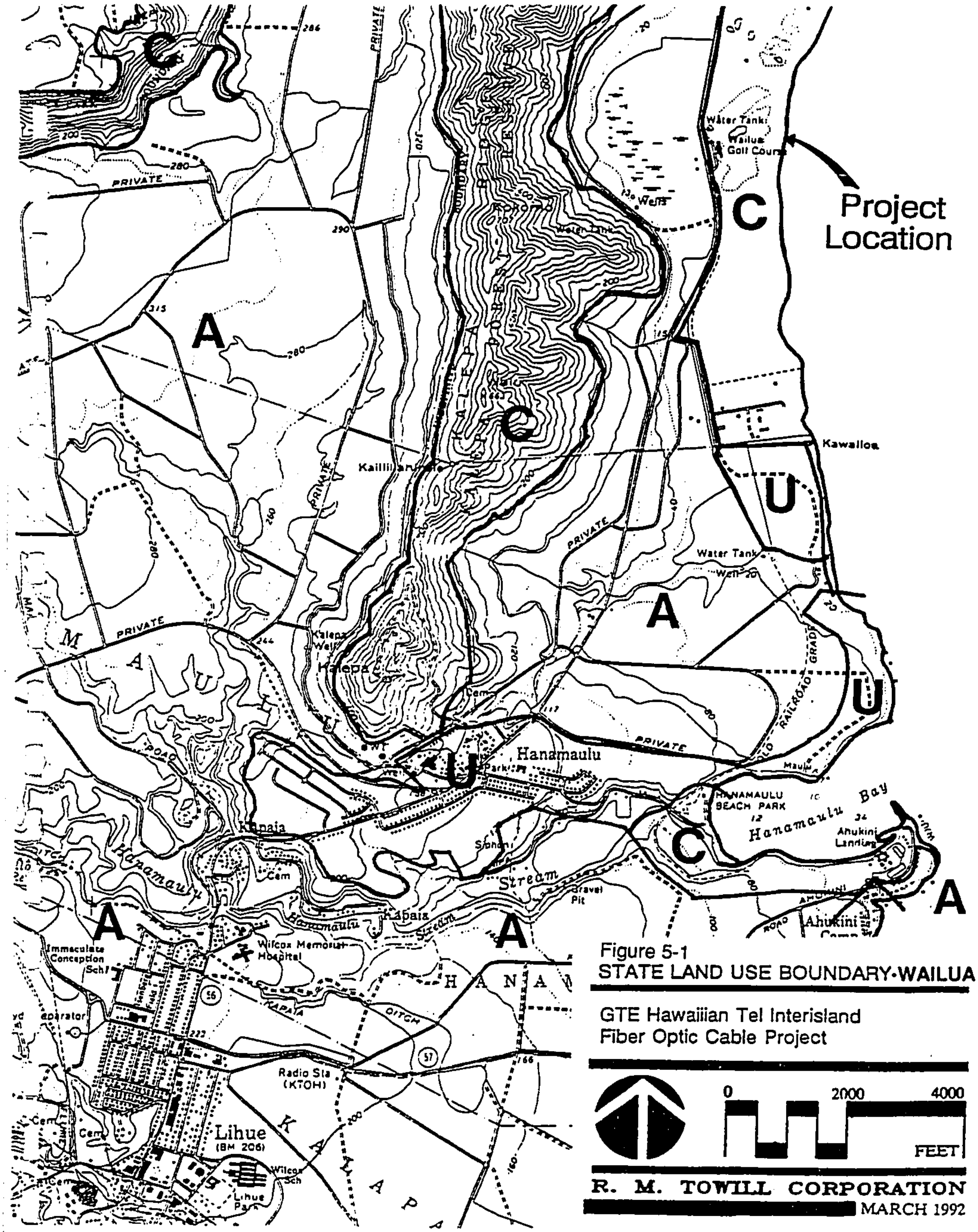

Figure 5-1
STATE LAND USE BOUNDARY-WAILUA

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Fiber Optic Cable Project

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MARCH 1992

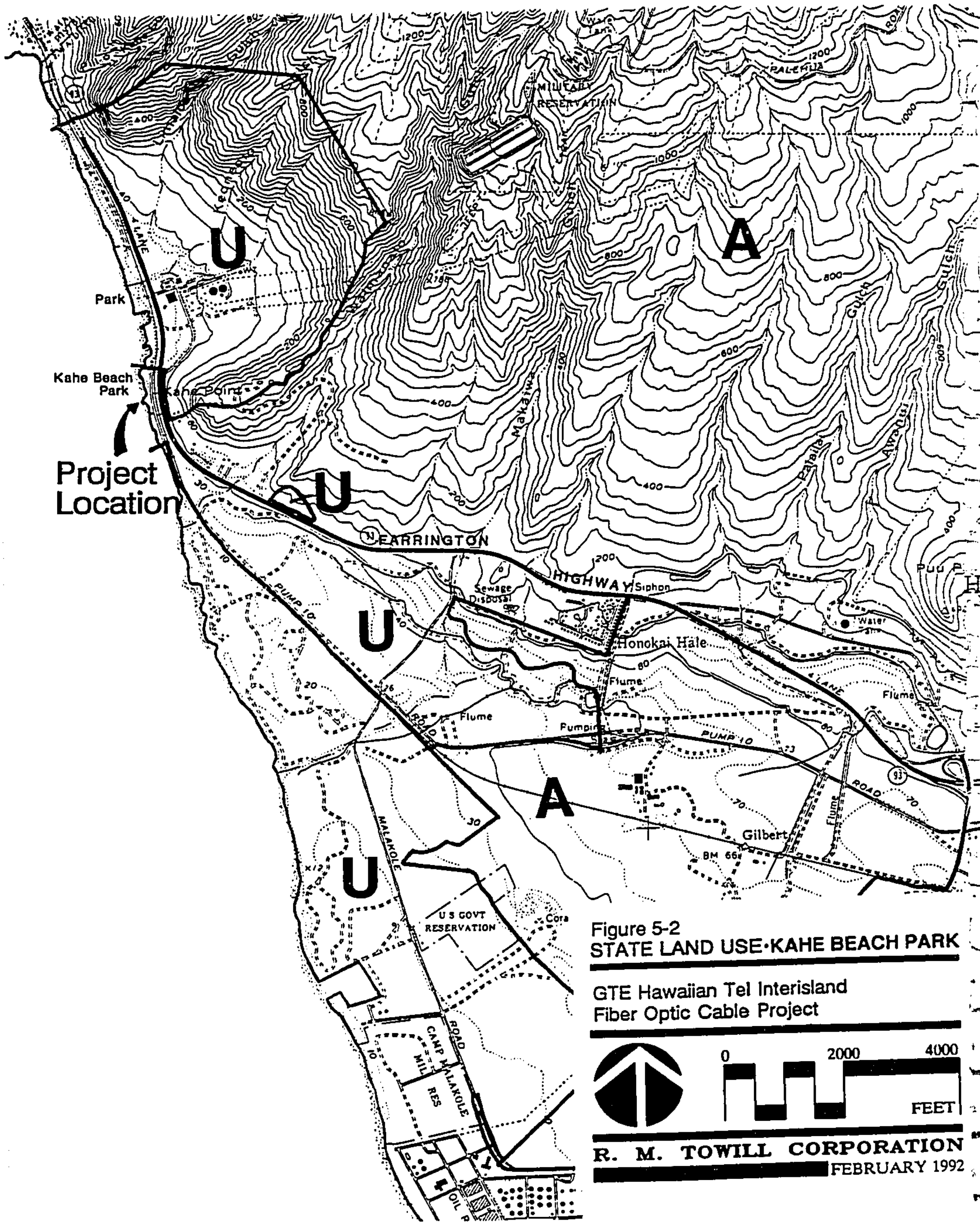

Figure 5-2
STATE LAND USE·KAHE BEACH PARK

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FEBRUARY 1992

Sandy Beach Park, Oahu

The State of Hawaii Land Use District classifications designate Sandy Beach Park as "Limited Use Conservation", and the surrounding areas as "Residential" and "Preservation" (see Figure 5-3). A Conservation District Use Permit will be applied for as part of this project." The purpose of the preservation districts is to preserve and manage major open space and recreation lands and lands of scenic and other natural resource value." "The purpose of the residential district is to allow for a range of residential densities." The proposed project does not require any amendments in the current State Land Use classification.

Mokapu Beach, Maui

The State of Hawaii Land Use District classifications designate Mokapu Beach as "Urban", and the surrounding areas as "Urban", "Rural" and "Agriculture" (see Figure 5-4). The "Urban" classification is defined as "areas characterized by city-like concentration of people, structures, streets and other related uses." The purpose of the agriculture district is to maintain a strong agricultural economic base and to prevent unnecessary conflicts among incompatible uses." The proposed project does not require any amendments in the current State Land Use classification.

Spencer Beach Park, Hawaii

The recommended route of the fiber optic cable from the shoreline up to Akoni Pule Highway is designated within the State Land Use Conservation District (see Figure 5-5) and will require the approval of the Board of Land and Natural Resources.

The balance of the cable route will occur either on Urban or Agricultural designated lands. Utility installations are permitted in these land use designations and therefore, no amendments will be sought in the current State Land Use classification.

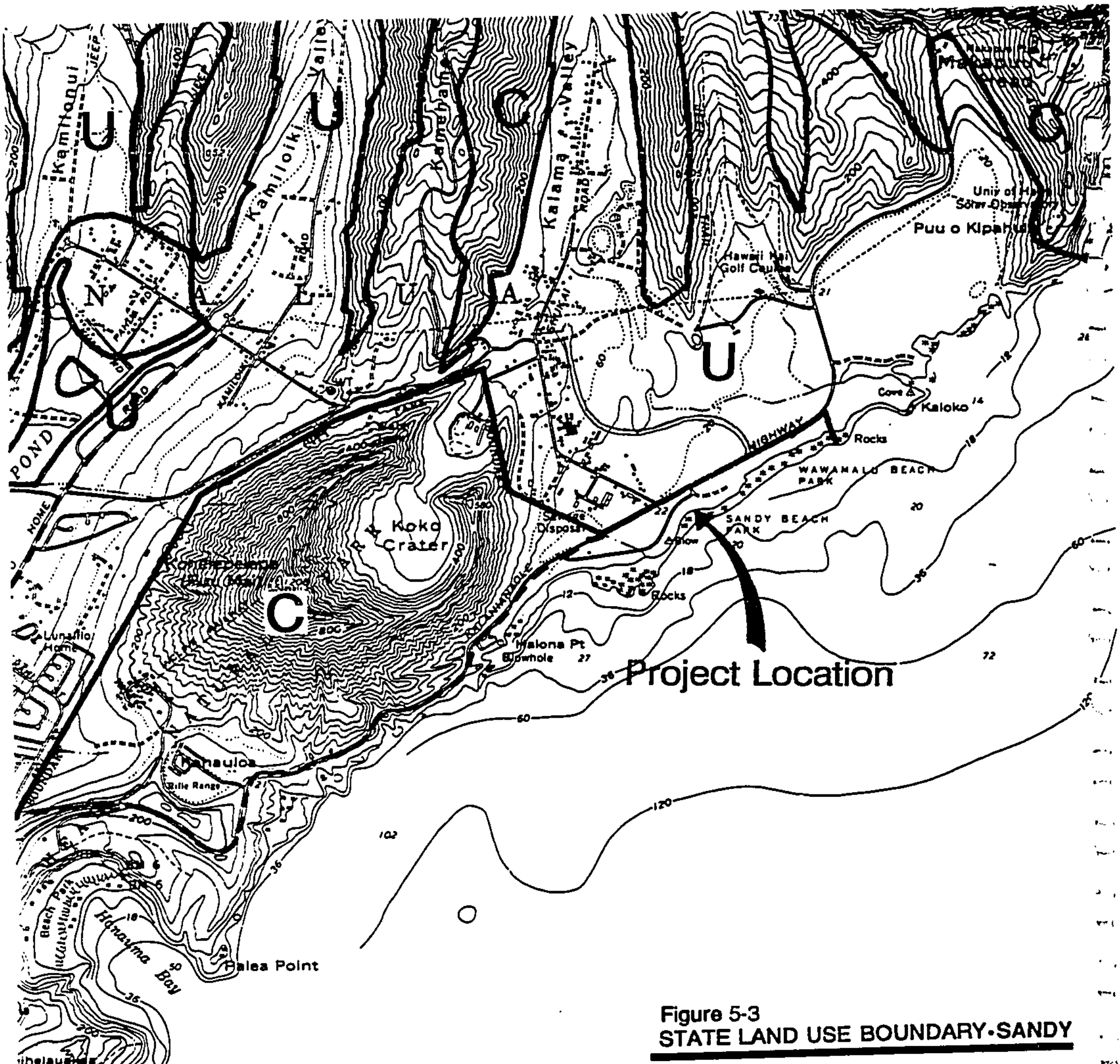

Figure 5-3
STATE LAND USE BOUNDARY-SANDY

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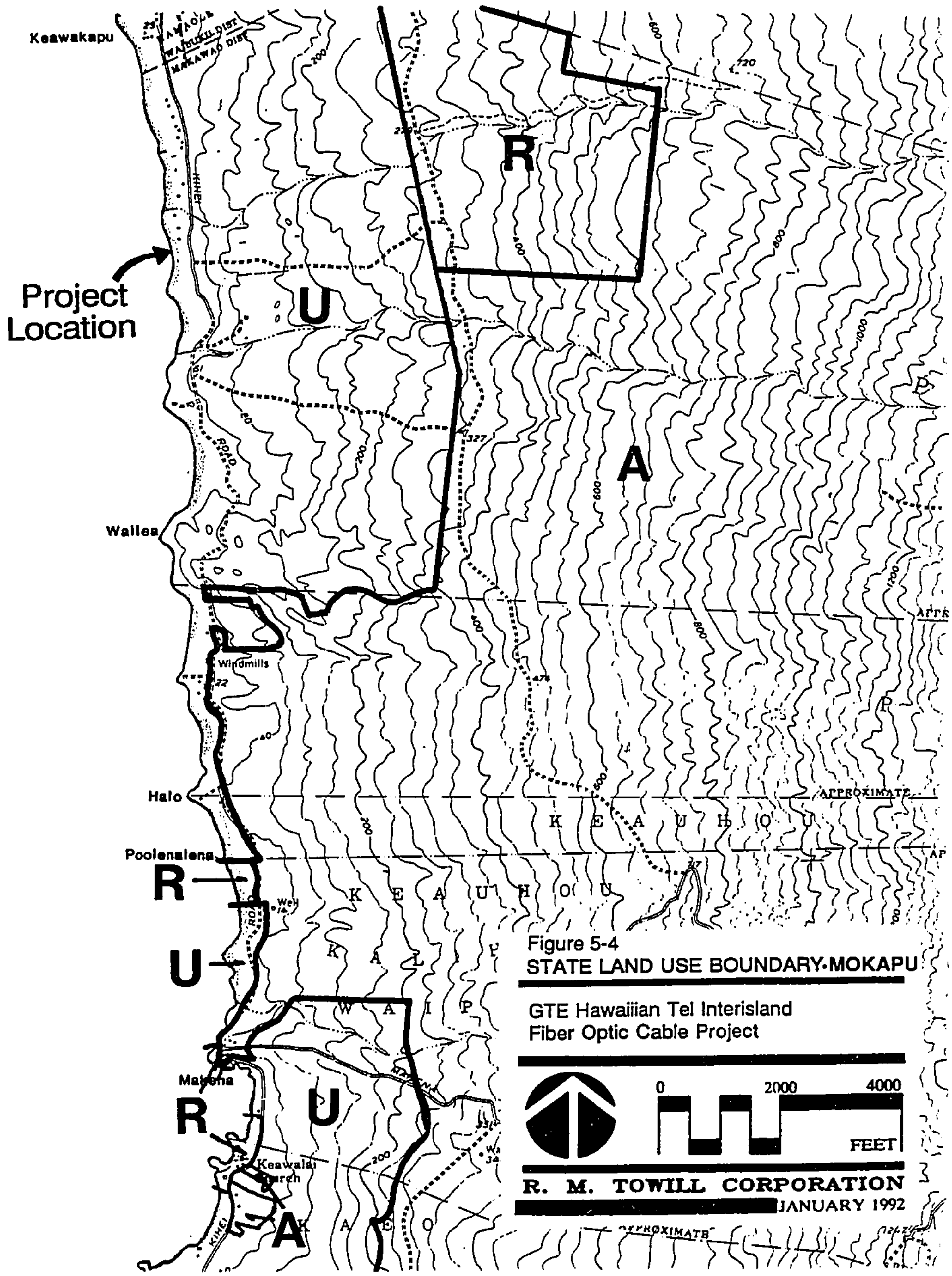

Figure 5-4
STATE LAND USE BOUNDARY-MOKAPU

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Fiber Optic Cable Project

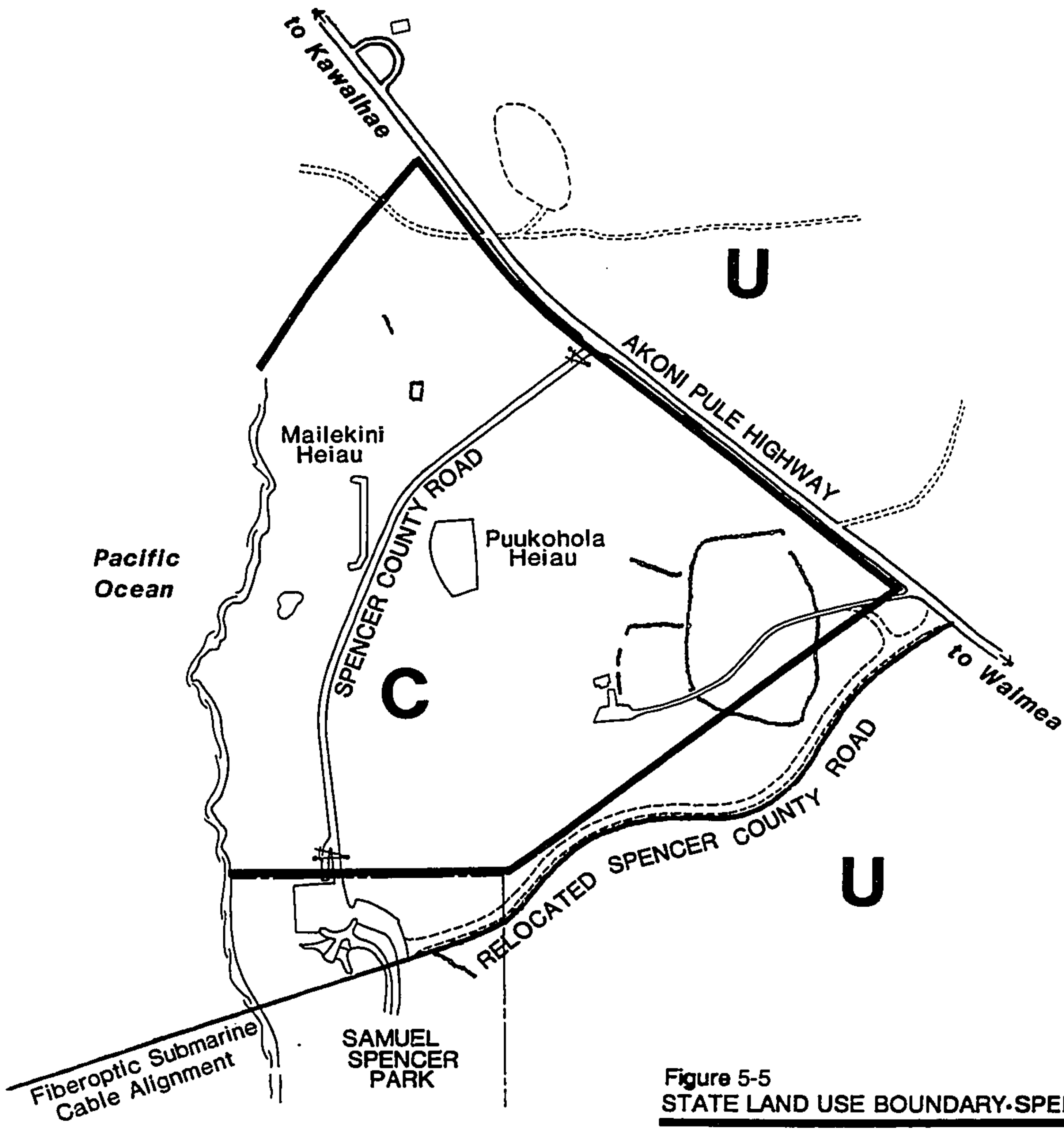

Figure 5-5
STATE LAND USE BOUNDARY-SPENCER

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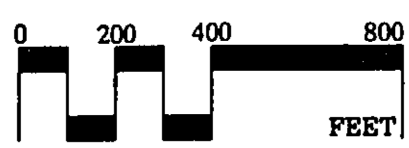
Fiber Optic Cable Project



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5.4 COUNTY ZONING

Wailua Golf Course, Kauai

The County of Kauai does not zone State Conservation District lands but defers to the State Land Use District Classification. Figure 5-6 identifies the existing County zoned lands in this area.

Kahe Point Beach Park, Oahu

Zoning for the Kahe Point Beach Park area is general preservation (P-2). The areas surrounding Kahe Point Beach Park are zoned intensive industrial (I-2), restricted agriculture (AG-1), general agriculture (AG-2), and country (see Figure 5-7).

Sandy Beach Park, Oahu

Zoning for the Sandy Beach Park area is restricted preservation (P-1). The areas surrounding Sandy Beach Park are zoned general preservation (P-2) and residential (R-5) (see Figure 5-8).

A zoning change will not be required for development of the proposed project. A Conditional Use Permit (CUP) will be sought for the proposed project, considered a Utility Installation - Type B.

Mokapu Beach, Maui

Zoning for the Mokapu Beach area is hotel (H-2). The areas surrounding Mokapu Beach are zoned apartment (A-1), open space or golf course (O), resort commercial (B-R), residential (R-3 and R-1), and hotel (H-1) (see Figure 5-9).

Spencer Beach Park, Hawaii

The County of Hawaii zoning for the project site is Open which permits utility installations (see Figure 5-10) . The site is also within the Special Managment Area as defined by the County of Hawaii (see Figure 5-11). A SMA permit was granted in October 1992. The proposed project, portions of which are within the Shoreline Setback Area, is also subject to the provisions of the Shoreline Setback Rules of the County of Hawaii. A shoreline

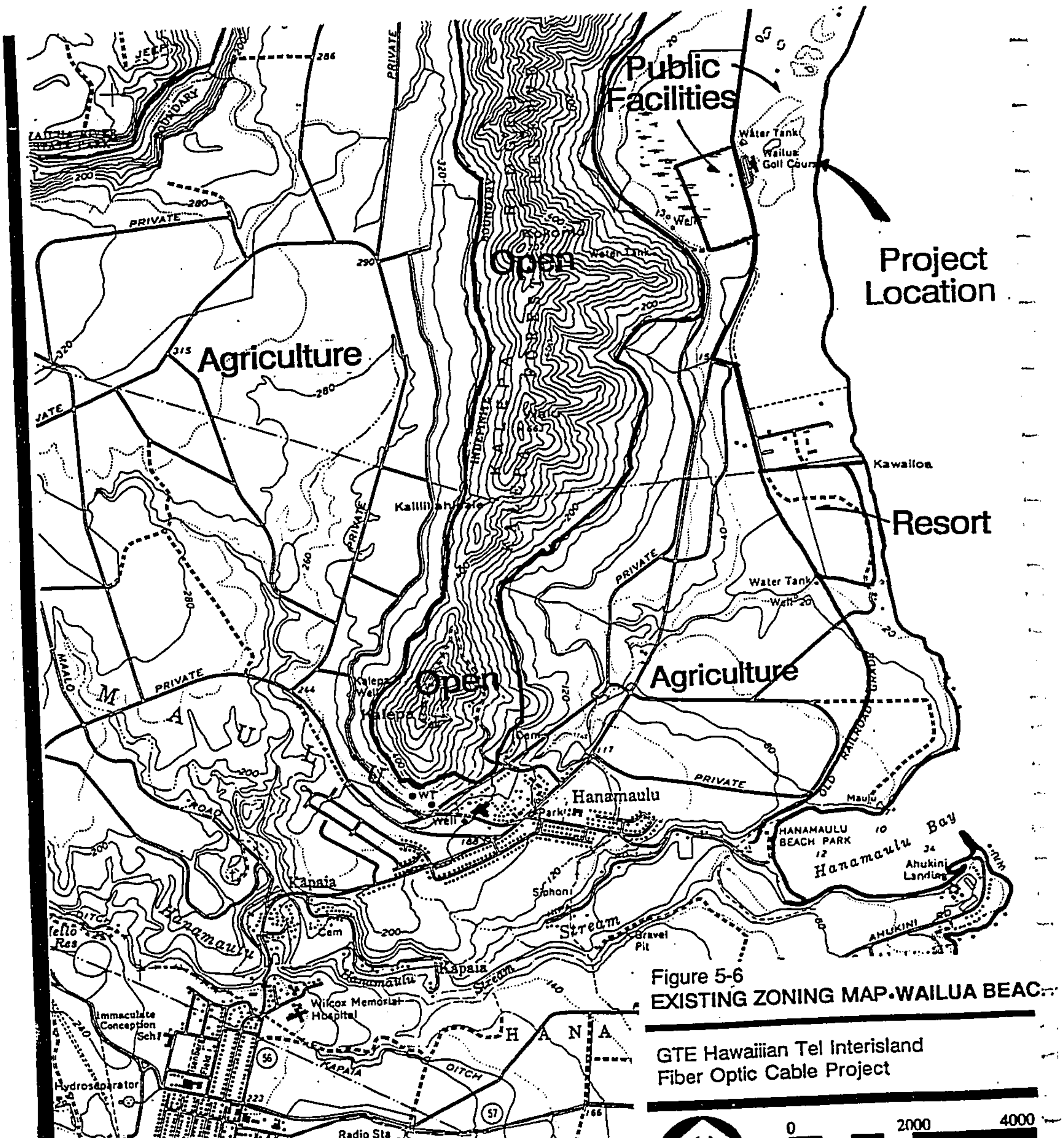

Figure 5-6
EXISTING ZONING MAP•WAILUA BEAC…

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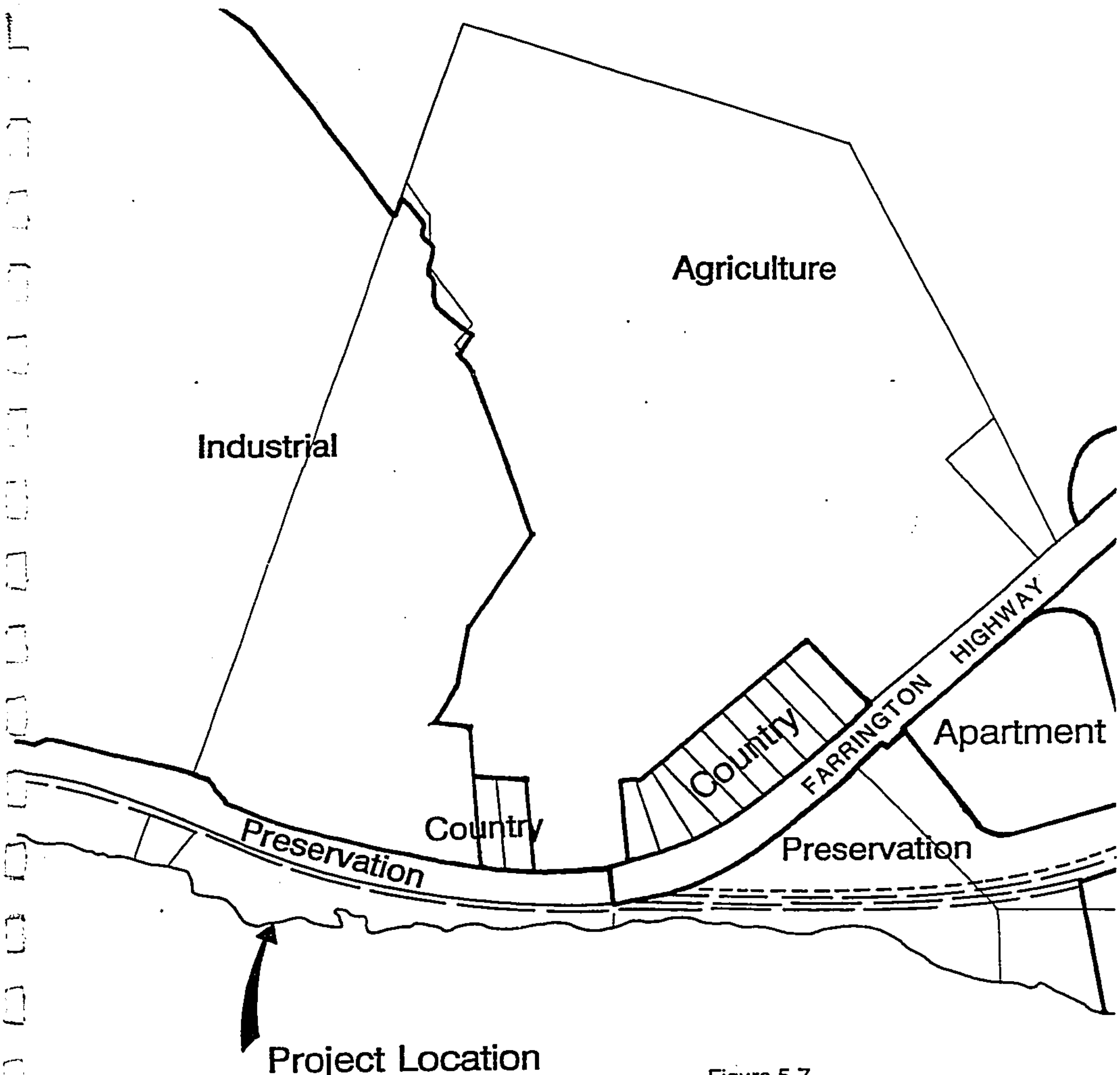

Figure 5-7
ZONING • KAHE BEACH PARK

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Fiber Optic Cable Project

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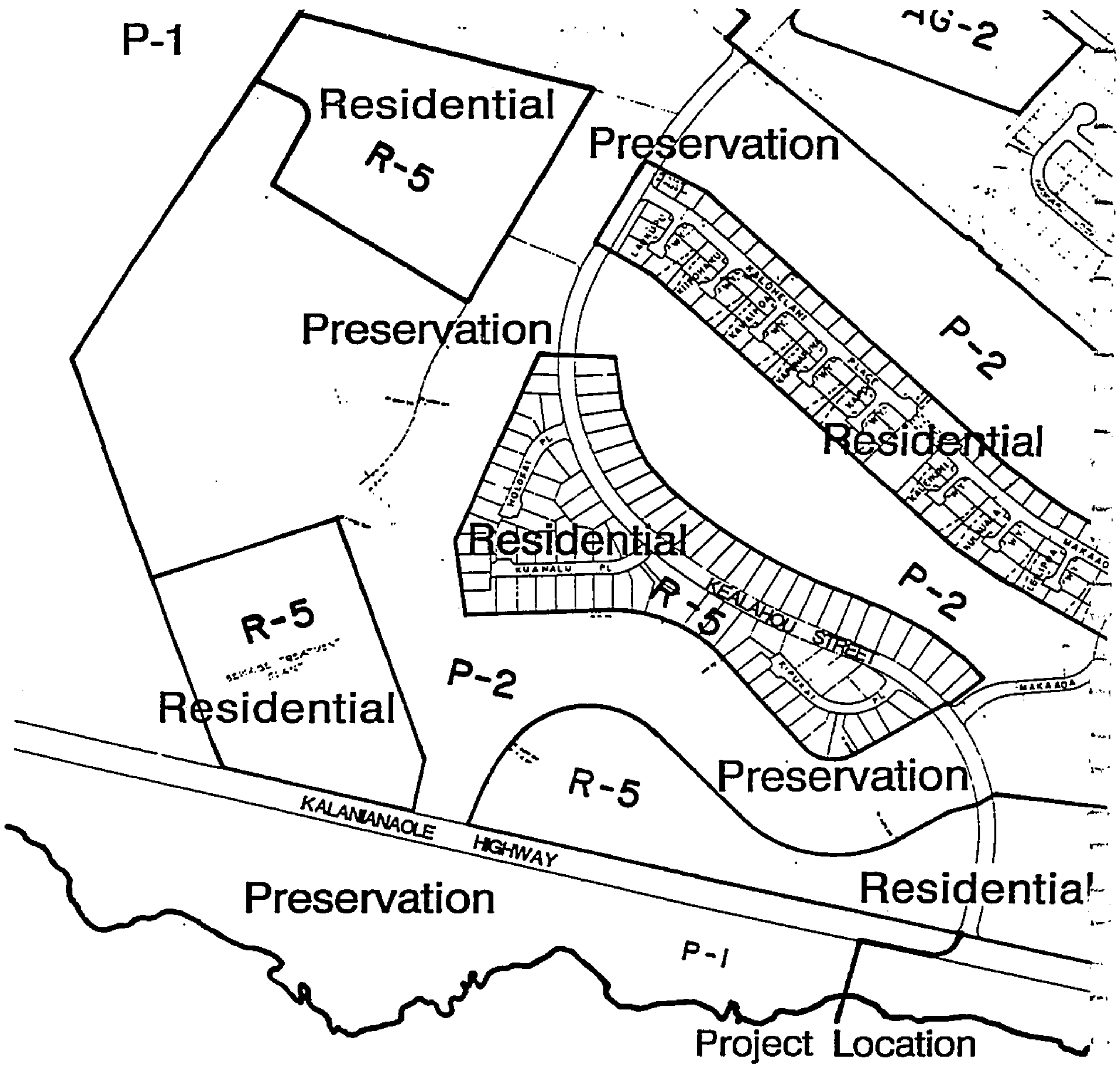

Figure 5-8
EXISTING ZONING MAP-SANDY BEACH

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Fiber Optic Cable Project

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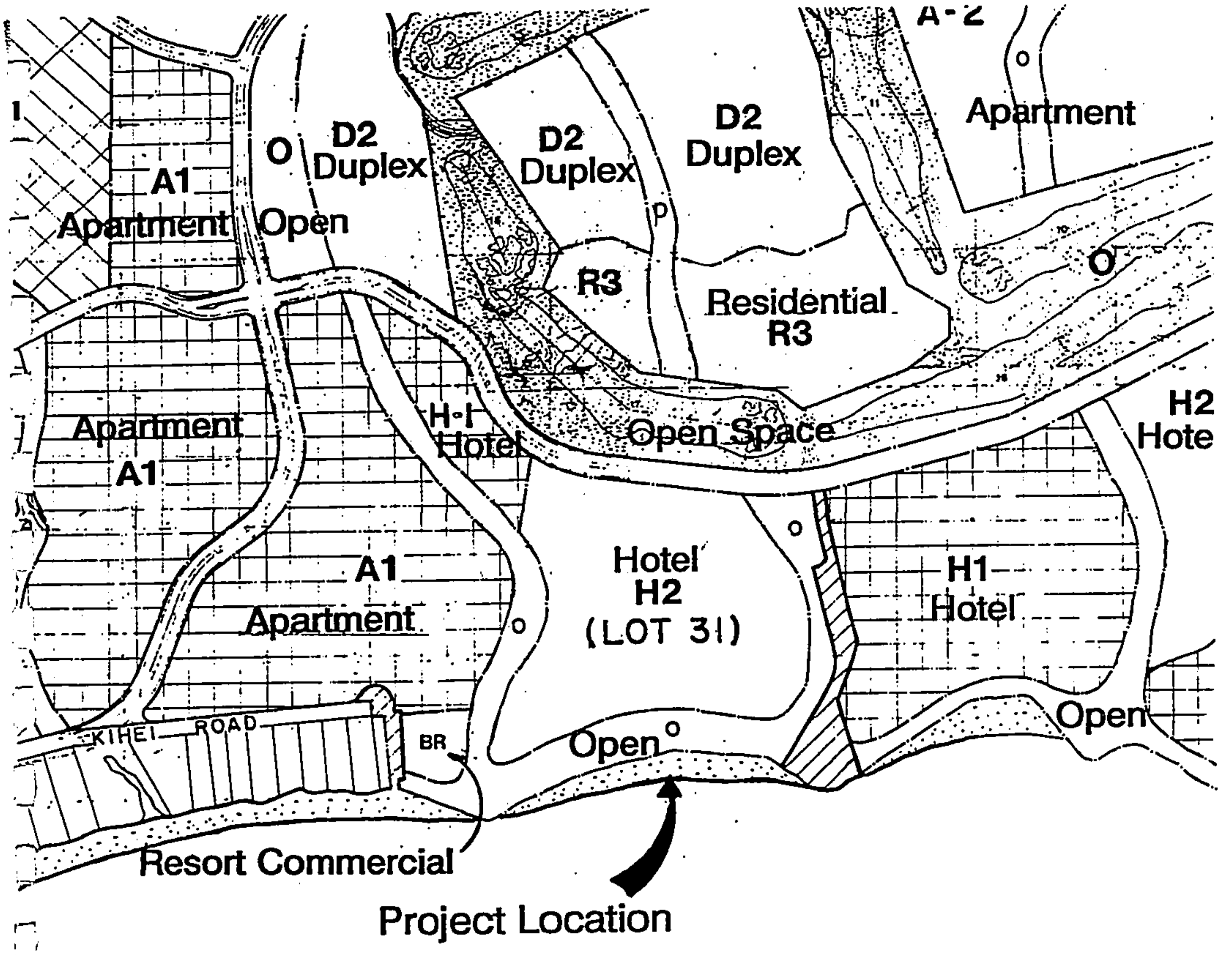

Figure 5-9
EXISTING ZONING MAP•MOKAPU

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Fiber Optic Cable Project

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JANUARY 1992

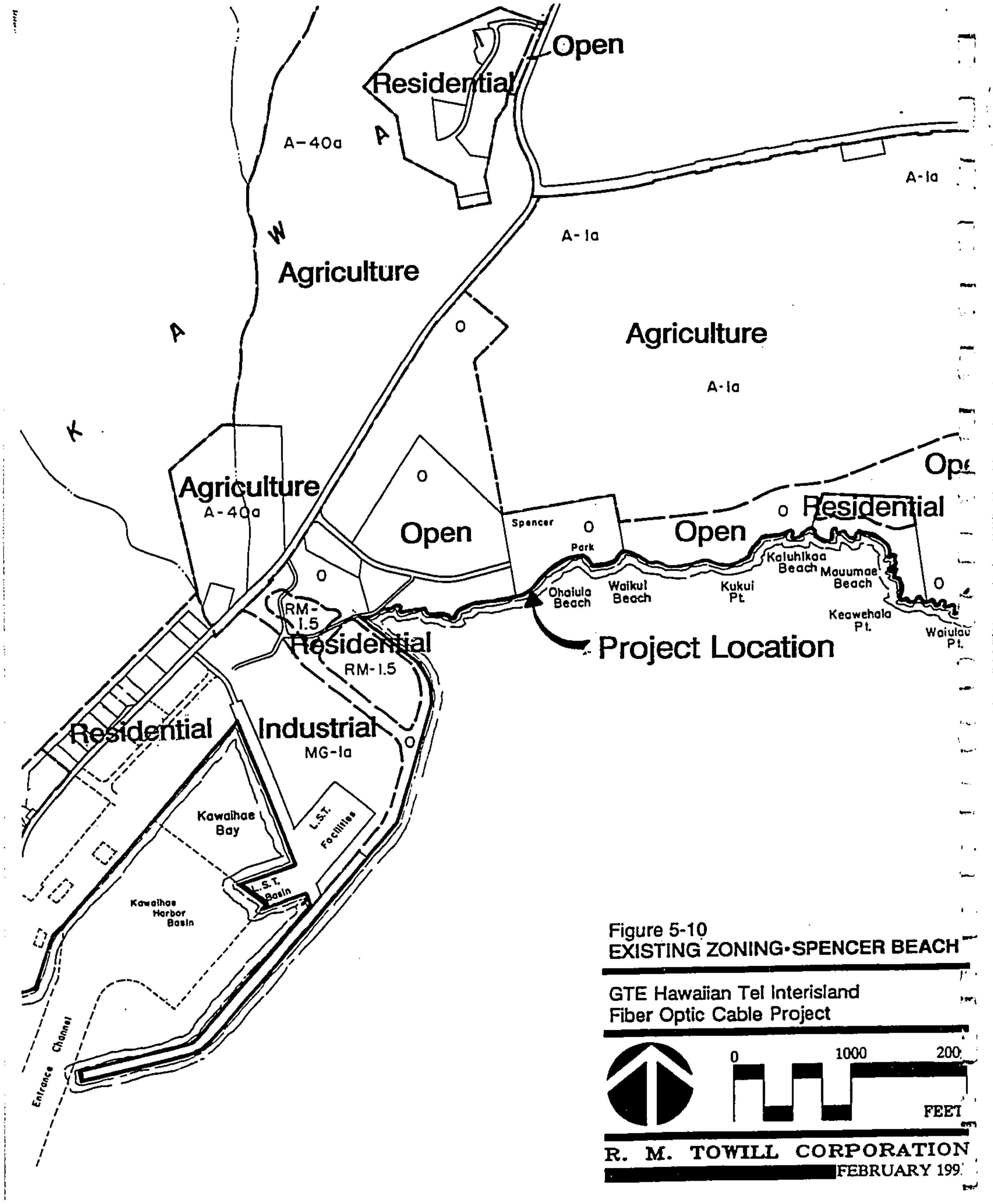

Figure 5-10
EXISTING ZONING•SPENCER BEACH

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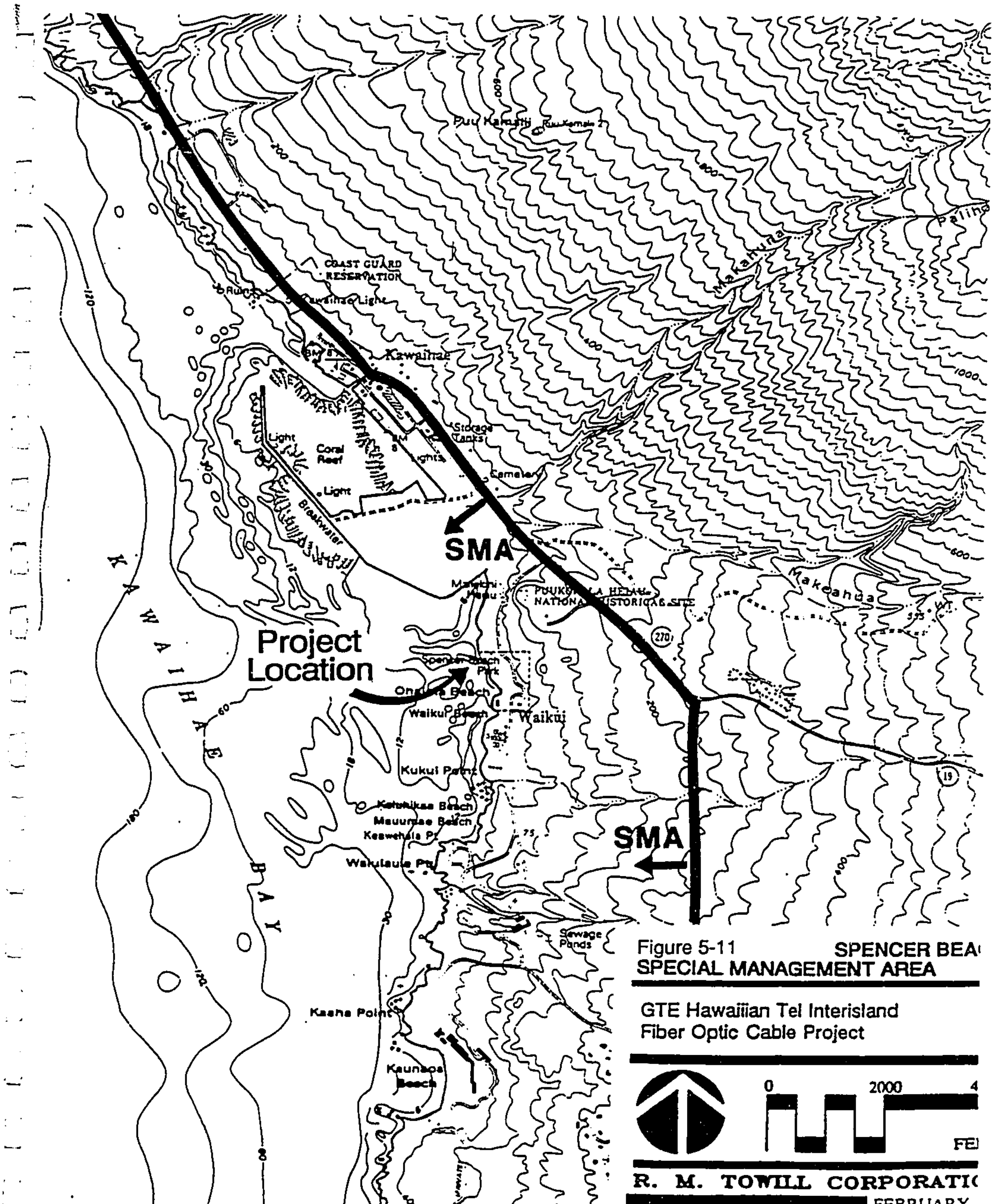

Figure 5-11 SPENCER BEA

SPECIAL MANAGEMENT AREA

GTE Hawaiian Tel Interisland Fiber Optic Cable Project

R. M. TOWILL CORPORATI

FEBRUARY

Setback Variance Permit was also granted in October 1992.

5.5 GENERAL PLANS

COUNTY OF KAUAI GENERAL PLAN
(Wailua Golf Course)

The County of Kauai General Plan provides a statement of long range social, economic, environmental, and design objectives for the island with a statement of policies necessary to meet these objectives. A specific objective of the General Plan relating to the proposed project is the maintenance and expansion of existing utilities systems. The proposed project is generally in conformance with the goals and objectives of the County General Plan.

CITY AND COUNTY OF HONOLULU GENERAL PLAN
(Kahe Point and Sandy Beach Parks)

The General Plan of the City and County of Honolulu provides a statement of long range social, economic, environmental, and design objectives for the Island of Oahu and a statement of policies necessary to meet these objectives. A specific objective of the General Plan relating to the proposed project is the maintenance and expansion of existing utilities systems. The proposed project is generally in conformance with the goals and objectives of the City and County General Plan.

COUNTY OF MAUI GENERAL PLAN
(Mokapu Beach)

The General Plan of the County of Maui provides a statement of long range social, eeconomic, environmental, and design objectives for the Island of Maui and a statement of policies necessary to meet these objectives. A specific objective of the General Plan relating to the proposed project is to provide public utilities which will meet community needs. The proposed project is generally in conformance with the goals and objectives of the County General Plan.

COUNTY OF HAWAII GENERAL PLAN
(Spencer Beach Park)

With respect to the Hawaii County General Plan, the Land Use Pattern Allocation Guide map indicates that the route of the cable installation is designated primarily within the Open Area. Surrounding areas are designated Medium Density Residential, Industrial and Urban Expansion. The cable project will assist in supporting the planned growth for the area and is compatible with planned uses.

5.6 SPECIAL MANAGEMENT AREA

Wailua Golf Course, Kauai

The County of Kauai has designated the shoreline and certain inland areas of Kauai as being within the Special Management Area (SMA). SMA areas are felt to have a sensitive environment and should be protected in accordance with the State's coastal zone management policies. The project area is within the SMA Boundary as defined by the County of Kauai (see Figure 5-12). A SMA permit necessary for development of the proposed project was granted on September 10, 1992.

The proposed project, portions of which are within the shoreline setback area, is also subject to the provisions of the Shoreline Setback Rules of the County of Kauai. Figure 5-12 shows the certified shoreline and shoreline setback line in the area where the project crosses the shoreline setback area. A Shoreline Setback Variance Permit was also granted on September 10, 1992.

Kahe Point Beach Park, Oahu

The City and County of Honolulu has designated the shoreline and certain inland areas of Oahu as being within the Special Management Area (SMA). SMA areas are felt to have a sensitive environment and should be protected in accordance with the State's coastal zone management policies. The project area is within the SMA Boundary as defined by the City and County of Honolulu (see Figure 5-13). The SMA permit necessary for development of the proposed project was granted on December 2, 1992, by the Honolulu City Council.

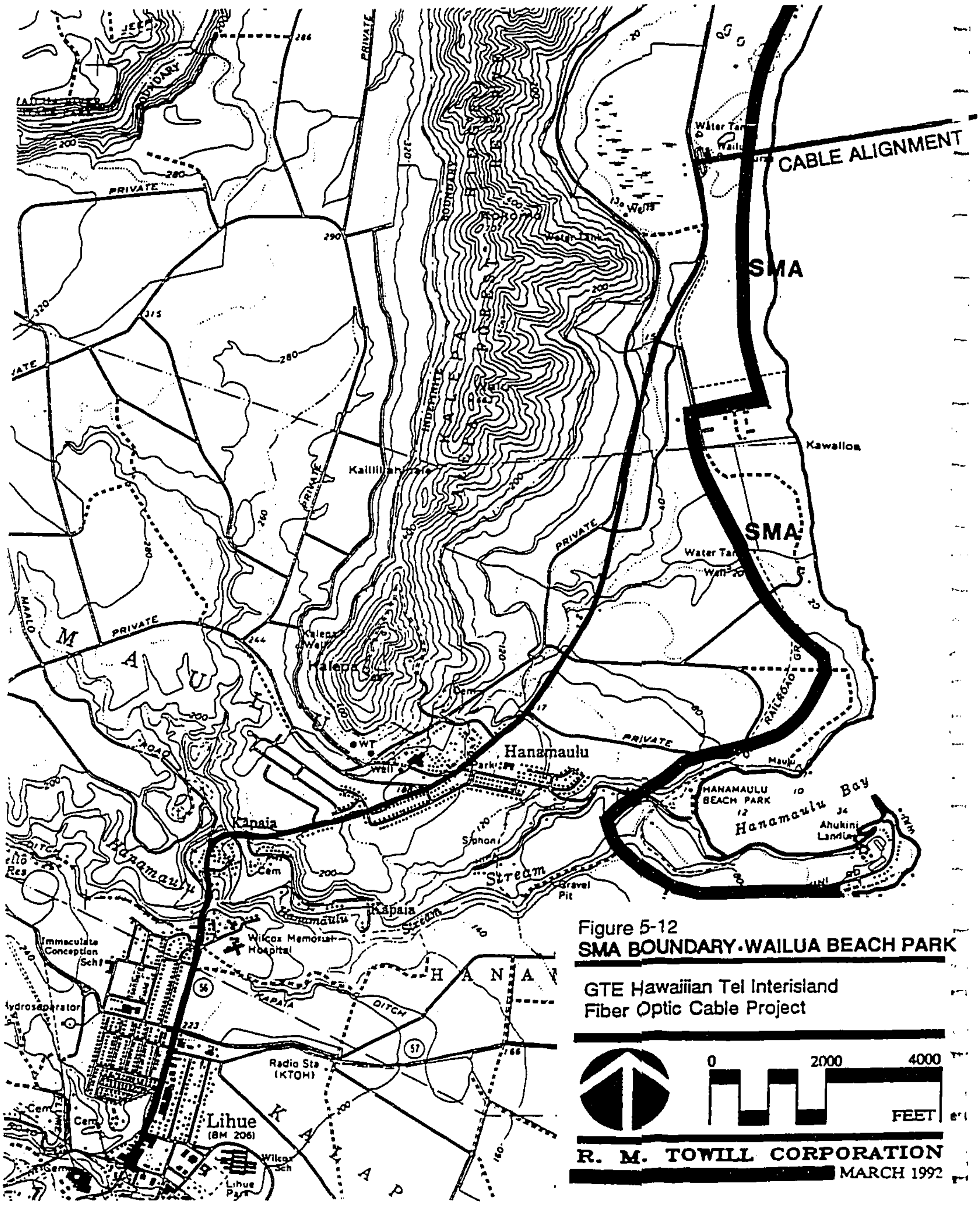

Figure 5-12
SMA BOUNDARY·WAILUA BEACH PARK

GTE Hawaiian Tel Interisland Fiber Optic Cable Project

0 2000 4000 FEET

R. M. TOWILL CORPORATION
MARCH 1992

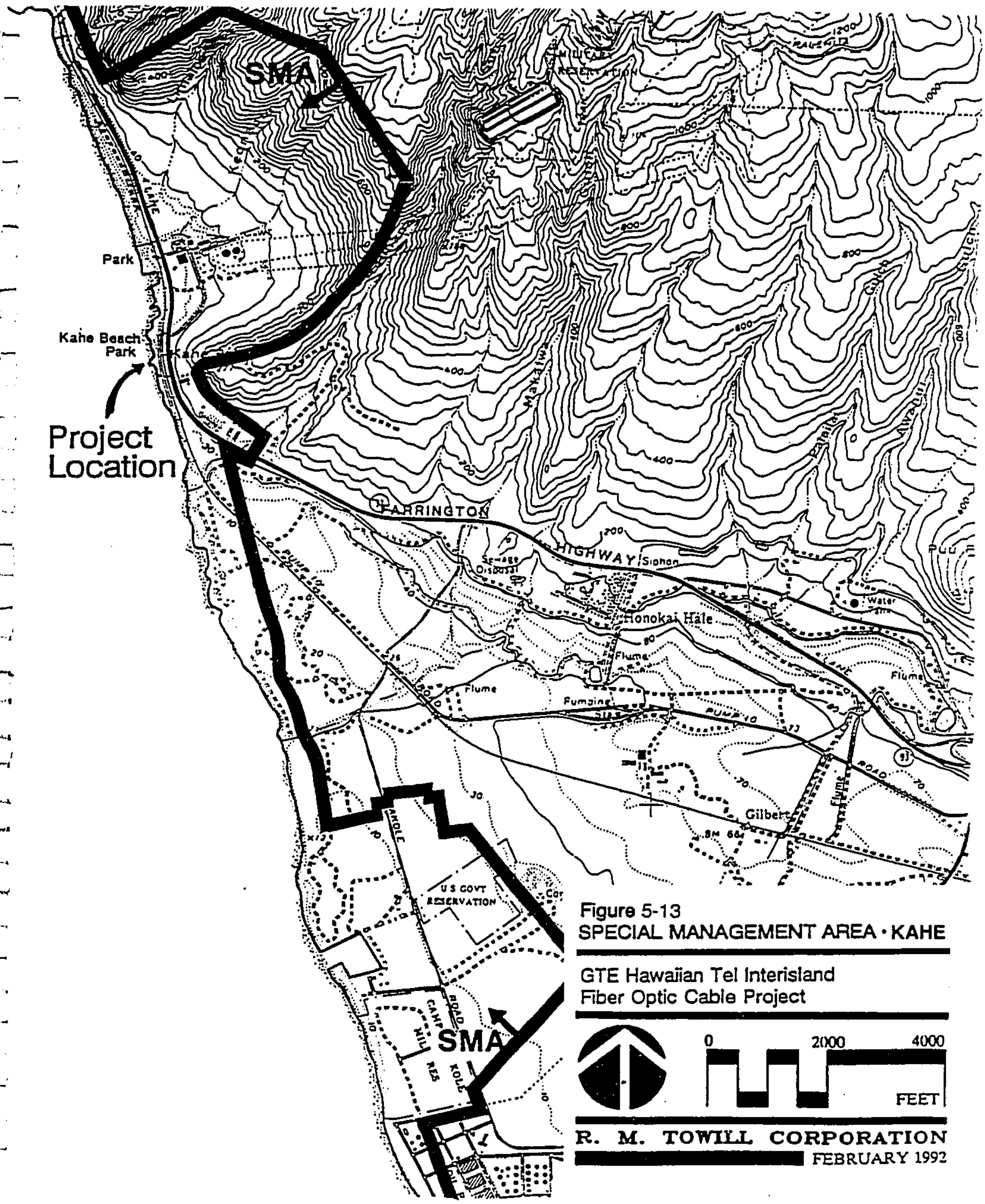

Figure 5-13
SPECIAL MANAGEMENT AREA · KAHE

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

R. M. TOWILL CORPORATION
FEBRUARY 1992

The proposed project, portions of which are within the shoreline setback area, is also subject to the provisions of the Shoreline Setback Rules and Regulations of the City and County of Honolulu. Figure 5-13 shows the certified shoreline and shoreline setback line in the area where the project crosses the shoreline setback area. A Shoreline Setback Variance Permit was also granted on December 2, 1992, by the Honolulu City Council.

Sandy Beach Park, Oahu

The City and County of Honolulu has designated the shoreline and certain inland areas of Oahu as being within the Special Management Area (SMA). SMA areas are felt to have a sensitive environment and should be protected in accordance with the State's coastal zone management policies. The project area is within the SMA Boundary as defined by the City and County of Honolulu (see Figure 5-14). A SMA permit necessary for development of the proposed project was granted on December 2, 1992 by the Honolulu City Council.

The proposed project, portions of which are within the shoreline setback area, is also subject to the provisions of the Shoreline Setback Rules and Regulations of the City and County of Honolulu. The Shoreline Setback Variance (SSV) Permit was granted on December 2, 1992.

Mokapu Beach, Maui

The County of Maui has designated the shoreline and certain inland areas of Kauai as being within the Special Management Area (SMA). SMA areas are felt to have a sensitive environment and should be protected in accordance with the State's coastal zone management policies. The project area is within the SMA Boundary as defined by the County of Maui (see Figure 5-15). The SMA permit necessary for development of the proposed project was granted on December 8, 1992.

The proposed project, portions of which are within the shoreline setback area, is also subject to the provisions of the Shoreline Setback Rules and Regulations of the County of Maui. The Shoreline Setback Variance was also granted on December 8, 1992.

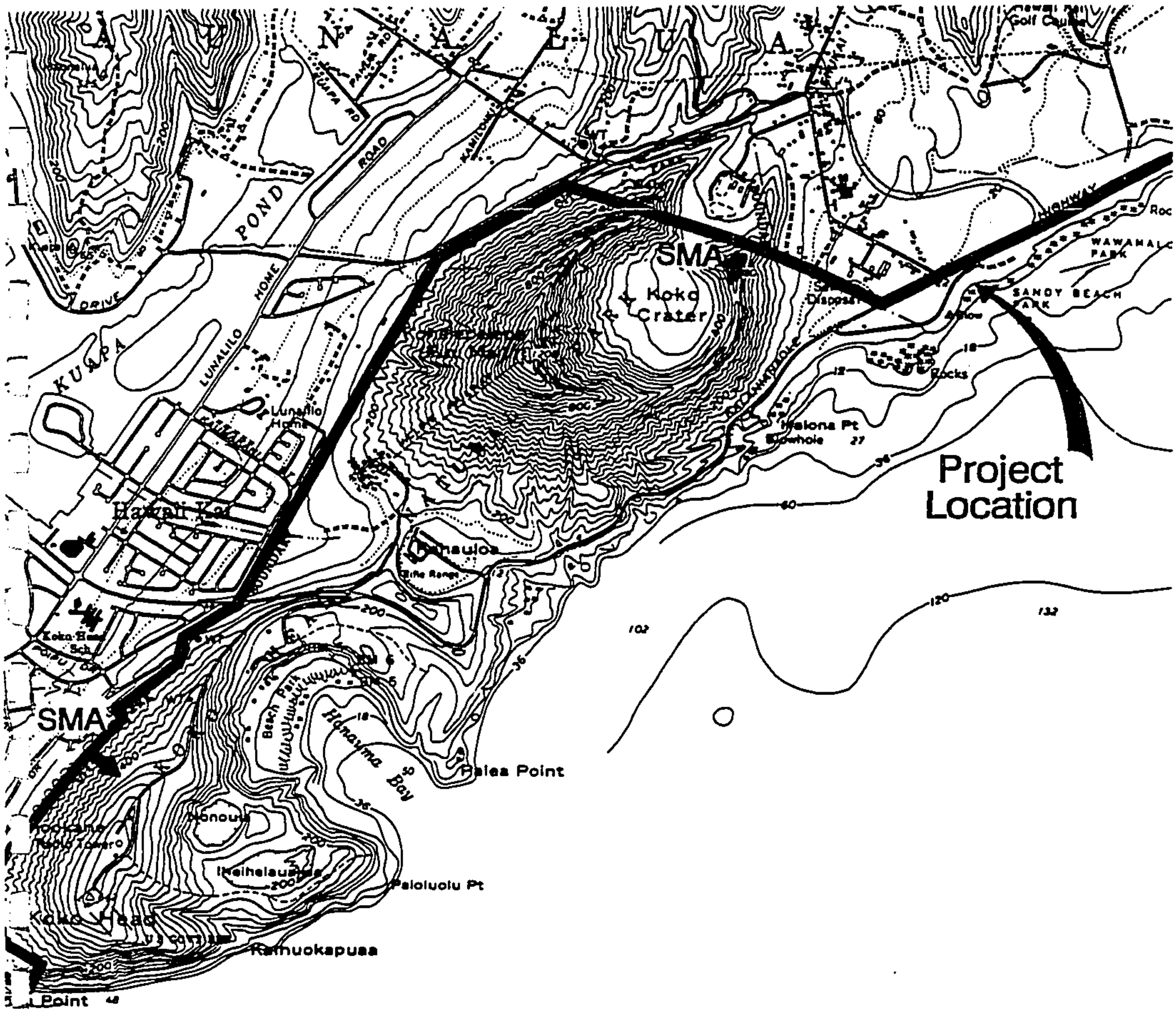

Figure 5-14 SANDY BEACH
SPECIAL MANAGEMENT AREA BOUNDARY

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

0 2000 4000
FEET

R. M. TOWILL CORPORATION
JANUARY 1992

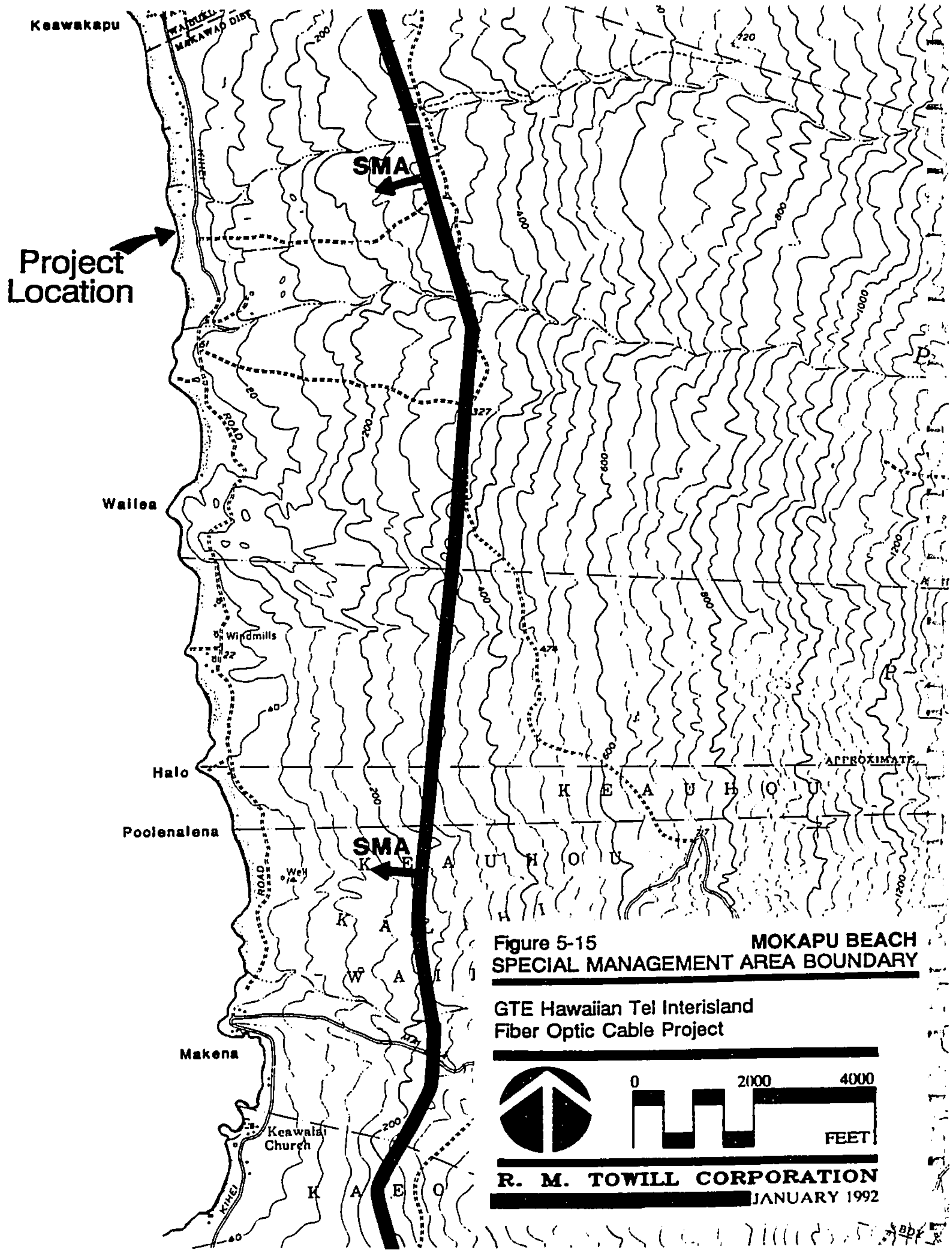

Figure 5-15 MOKAPU BEACH
SPECIAL MANAGEMENT AREA BOUNDARY

GTE Hawaiian Tel Interisland
Fiber Optic Cable Project

R. M. TOWILL CORPORATION
JANUARY 1992

SECTION 6

ALTERNATIVES TO THE PROPOSED ACTION

6.1 NO ACTION

The no action alternative will contribute to further degradation of current inadequate interisland telecommunications facilities. A primary disadvantage of this alternative would be that, without the development of a interisland fiber optics cable, GTE will not have sufficient capacity to meet all interisland traffic in 1993. Losses resulting from this alternative would include:

- Lost employment opportunities which would have been realized in connection with the cable laying procedure, maintenance and operation; and

- Lost tax revenues for City and State governments from the cable vendor, and increased demand for public and private telecommunication usage.

6.2 ALTERNATIVE SITES

Wailua Golf Course, Kauai

A site selection study was prepared in August 1991 and included the Ahukini Coast for consideration. However, this site was removed from further consideration due to poor geologic conditions such as rocky and irregular inshore bottom with numerous rock and coral outcrops which require extensive cable anchoring and armoring. In addition, a steep underwater offshore ledge and a high and a steep on-shore bank make cable laying procedures difficult and expensive.

The site selection study points out that the overall criteria was best met with Wailua Golf Course. The continuous sandy bottom into deeper water is not available at either the Wailua Bay or the Hanamaulu Bay site. In addition, public land ownership lowers easement costs. Although this is true for Wailua Bay, an offsetting factor is that Wailua Bay is being considered by the State Department of Land and Natural Resources for inclusion in the National Register of Historic Sites.

Hanamaulu Bay, which contains privately owned lands immediately behind the landing site, is being considered for future development. AMFAC/JMB, would therefore make acquisition costs high. In addition, an inshore sand channel which extends into the Bay is very irregular and narrow at the tip of the breakwater. Hard bottom is suspected in this immediate vicinity. Toward the ocean, there is at least 500 feet of reef that would have to be crossed by trenching and/or anchoring and cable armoring.

If Wailua Golf Course is removed from consideration, Wailua Bay would be the first alternate. The advantages of Wailua Bay over Hanamaulu Bay are that Wailua Bay is situated on publicly-owned lands; has more conducive physical features; and does not require crossing privately-owned lands mauka of the landing site.

As indicated, however, a major consideration will be the need to address historic and archaeological issues which currently prevent a more serious consideration of the site.

Kahe Point Beach Park, Oahu

The area considered for the leeward Oahu cable landing extended from the Barbers Point Naval Air Station to Pokai Bay, a distance of approximately 14 miles. Existing facilities which limit the selection of cable route areas include cooling water intakes and discharges for the Kahe Generating Station, a U.S. Navy underwater test range, an ocean outfall for domestic sewage, and a small boat harbor.

The coastline south of Kahe Point was excluded from further consideration during the office study due to extensive resort, commercial shipping, industrial and military use. Activities include a major resort development, a deep draft harbor, and offshore oil moorings and associated underwater pipelines. This existing usage precludes a cable landing anywhere along the coastline between Kahe Point and Ewa Beach.

The following is a discussion of the areas initially considered but not selected:

Camp Malakole has an "uneven, irregular bottom out to the 70 foot depth, requiring cable protection, trenching or anchoring for a 4,000 foot distance" (Sea Engineering, January 1990). Other constraining factors are the potential for discovery of archaeological remains and damage from increasing shipping activities around Barbers Point Harbor.

Nanakuli Beach Park has optimal nearshore conditions which include a sand channel extending all the way to shore and deep water near shore. However the area is unavailable due to an existing U.S. Navy submarine test range (FORACS Range) which has several cables running offshore. "Discussions with the range manager indicated that the Navy would not permit placement of a cable across their existing cables, due to their requirements for cable maintenance and possible expansion of the range. An incoming fiber optic cable would cross most, if not all, of the hydrophone cables. This site was therefore eliminated from further consideration" (Sea Engineering, January 1992).

One disadvantage of Pokai Bay is its proximity to the Waianae Small Boat Harbor which could create potential problems due to future harbor expansion and/or marine dredging. Other constraining factors are the potential for discovery of archaeological remains in the backshore area and public use impacts.

Pokai Bay is a heavily used recreational area. The north half of the beach is restricted to military personnel, and there are three surf sites off the military beach. The waters in the south half of the bay are calm due to the protection offered by the breakwater. According to AECOS (1978), Pokai Bay Beach Park has the best protected and most stable sand beach along the entire Waianae coast. Activities include swimming, wading and canoe paddling. The heavy recreational use of the bay has resulted in past conflicts between swimmers and boaters. State boating regulations now separate the two activities.

"A sand channel off the beach park corresponds to the mouth of Ulehawa Stream. Inshore the sand channel is winding and irregular, with a typical width of 150 to 200 feet. The sand channel terminates approximately 300 feet offshore. The bottom between the inshore limit of the sand channel and the beach is scoured limestone shelf, with pronounced surge channels and ridges. The irregularity of the bottom in this zone increases with distance toward shore. Because of the bottom conditions and the shape of the sand channel, cable protection would probably be required out to the 40 foot water depth, 2000 feet offshore. At this point, the channel opens into a large sand deposit. The area just off the beach would present a particular problem due to the vertical relief, and extensive trenching would probably be required to prevent bridging of the cable across the surge channels" (Sea Engineering, January 1990).

Sandy Beach Park, Oahu

The area initially considered for the east Oahu cable landing extended from the Hawaii Kai Marina entrance channel to the north end of Kailuà Bay, a distance of approximately 18 miles. The areas initially considered but not selected are discussed below:

Disadvantages at this location include the lack of offshore sand deposits and sandy beaches to utilize for a cable landing. The fringing reef off Hawaii Kai is approximately 3500 feet wide and is environmentally sensitive.

A sand channel extending seaward from the south side of the beach provides a potential cable route. However, extremely heavy recreational use and the difficulty of heavy equipment access to that part of the beach precluded further consideration of this site.

"An advantage of this site is that the cable could make landfall at the end of the pier, thereby shortening the ocean route by 900 feet, and eliminating passage through the surf zone. However a 30 foot vertical ledge drops to the 60 to 70 foot water depth 5000 feet from the end of the pier. The cable would require protection from the ledge shoreward (Sea Engineering, January 1992)."

Waimanalo Beach possesses a poor shoreline and nearshore access. "A shallow reef defines the seaward boundary of Waimanalo Bay, and also marks the end of the sand bottom. The reef is 4 to 8 feet deep and is very irregular. This zone extends seaward for approximately 2000 feet. This shallow reef would present a formidable obstacle to cable placement, since this zone is also subjected to significant wave energy. Seaward of this zone, the bottom is limestone rock and coral. There are no sand channels or deposits (Sea Engineering, January 1992)." Also there is a potential for discovery of archaeological remains according to the Department of Land and Natural Resources Historic Sites Office

Kailua Beach has extremely difficult offshore conditions involving an extensive and shallow reef and predominately hard bottom. "There is one large offshore sand channel, but it is very irregular with steep ledges on its borders (Sea Engineering, January 1992)." Other constraining factors are the potential for discovery of archaeological remains and major public use impacts.

Mokapu Beach, Maui

The area initially considered for the Maui cable landing included the consideration of two landing sites. One in west Maui in the Lahaina area with a secon landing site in the Kihei-Wailea area. The purpose of the two sites was for the linking of Maui to Oahu via Lahaina, and the linking of Maui to Hawaii via Kihei. Based on the distance between Maui and Oahu, it was decided to provide for a single landing site on Maui in the Kihei-Wailea area. The alternative landing sites investigated included the following:

Kamaole Beach Parks I, II, and III were considered but the disadvantages at this location include the lack of offshore sand deposits and the finding of a coral belt that parallels the beach. The fringing reef is approximately 3,500 feet wide and is environmentally sensitive.

Keawakapu Beach provided a potential cable route, however, the same coral reef that fronts the Kamaole Beaches exist here. Further, recreational use and the difficulty of heavy equipment access to that part of the beach precluded further consideration of this site.

Ulua Beach Park was considered and is further south of the proposed cable landig site. The coral reef that starts in Kihei continues at this point. Access to the beach is limited and is used by local residents as well as visitors. For these reasons, this beach was eliminated from further consideration.

Spencer Park Beach, Hawaii

In August of 1991, a study was conducted to evaluate sites and ascertain land use permit requirements. The study identified three possible landing sites for the Maui to Big Island segment of the fiber optic cable where underwater geology would be most suitable: Spencer Beach, Hapuna Beach, and Mauna Kea Hotel. The study recommends Spencer Beach as the landing site because the site exhibits adequate characteristics including a nearshore alignment that can avoid most of the reefs and coral heads which lie along side and within a small sandy channel leading away from the shoreline to the ocean.

Should Spencer Beach be removed from consideration, Hapuna Beach would be the alternate landing site. Hapuna Beach has favorable bottom conditions including a long sandy channel with good access to the shore. Compared to Hapuna Beach, it is anticipated that public concern would be lower at Spencer Beach. According to the county Planning Department, Hapuna Beach is heavily used and has a well organized constituency which opposes any development activity within the immediate area. If Hapuna Beach requires further consideration, it is recommended that the public be queried by a dialogue involving the community and GTE Hawaiian Telephone, and state and county representatives.

6.3 ALTERNATIVE TECHNOLOGY

The following describes the alternatives to fiber optic cable technology:

6.3.1 Microwave Radio Systems

The use of additional or modification of Hawaiian Tel's existing interisland microwave radio systems is not a feasible alternative due to the linear arrangement of the main Hawaiian Islands. The linear arrangement of the main Hawaiian Islands limits the possible transmission paths between the islands and leads to transmission congestion. Problems associated with transmission congestion of microwave radio systems include:

- Introduction of distortion to voice band data and voice transmission; and
- Loss of signal strength and signal reliability.

In comparison with microwave radio systems, fiber optic technology is the only means of providing the capacity necessary for interisland digital circuits without distortion in voice band data and transmission, and problems with signal strength and reliability.

6.3.2 Satellites

Satellites are not a feasible alternative based on the large interisland capacity requirements projected in the GTE Hawaiian Tel forecasts. Extreme disadvantages associated with use of satellites include:

- Transmission delays due to technical and atmospheric limitations involving the distance the radio waves must travel;
- Visual and aesthetic intrusion caused by the need for ground stations and radio antennas which must be constructed to accept the satellite transmissions; and
- Difficulties associated with "double hops" which occur when data must be retransmitted in order to establish a secure voice circuit.

In comparison with satellites, fiber optic technology is the only means of providing the capacity necessary for interisland digital circuits without transmission delays and major visual and aesthetic problems.

6.4 RECOMMENDED ACTION

The recommended action is to proceed with the establishment of a submarine fiber optic cable system with landing at Wailua Golf Course, Kahe Point Beach Park, Sandy Beach Park, Mokapu Beach, and Spencer Beach Park. From there, the cable will be located underground or overhead within existing right-of-ways.

SECTION 7

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

No short-term exploitation of resources resulting from development of the project site will have long-term adverse consequences. The appearance of the land portion of the existing site will not be altered. The cable will be visible on the ocean bottom portion of the project site and will alter its appearance.

Once construction activities are completed there will be no affect on recreational activities, marine life, or wildlife.

Long-term gains resulting from development of the proposed project include provision of more effective State telecommunications systems (by means of fiber optic cables). The proposed project will maintain and enhance economic productivity by increasing telecommunications service between islands.

SECTION 8

IRREVERSIBLE/IRRETRIEVABLE COMMITMENT OF RESOURCES BY THE PROPOSED ACTION

Development of the proposed project will involve the irretrievable loss of certain environmental and fiscal resources. However, the costs associated with the use of these resources should be evaluated in light of recurring benefits to the residents of the region, the State of Hawaii and the City and County of Honolulu.

It is anticipated that the construction of the proposed project will commit the necessary construction materials and human resources (in the form of planning, designing, engineering, construction labor, landscaping, and personnel for management and maintenance functions). Reuse for much of these materials and resources is not practicable. Although labor is compensated during the various stages of development, labor expended for project development is non-retrievable.

SECTION 9

NECESSARY PERMITS AND APPROVALS

9.1 STATE

Department of Land and Natural Resources

- Conservation District Use Permit
- Right-of-Entry
- Establishment of Offshore Easement

Office of State Planning

- Coastal Zone Management Consistency Review

Department of Health

- Section 401, Water Quality Certification

Department of Transportation

- State Highway Rights-Of-Way

9.2 COUNTY

Kauai County, Wailua Golf Course

Planning Department

- Shoreline Management Area Permit
- Shoreline Setback Variance

City and County of Honolulu, Kahe Beach Park

Department of Land Utilization

- Shoreline Management Area Permit
- Shoreline Setback Variance

City and County of Honolulu, Sand Beach Park

Department of Land Utilization

- Shoreline Management Area Permit
- Shoreline Setback Variance
- Conditional Use Permit, Type 1

Maui County, Mokapu Beach

Department of Planning

- Shoreline Management Area Permit
- Shoreline Setback Variance

Hawaii County, Spencer Beach Park

Department of Planning

- Shoreline Management Area Permit
- Shoreline Setback Variance

9.3 FEDERAL

U.S. Army COE

- Corps of Engineers Section 404/Section 10

9.4 PRIVATE

Access Easement

SECTION 10

CONSULTED AGENCIES AND PARTICIPANTS IN THE PREPARATION OF THE ENVIRONMENTAL ASSESSMENT

10.1 FEDERAL AGENCIES

U.S. Army Corps of Engineers

U.S. Coast Guard

10.2 STATE AGENCIES

Department of Land and Natural Resources

- Aquatic Division
- Land Management Division
- Conservation and Environmental Affairs

Department of Transportation

Department of Health

Department of Business and Economic Development

10.3 COUNTY

Kauai County, Wailua Golf Course

Office of the Mayor

Kauai County Council

Department of Planning

Department of Parks & Recreation

Department of Public Works

City and County of Honolulu, Kahe Beach Park

Department of General Planning

Department of Land Utilization

Department of Public Works

Department of Parks and Recreation

Mayors Office

Councilman John Desoto

Councilwoman Donna Kim

City and County of Honolulu, Sandy Beach Park

Department of General Planning
Department of Land Utilization
Department of Public Works
Department of Parks and Recreation
Mayors Office
Councilman John Felix
Councilwoman Donna Kim

Maui County, Mokapu Beach

Department of Public Works
Department of Planning
Mayor's Office
Managing Director
Councilman Herbert Kihune

Hawaii County, Spencer Beach Park

Department of Planning
Mayor's Office
Councilman Russell Kokubun

10.4 INDIVIDUALS AND GROUPS

Wailua Golf Course, Kauai

Kauai Golfer's Association
Hawaii's Thousand Friends, Kauai Chapter
Sierra Club, Kauai Chapter
Mr. Herbert Apaka

Sandy Beach Park, Oahu

Save Sandy Beach Coalition

Mokapu Beach Park, Maui

Wailea Resort Company

Stouffers Wailea Beach Hotel

McCormack Properties

Kihei Community Association

Makena Homeowners Association

Spencer Beach Park, Hawaii

The Ocean Recreation Council of Hawaii (Torch)

David Tarnas

SECTION 11

COMMENTS AND RESPONSES TO THE DRAFT CDUA ENVIRONMENTAL ASSESSMENT

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF PUBLIC SAFETY
677 Ala Moana Boulevard, Suite 1000
Honolulu, Hawaii 96813

GEORGE W. SUMNER
DIRECTOR

ROBERT C. VIDUYA
DEPUTY DIRECTOR

GEORGE IRANON
DEPUTY DIRECTOR

ERIC PENAROSA
DEPUTY DIRECTOR

March 18, 1993

No. 93-18626

DH

TO: Roger C. Evans, Administrator
Office of Conservation and Environmental Affairs
Department of Land and Natural Resources

FROM: Robert Viduya, Deputy Director for Administration

SUBJECT: CDUA FOR GTE HAWAIIAN TEL INTERISLAND FIBER-OPTIC CABLE SYSTEM

We reviewed the subject application as you requested.

The Department of Public Safety has an ongoing project to convey sewage from both the Kauai Community Correctional Center (KCCC) and the Wailua Golf Course (WGC) Clubhouse to the county's Wailua Sewage Treatment Plant via a new pump station and two each 3" forcemains. Routing of the forcemains has not been finalized at this time, but the primary routing considered runs through WGC.

Based on the information provided in the CDUA, there does not appear to be a conflict between the route chosen by GTE Hawaiian Tel for their fiber-optic cable(s) and the proposed route for the KCCC forcemains and related connections to the Clubhouse.

We have no other comments at this time.

PPB-C
[1712n]

'93 MAY 24 AM 8:16

"An Equal Opportunity Employer/Agency"

R. M. TOWILL CORPORATION

420 Waiakamilo Rd #411 Honolulu, HI 96817-4941 (808) 842-1133 Fax (808) 842-1937

May 16, 1993

Mr. Robert Viduya
Deputy Director for Administration
Department of Public Safety
677 Ala Moana Boulevard, Suite 1000
Honolulu, Hawaii 96813

Dear Deputy Director Viduya:

SUBJECT: Review of CDUA Environmental Assessment for GTE Hawaiian Tel Fiber Optic Cable System, CDUA No. SH-2591

Thank you for your letter concerning the proposed GTE Hawaiian Tel Fiber Optic Cable System Environmental Assessment. You have reviewed the proposed routing of the fiber optic cable in relation to your future proposal to install two 3-inch forcemains in the vicinity of the Wailua Golf Course Clubhouse. You indicated there does not appear to be a conflict and have no other comments to offer at this time.

Should you have additional comments please contact us at our above address.

Very truly yours,

Brian Takeda
Senior Planner

BT/bl
cc Patrick Mau, Norman Ober, GTE Hawaiian Tel
RDE, CK RMTC

Engineers Planners Photogrammetrists Surveyors Construction Managers

International Archaeological Research Institute, Inc.

PREHISTORIC & HISTORIC INVESTIGATIONS • CULTURAL RESOURCES ASSESSMENTS & PLANNING • PALEOENVIRONMENTAL STUDIES

March 8, 1993

RMT		VC	
DK		KTS	
RYK			CA
REC'D MAR 1			RMTC
RDE			
CSY			
DKAT			

Brian Takeda
R.M. Towill Corporation
420 Waiakamilo Road, Suite 411
Honolulu, Hawai'i 96817

SUBJECT: COMMENTS CONCERNING THE GTE HAWAIIAN TEL INTERISLAND FIBER OPTIC CABLE SYSTEM AND ITS WAILUA GOLF COURSE LANDING SITE AT WAILUA, KAUA'I

Dear Mr. Takeda:

I recently completed research involving the Kaua'i Community Correctional Center Sewage Force Main Project at Wailua Kaua'i. Our project area includes the Wailua Golf Course (WGC) and a literature review brought us into contact with a report by Folk and Hammatt (1992) titled *Archaeological Assessment of the Proposed Fiber Optic Cable Landing for Wailua, Kaua'i*. I am concerned that information overlooked by this archaeological assessment will give the Historic Preservation Division, OEQC, and the contractor the erroneous impression that numerous single and multiple burials are unlikely where the cable comes ashore at the WGC Driving Range. A negative declaration should not be anticipated given the presence of burials and their cultural significance to the area. For comments concerning this cultural significance I suggest you contact the Kaua'i Burial Council.

Folk and Hammatt overlooked a 1977 report by Cox (*Report on the Burials Recovered during the Effluent Reclamation Project, at Wailua, Puna, Kaua'i Island*) that encountered 13 burials along a corridor through the golf course. This report cites "clusters of burials" encountered and multiple burials or groups of individual burials being common in the southern half of the course, which is the proposed route for the fiber optic cable. In addition, informants relate that "hundreds" of burials were unearthed when the driving range was constructed. This is in opposition to Folk and Hammatt's conclusion that, "Groups of burials -*i.e.*, cemeteries or conscribed graveyards- within the proposed corridor are not expected ...." (1992:i). This "survey" by Folk and Hammatt was totally inadequate and should not be the basis for your anticipation of a negative declaration for this project.

Sincerely,

Conrad Erkelens
Archaeologist

cc: OEQC
Don Horiuchi
Larry Hartshorn

HAWAII: 949 McCully St., Suite 5, Honolulu, Hawaii 96826 Telephone: (808) 946-2548, 943-0629 Facsimile: (808) 943-0716
GUAM: P.O. Box 22621, GMF, Guam 96921 Telephone/Facsimile: (671) 734-2755
SAIPAN: Lower Base Professional Center, P.O. Box 1837, Saipan, MP 96950 Telephone: (670) 322-3830, 322-4370 Facsimile: (670) 322-4251

CULTURAL SURVEYS HAWAII

Archaeological Studies

Hallett H. Hammatt, Ph.D.
733 N. Kalaheo Avenue, Kailua, Hawaii 96734
Bus: (808) 262-9972/ Fax: 262-4950

March 12, 1993

Mr. Brian Takeda, Senior Planner
R.M. Towill Corp.
420 Waiakamilo Rd., #411
Honolulu, HI 96817-4941

Subject: Response to letter from Mr. Conrad Erkelens, International Archaeological Research Institute, Inc., dated March 8, 1993 addressed to Brian Takeda.

Dear Brian:

This is in response to your request for an answer to the above letter. The items of response are as follows:

1. Mr. Erkelens is concerned that Cultural Surveys Hawaii ignored and underestimated the likelihood of encountering burials in the route of the Fiber Optics cable.

Our report presents clear lines of evidence that burials are expected; previous archaeology, informant interviews, knowledge of Hawaiian burial patterns. All this is reflected in our recommendations which speak on this point as follows:

> The established presence of human burials in the beach and dune sand deposits along the coast of Wailua *makai* of Kalepa-Nonou Ridge indicates a strong probability that burials will be encountered during excavation of the trench through the golf course for the proposed fiber-optic cable. Although only individual isolated burials have been reported near the cable corridor we believe that archaeological subsurface testing of the precise trench line should be conducted once the exact line is surveyed and staked in the field. This testing is necessary to ensure that such burials as may be encountered are not grouped or concentrated in the manner of a cemetery or family graveyard.
>
> Continuous on-site monitoring by archaeologists is recommended during all excavation work in undisturbed beach and dune sand deposits between the wave cut bank at the shoreline and Kuhio Highway. This recommendation is based on the probability of undisturbed sand beach and dune deposits in the cable corridor, and our knowledge of apparently individual and isolated human burials within the bounds of the Wailua Golf Course (Folk and Hammatt, 1992:12).

2. Mr. Erkelens is concerned that Folk and Hammatt overlooked a 1977 Cox study in which Cox encountered burials at the north portion of the golf course.

The authors were aware of this report and did not, at the time of their report preparation, have a copy. A copy was not in the State Historic Preservation Division library. Dr. Kikuchi of Kauai Community College found what is believed to be one of the few copies in existence. This copy was sent to Hal Hammatt, who also circulated it to Nancy McMahon for inclusion in the SHPD library so it would be available to other archaeologists. Because the report was not available it was not quoted in the 1992 Hammatt and Folk report. The authors were aware of its existence but had only second-hand knowledge of its content. Since we were well aware of the existence of burials the content of the Cox report does not significantly change our findings.

3. Mr. Erkelens relates informants telling of 'hundreds' of burials unearthed when the driving range was constructed. We cannot evaluate this evidence without more information on the identify and reliability of these informants. Mr. Erkelen's statement is not substantiated by the 1977 Cox Report or by Folk and Hammatt 1992 interviews which included the present Golf Course Superintendent, Mr. Koga, and Mr. Shirai, Superintendent from 1946 to 1978. Both related the locations of 3 previously found burials. We consider these individuals quite reliable, who in their official capacities would have been informed of findings in the golf course over a long period of its history. We therefore adhere to our original conclusions.

4. Mr. Erkelens refers to our 1992 study as a survey.

In the title, the introduction, the scope of work, and in the summary of results and recommendations it is clearly stated that this study is an assessment as distinguished from an inventory survey. Extensive *ahupua'a* study was not conducted nor was subsurface testing. We suggest that Mr. Erkelens consult the draft rules for historic review available at DLNR for the definition of an inventory survey. The Historic Preservation Division also has a brochure with a shortened version of procedures and definitions.

5. Mr. Erkelens refers to our study as being totally inadequate and should not be the basis for anticipation of a negative declaration.

It is the function of the State Historic Preservation Division to evaluate our reports for adequacy. Our report has been submitted to the Division and we have anticipated and abided by their recommendations. In addition, this project has been taken before the Kauai Island Burial Council. All parties have concurred with Cultural Surveys Hawaii's recommendations that sub-surface testing take place in the proposed cable alignment and that laying of the cable be monitored full-time by an archaeologist.

We would like to assure Mr. Erkelens that all parties involved in this project are fully aware of the potential impact on sensitive archaeological resources and that every effort will be made to mitigate these impacts in a responsible and sensitive manner. We appreciate Mr. Erkelen's concern and hope that the information provided above is helpful to him and to International Archaeological Research Institute, Inc. in their independent assessment.

Sincerely,

Hallett H. Hammatt, Ph.D.
William H. Folk, B.A.

March 22, 1993

LOG NO: 7634
DOC NO: 9303NM07

MEMORANDUM

TO: Roger Evans, OCEA

FROM: Don Hibbard, Administrator
State Historic Preservation Division

DH

SUBJECT: CDUA SH-2618 -- Historic Preservation Review -- Conservation District Use Application - Interisland Fiber Optic Cable Easement (GTE Hawaiian Tel)
File No. SH-2618
Various Locations, State of Hawaii

The locations that are proposed for this project involve the four counties. We have reviewed GTE Hawaiian Tel.'s proposal for various County, State and Federal permits. We have the following comments by location:

Wailua, Kauai (TMK:3-9-02: 2

The archaeological report (Folk and Hammatt, Cultural Surveys Hawaii, March 13, 1992, Archaeological Assessment of the Proposed Fiber Optic Cable Landing for Wailua, Kaua'i) is only a field assessment document and not an acceptable archaeological inventory survey report to determine if significant historic sites were present. We responded directly to the applicant's agent on this archaeological assessment and indicated that an archaeological inventory survey needed to be conducted.

Subsurface test excavations were not conducted which would give a more accurate determination whether significant historic sites are present. It was our understanding from the applicant's agent (R.H. Towill) that this archaeological work would disrupt the golf course activity. Given some flexibility in the design route, we understand the inventory survey will be completed several weeks before the cable will be brought in. With this flexibility and the fact that the survey will occur, it should be possible to ensure that the project will have "no adverse effect" on significant historic sites. Once the inventory survey is complete, if significant historic sites or burials are present, then a mitigation plan will be needed and the applicant is aware of this.

Therefore, in order to ensure that there is "no adverse effect" to significant historic sites, we recommend that a condition be attached to any approved CDUA requiring that an archaeological inventory survey be conducted by a qualified archaeologist for this portion of the project area. A report documenting the project area

submitted to our Division for review and approval. The condition should also state that if significant historic sites are found, an acceptable mitigation plan will need to be developed in consultation with our Division.

If you have any questions, please call Nancy McMahon (587-0006), our staff archaeologist for the County of Kaua'i.

Sandy Beach Park, Maunalua, O'ahu (TMK: 3-9-12: 2)

Historic Preservation review for this project is complete, with a determination of "no effect" on historic sites.

Kahe Point Beach Park, Honouliuli, 'Ewa, O'ahu (TMK: 9-2-3: 15)

Archaeological inventory survey of this project area identified a sea cave and fissures with possible historic remains. The Environmental Assessment notes that it will be easy to avoid the cave and fissures during construction. In order to ensure that there is "no effect" to possible historic sites in the cave and fissures, a second condition should be attached to any CDUA that specifies that the Historic Preservation Division be given the opportunity to review detailed plans that show the relationship of this landing site to these features.

Mokapu Beach, Maui

We have previously determined that the proposed project will have "no effect" on historic sites. An archaeological survey identified no historic sites in the proposed project site.

Spencer Beach Park, Hawaii (TMK: 6-2-01: 8 and 6 [por.])

An archaeological inventory survey was conducted on the above parcel by Borthwick and Hammatt (1992: "Archaeological Assessment of the Proposed Fiber Optic Landing for Spencer Beach Park, Island of Hawaii"). No historic sites were located. Hence, this project will have "no effect" on historic sites.

NM:amk

R. M. TOWILL CORPORATION

420 Waiakamilo Rd #411 Honolulu, HI 96817-4941 (808) 842-1133 Fax (808) 842-1937

April 17, 1993

Mr. Keith W. Ahue
Chairperson
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Chairperson Ahue:

SUBJECT: Comments Concerning CDUA SH-2618 and Coordination of Archaeological Inventory Survey for GTE Hawaiian Tel Interisland Submarine Fiber Optic Cable System Landing at Wailua Golf Course, Wailua, Kauai

This is in response to concerns expressed in memorandum dated March 22, 1993 (attached), concerning need to conduct an archaeological inventory survey report for the proposed Wailua Golf Course cable landing site.

Please be advised we are working with Cultural Surveys Hawaii to ensure completion of the archaeological testing. Work is proceeding to coordinate entry requirements with the County of Kauai. Ms. Nancy McMahon, State Historic Preservation Division, will be notified once this schedule is established and will be kept apprised of the progress of testing.

Please do not hesitate to call should you have any questions.

Very truly yours,

Brian Takeda
Senior Planner

BT/bt
Attachment
cc Patrick Mau, GTE Hawaiian Tel
SK, CK, RDE RMTC

APPENDIX A

Marine Environmental Analysis of Selected Landing Sites Wailua Golf Course, Kauai

GTE Hawaiian Tel
Interisland Fiber Optic Cable System

MARINE ENVIRONMENTAL ANALYSIS OF SELECTED LANDING SITES

Prepared For:

R.M. Towill Corporation
420 Waiakamilo Rd., Suite 411
Honolulu, Hawaii 96817

Prepared By:

Sea Engineering, Inc.
Makai Research Pier
Waimanalo, Hawaii 96795

AND

Environmental Assessment Co.
1804 Paula Drive
Honolulu, Hawaii 96816

March 1992

91-85

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I. INTRODUCTION

GENERAL

GTE Hawaiian Tel is planning the installation of an Interisland Fiber Optic Cable System linking the islands of Kauai, Oahu, Maui and Hawaii. The site selection and evaluation process has been underway since early 1991, and Sea Engineering, Inc. has been retained over that period by the R.M. Towill Corporation to evaluate the marine considerations for potential landing sites and to assist in the preparation of the Environmental Assessments for the recommended landing sites. Dr. Richard Brock of the Environmental Assessment Company, a subconsultant to Sea Engineering, Inc., was responsible for characterizing the nearshore marine biological conditions along the cable routes and also assisted with the impact evaluation.

This report describes the nearshore marine selection process, the alternatives considered, the physical and biological characteristics of the nearshore cable routes, and the anticipated marine environmental impacts.

Figure I-1 shows the interisland cable configuration and the recommended landing sites.

ROUTE SELECTION PROCESS

This report describes only the nearshore marine considerations of the selection process. Other considerations included land suitability, deep ocean conditions, public usage and terrestrial and marine impacts. A series of two Working Papers, prepared by the R.M. Towill Corporation (1991), describe in detail the overall selection process, the alternatives considered, and the rationale for the recommended routes.

The coastal sector boundaries for the potential cable landing sites were initially defined by two primary constraints:

1. The total cable length between central offices was limited to a maximum of 200 kilometers, and preferably to less than 185 km. Cable lengths over 200 km would require an expensive subsea repeater.

2. Proximity of the cable landing site to a central office was desirable, along with relatively easy access to the central office via available pole lines, duct lines, or other GTE infrastructure.

Given these constraints, sectors of coastline were delineated which bounded the potential landing areas. An office evaluation of each coastal sector was then completed, utilizing existing literature, color aerial photographs, marine charts, coastal inventories prepared by state and Federal agencies, and personal knowledge of nearshore physical and biological

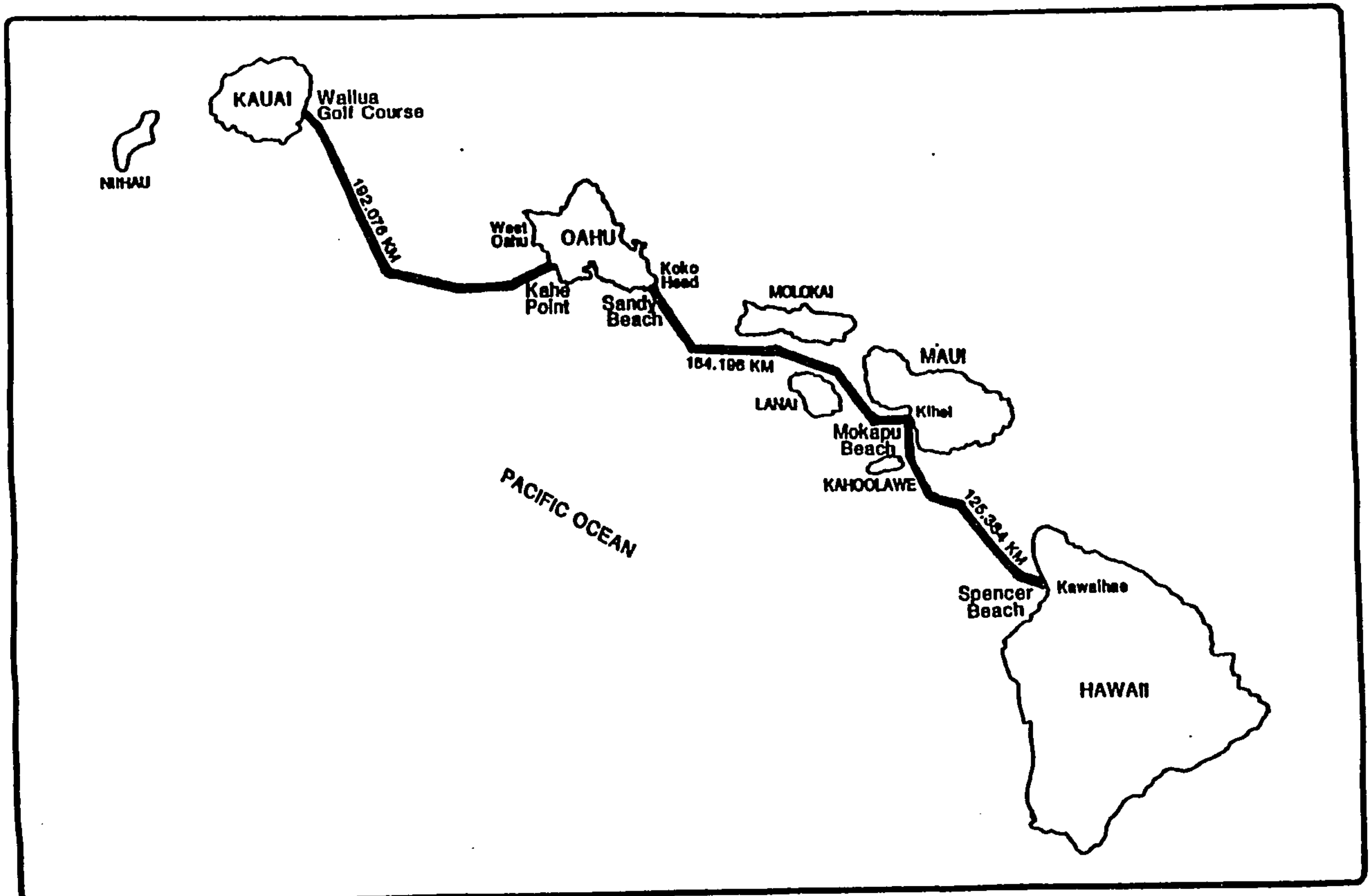

FIGURE 1. SUMMARY OF RECOMMENDED GTE HAWAIIAN TEL FIBER OPTIC LANDING SITES - STATE OF HAWAII

characteristics and uses. A one day field reconnaissance was then conducted in each sector to select three potential landing sites in each sector. If no suitable sites were found within the sector limits, the sector was enlarged as required.

Following the consolidation of all planning considerations mentioned above (terrestrial and marine) a more detailed field study was conducted at each site by an ocean engineer and marine biologist. The objective of this phase was to select the primary and secondary route alternatives.The marine biologist was incorporated into this phase of the study to conduct a preliminary assessment of the selected alternatives and to ensure that there were no overriding environmental constraints.

After initial approval by the client of the recommended route, a detailed bathymetric survey was conducted at each site. During this survey, while accurate positioning equipment was available, a diver was towed along the route centerline, and his visual observations were correlated with the track line and the water depth. This step provided valuable information about the precise conditions along the route, and also ensured that there were no unexpected conditions in the nearshore area.

One additional field trip was made to each site, for the express purpose of describing the physical and biological characteristics of the route and adjacent areas, and to evaluate the potential environmental impacts.

The limit of the diving surveys was the 100 foot depth contour. However, the diving support vessels were equipped with fathometers, and track lines were run to the 180 foot depth to ensure that no steep ledges were encountered beyond the limit of the visual survey.

MARINE SELECTION CRITERIA FOR NEARSHORE
CABLE ROUTE EVALUATION

Throughout the cable route selection and evaluation process the primary objective was to find a suitable, safe cable route which would also result in the minimum environmental impacts possible in that sector.

Specific selection criteria included the following:

1. Sandy bottoms and coastlines were preferred, both for integrity of the cable and to *minimize environmental impacts.* Experience at other cable landing sites on Oahu (Makua Beach, Makaha Beach and Nanakuli Beach) indicates that cables on sandy bottoms tend to sink into the sand. No cable cross section is exposed, and wave forces on the cables are therefore minimal. In most of these areas, the winter surf and shorebreak can be very large, yet the numerous cables making landfall there have remained stable.

   Hawaii beaches are usually in a dynamic balance with a large offshore sand deposit, and the two are frequently linked by a continuous sand channel, thus providing the ideal configuration for a cable route. In addition to the engineering advantages, the environmental effects of a placing a cable on a sandy bottom are much less than placing one across a diverse coral community.

2. Minimizing the horizontal distance from the shoreline to the 60 foot depth was another important factor. This is the zone of maximum wave forces, and the assumption was made that some form of cable protection or anchoring would be required when crossing any hard bottom inshore of the 60 foot contour. This distance is also an important factor in the cable landing process. The cable ship can approach shore to approximately the 50 or 60 foot depth, where it is then held in place by tugs. As the cable is towed to shore by a small boat or tug, floats are attached to the cable as it is paid out, so that it floats on the surface until the shore connection is secured. During this time, the cable position must be maintained along the route centerline. Strong currents or long distances make this process more difficult. The goal was to select a route where the distance from shore to the 60 foot contour was less than 4000 feet.

3. There is a semi-continuous ledge which drops off from the 60 foot contour, and extends through many of the coastal sectors of Hawaii. This ledge was formed during an ancient stand of the sea, and typically has a vertical drop of 30 feet or more. This ledge was present in the Kauai sector, both Oahu sectors and the Maui sector. It was therefore important to find a route which either avoided the ledge or passed through a channel in the ledge. Fortunately, the sand channels connecting the beaches to the deeper offshore deposits often bisect the ledge.

4. Routes were selected to avoid, to the maximum extent possible, environmentally sensitive areas or areas frequented by rare or endangered species. A specific example was the avoidance of areas used by green sea turtles for resting or forage. The marine biological consultant was an early participant in the study, so that environmental input was received during the initial route evaluations.

II. GENERAL OCEANOGRAPHIC CHARACTERISTICS

WINDS

The predominant winds in the Hawaiian Islands are the northeast trades, which are present approximately 70 percent of the time with an average speed of 13 mph. The frequency of tradewinds varies greatly with the season. They occur 90-percent of the time during the months of April to October. The winter season (November to March) is defined by a weakening of the high pressure system generating the tradewinds, and the frequency of occurrence decreases to approximately 50-percent. During the winter season, low pressure systems periodically displace the tradewinds, resulting in south or southwest winds known as "Kona" winds. Kona winds, which occur rarely in summer and 17-percent of the time in the winter, range from light and variable to gale or hurricane force.

PREVAILING WAVE CLIMATE

The general Hawaiian wave climate can be described by four primary wave types; the northeast tradewind waves, south swell, North Pacific swell and kona storm waves. These wave types and their general approach direction are shown on Figure II-2.

Tradewind waves may be present in Hawaiian waters throughout the year, but are most frequent in the summer season, between April and September, when they usually dominate the Hawaiian wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Typical deepwater tradewind waves have periods of 5 to 8 seconds and heights of 4 to 10 feet. During gale conditions tradewind waves may reach heights in excess of 20 feet.

South swell is generated by southern hemisphere storms, and is most prevalent during the months of April through October. These long, low waves approach from the southeast through southwest, with typical periods of 12 to 20 seconds and deepwater heights of 1 to 4 feet. Although their deepwater height is relatively low, the long period results in considerable shoaling near shore with resultant large breaker heights. The surf along the exposed south shores of the islands occasionally reaches heights of 15 feet.

North Pacific swell is produced by winter storms in the North Pacific Ocean and by mid-latitude low pressure areas. North swell may arrive in the Hawaiian Islands throughout the year, but is largest and most frequent during the winter months of October through March. North Pacific swell typically has periods of 12 to 20 seconds and deepwater heights of 5 to 15 feet. The approach direction is typically from the west-northwest through north-northeast. North Pacific swell results in some of the largest waves in Hawaiian waters.For example, breaking wave heights approaching 50 feet were observed in December 1969.

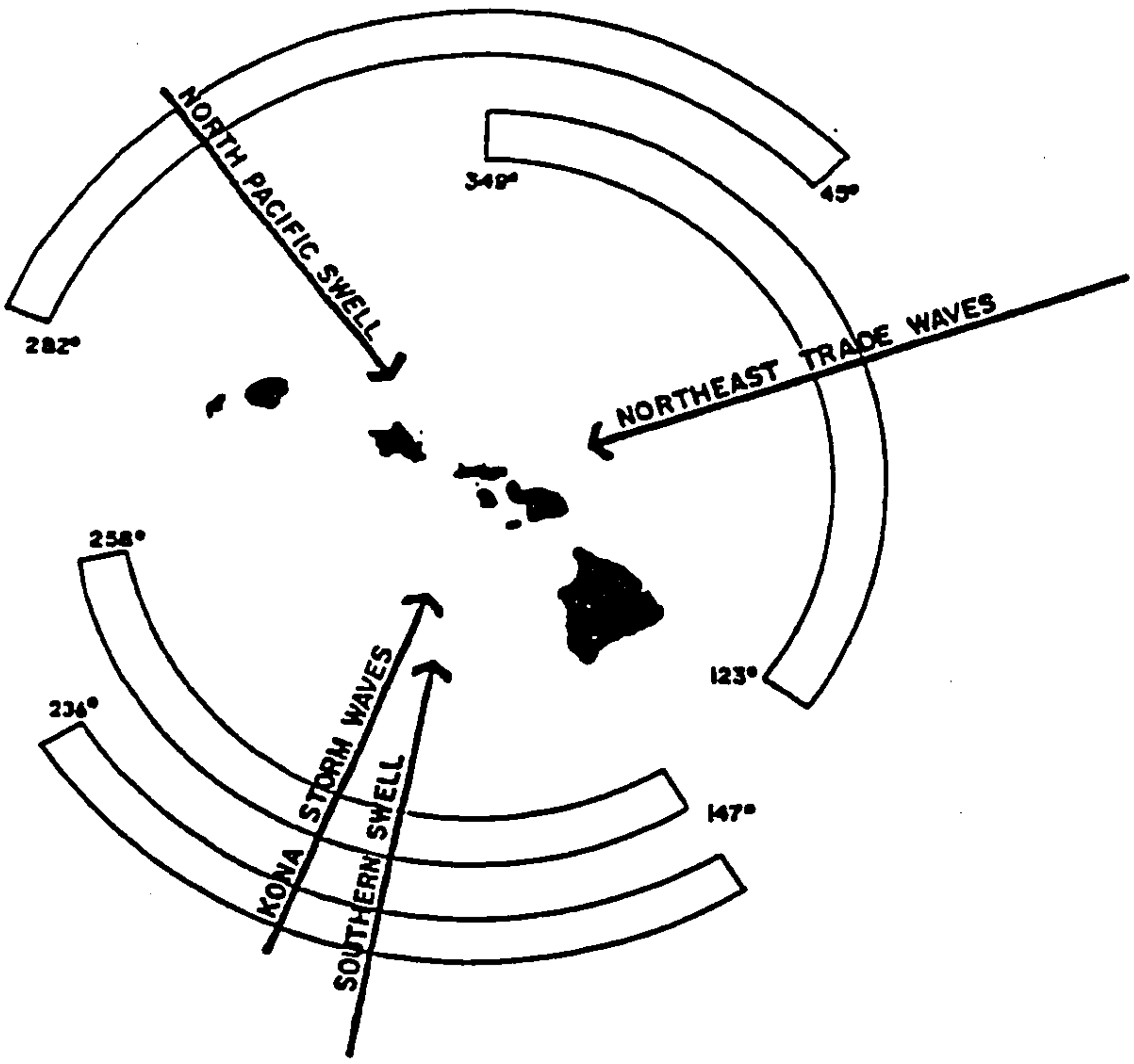

FIGURE 2.

GENERALIZED WAVE TYPES

(Adapted From The Atlas of Hawaii)

Kona storm waves are generated by intense winds associated with local fronts or low pressure systems and typically have periods ranging from 6 to 10 seconds and typical heights up to 10 feet, but during severe storms heights can approach 20 feet. These waves are most common in late winter and early spring, approaching from the south to southwest.

Hurricane Storm Waves

Hurricanes form near the equator, and in the central North Pacific usually move toward the west or northwest. The primary hurricane season is July through September. These tropical storms or hurricanes usually pass south of the Hawaiian Islands, with a northward curvature near the islands. Late season tropical storms and hurricanes follow a somewhat different track, forming south of Hawaii and moving north toward the islands.

There are many recorded tropical storms or hurricanes which have approached the Hawaiian Islands during the past 35 years, and hurricane waves are generally selected as the design criteria for coastal projects. Most of these storms passed well south or west of the islands, or weakened in intensity as they reach Hawaii, but there have been notable exceptions. Hurricanes Hiki, Della, Nina and Fico passed within about 200 miles of the islands, Dot passed over Kauai, and Iwa passed with 30 miles of Kauai. The report Hurricanes in Hawaii (Haraguchi, 1984), prepared for the U.S. Army Corps of Engineers presents hypothetical model hurricanes for the Hawaiian Islands. The model Hawaiian Hurricane is defined as the probable hurricane that will strike the Hawaiian Islands in the future. The characteristics of the model hurricane are based on the characteristics of hurricanes Dot and Iwa. The predicted wave height and period for the model hurricane are calculated to be 31 feet and 12.0 seconds.

This is a worst case scenario; the actual likelihood of this occurring at one particular site is very low. It is more likely that the storm would pass at some distance, thus the wave height at a particular site would depend on the storm track and decay distance over which the waves travel.

TIDES

The tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e. two tidal cycles per day with the range of water levels being unequal). The average daily tidal range is approximately 2 feet, the maximum range is 2.8 feet.

COASTAL CURRENTS

Coastal currents in Hawaii are influenced by several factors: large scale oceanic currents, tidal currents, wind-driven currents, waves, and island topography. Hawaii is located in the region of the Pacific North Equatorial current, which generally flows to the west with north current speeds ranging from 0.1 to 1 knot. The current direction may vary from west southwest to north-northwest, and the average speed is estimated to be approximately 0.5 knots. Eddies may form in this current as it passes through the islands. Large scale eddies may also be caused by wind circulation patterns around the large mountains on the islands, and small scale eddies may be caused by local landforms.

In most nearshore locations in Hawaii, the tidal flow is the primary current component. Tidal currents are reversing and generally follow bathymetric contours. The maximum tidal current speed in most locations is 2 knots, with speeds of 0.3 to 1.0 knot being typical. Surface currents are modified by the prevailing winds. Past studies around Oahu have indicated that the top 5 to 15 feet of the water column is influenced during moderate trade wind conditions.

The circulation at any particular location is due to a combination of the above factors.

TSUNAMIS

Tsunami, or seismic sea waves, are primarily generated by submarine earthquakes and earth movement with magnitudes greater than about 6.5 on the Richter scale. Coastal and submarine landslides and volcanic eruptions can also generate tsunamis. The Hawaiian Islands are directly exposed to the major tsunami wave generating areas in the Pacific Ocean: the Kuril-Kamchatka-Aleutian region of the north and northwestern Pacific, the west coast of South America, and the seismically active southwest Pacific. Over 80 tsunamis have been observed in the Hawaiian Islands since 1813, and 22 of them resulted in significant damage. The most damaging occurred in 1946 when an earthquake in the East Aleutian Islands generated a tsunami which killed 173 people in Hawaii and caused $26 million in property damage in Hilo alone.

Tsunami wave periods vary from 5 minutes to over 1 hour. Tsunami wave heights in the deep ocean are only a foot or two and their passage is generally not noticeable. However, in coastal regions, the tsunami wave may be subject to extensive transformation by the shallow water processes of refraction and shoaling, and also resonance in bays and harbors, and it may result in a much amplified wave height at the shoreline. Procedures have been developed for the U.S. Army Corps of Engineers, Pacific Ocean Division to determine tsunami wave elevations along the coastlines of Hawaii for various frequencies of occurrence (Manual For Determining Tsunami Runup Profiles on Coastal Areas of Hawaii, 1978). Tsunami runup elevations computed for 50 and 100 year tsunamis in the landing site areas are presented in later sections of this report.

III. METHODOLOGY FOR MARINE BIOLOGICAL SURVEYS

GENERAL

The quantitative sampling of macrofauna of marine communities presents a number of problems; many of these are related to the scale on which one wishes to quantitatively enumerate organism abundance. Marine communities in the areas surveyed for this surveyed may be spatially defined in a range on the order of a few hundred square centimeters (such as the community residing in a Pocillopora meandrina coral head) to major biotopes covering many hectares. Recognizing this ecological characteristic, the sampling program was designed to delineate all major communities in the limits of the study areas and to quantitatively describe these communities. Thus a number of methods were used.

To obtain an overall perspective on the extent of the major communities or "zones" occurring in the study area, divers were slowly towed behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. This exercise allowed the qualitative delineation of major biotopes based partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each of these, stations were established and quantitative studies were conducted, including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrats. Besides these quantitative measures, a qualitative reconnaissance was made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments were carried out using SCUBA.

Biotopes are defined by physical characteristics including water depth, relative exposure to wave and current action, and the major structural elements present in benthic communities. The latter include the amount of sand, hard substratum, and vertical relief present as well as the biological attributes of relative coral coverage, fish abundance, and dominant species of the coral community. Biotopes are named for the distinctive features of the zone. It should be noted that the boundaries of each zone are not sharp but rather grade from one to another; these are ecotones or zones of transition.

The locations of stations were subjectively chosen as being representative of a given biotope. Immediately following station selection, a visual census of fishes was undertaken to estimate their abundance. These censuses were conducted over a 4 x 25 meter corridor and all fishes within this area from the bottom to the water surface were counted. Data collected included the number of individuals of each species as well as an estimate of individual lengths of all fishes seen; the length data were later utilized in estimating the standing crop of fishes present at each station using linear regression techniques (Ricker 1975, Brock and Norris 1989). A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 25m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels or puhis (family Muraenidae) and nocturnal species, e.g., squirrelfishes or ala'ihis (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus or rockfishes, family Scorpaenidae; the flat fishes or paki'is, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any com- parisons between surveys. In the present study, one individual carried out all of the visual censuses. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2cm in some dimension (without disturbing the substratum) were censured in a 4 x 25m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some sea urchins and sea cucumbers). Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censuring technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae were quantitatively surveyed by use of quadrats and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points were assessed (once every 50cm). These data have been converted to percentages. Quadrat sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in six one-meter square frames placed at five-meter intervals along the transect line established for fish censuring (at 0, 5, 10, 15, 20 and 25m).

If macrothalloid algae were encountered in the 1 x 1m quadrats or under one of the 50 points, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats.

During the course of the fieldwork notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near to the study area. With green turtles, efforts were made to record the size (straight line carapace length) of the individuals seen as well as the presence of tags, tumors or any deformities. We also attempted to note the presence of appropriate resting and foraging areas for green turtles.

IV. WAILUA GOLF COURSE, KAUAI

ALTERNATIVES CONSIDERED

Areas considered for a fiber optic cable landing site extended from Nawiliwili Harbor to Wailua Bay, a distance of approximately 8 miles. Figure IV-1 shows this coastal sector.

Nawiliwili Harbor was eliminated from consideration during the initial office study, because of the potential threat to cable integrity from commercial shipping activity and the periodic maintenance dredging of the harbor entrance channel.

The selected landing site is located off the Wailua Golf Course, and is described in detail later in this report. Other areas investigated but not selected are discussed below.

The 12,000 foot long coastline south of Hanamaulu Bay and the Ahukini Recreation Pier State Park was investigated during the first field reconnaissance. The inshore bottom consists of limestone rock and coral, and is very irregular, with depressions, ledges and surge channels. A very steep ledge was located approximately 3500 feet offshore. This ledge would present a serious obstacle to placement of a cable. The top of the ledge was at 60 feet and the bottom at 150 feet. An additional drawback was a high steep bank at the shoreline which would make equipment access difficult for the shore landing. This site was eliminated from further consideration due to the unfavorable physical conditions.

Hanamaulu Bay offers marginal conditions for a cable landing. An offshore sand channel extends partially into the bay, but to take advantage of the channel the cable would have to approach the shoreline obliquely from the east-northeast. This would require crossing 500 feet of hard bottom near shore and an undetermined length of hard bottom beyond the breakwater. The shape of the sand channel is irregular, and the route might also cross hard bottom in the vicinity of the breakwater tip. The site was not investigated in enough detail to determine whether or not the ledge at the 60 foot depth could be avoided. This site was dropped from consideration due to the marginal offshore conditions and on-land constraints.

There is a pronounced sand channel in Wailua Bay, connecting the sandy beach with an extensive offshore sand deposit. The south side of the channel was checked during the site visit, and the sand appeared to be thick and bounded by limestone and reef outcrops. The sand channel is slightly undulating, and the north side would have to be carefully mapped to ensure that a cable could be aligned in the channel. The main disadvantage of this site is the distance to the 60 foot contour, which is located approximately 5000 feet offshore. Other disadvantages include the potential instability of the beach during flooding of the Wailua River, and the potential archaeological sensitivity of the sand dunes along the backshore.

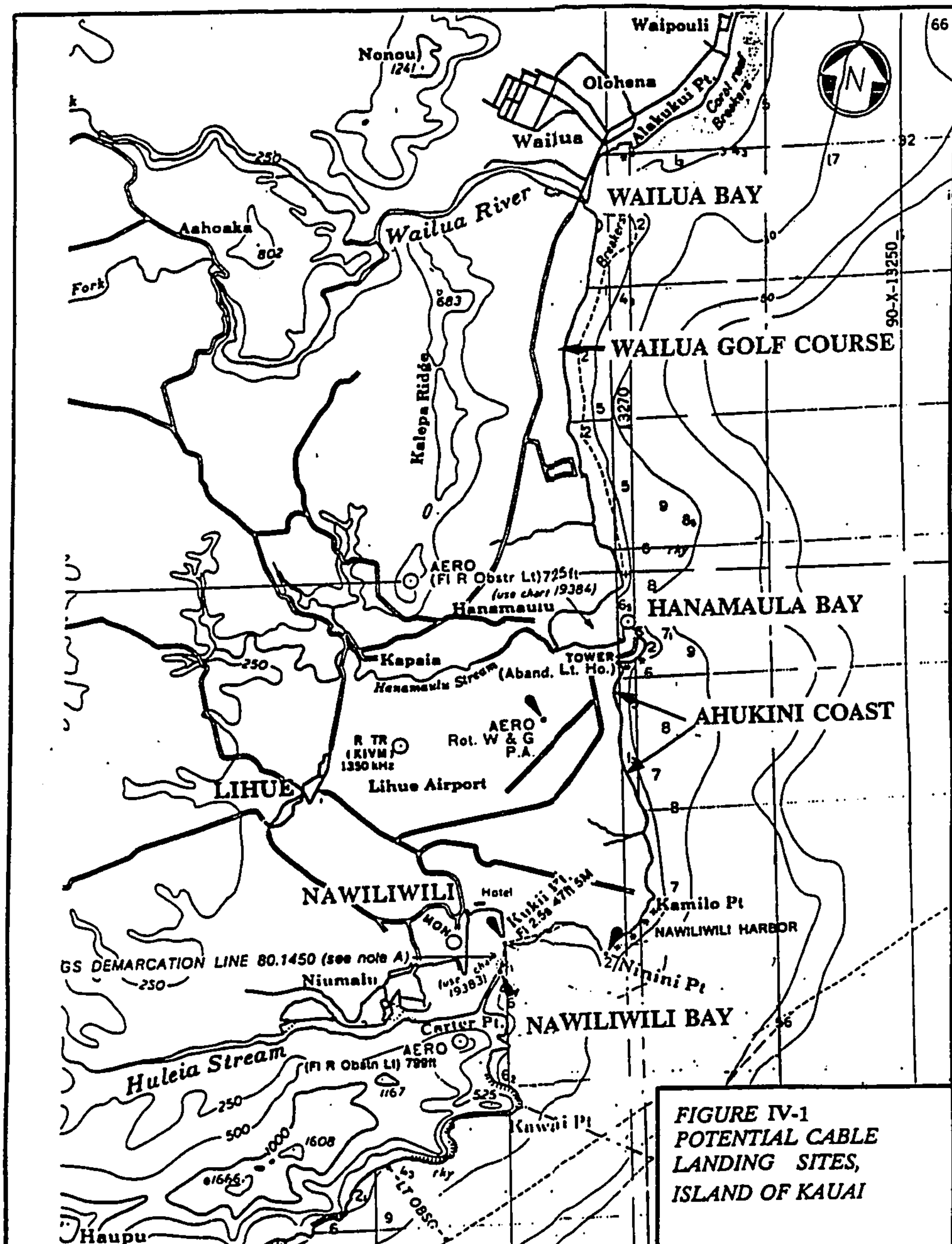

FIGURE IV-1
POTENTIAL CABLE LANDING SITES, ISLAND OF KAUAI

DESCRIPTION OF THE SELECTED ROUTE

General Description: The Wailua Golf Course landing site is located adjacent to the Wailua Golf Course along the east coast of Kauai. A 14,000 foot long narrow sand beach extends from the Kauai Hilton to the Wailua River. The sector fronting the golf course is part of this beach. A 500 foot wide fringing reef is almost continuous off the southern part of the beach, but becomes intermittent off the golf course.

Shoreline History: The beach along the southern half of the golf course has undergone significant erosion in the last 40 years. The vegetation line has eroded over 50 feet since 1950 along segments of the beach. A 3500 foot long revetment was constructed between 1987 and 1988 to protect this portion of the golf course. The beach area in front of the club house has been relatively stable, while to the north the beach has accreted up to 60 feet since 1950.

Existing Usage: The Wailua Golf Course occupies the backshore of the entire landing site area. Two fairways and a green are located along the vegetation line; in the remaining areas, the golf course is set inland, and there is a band of trees and shrubs between the golf course and the vegetation line. Nukolii Beach Park is located to the south of the golf course, and Lydgate State Park is located to the north. The beach is relatively narrow, and the nearshore bottom is shallow. The beach is used for recreation. Turbulence created by waves breaking on the wide reef reduces water visibility in this area. Spearfishing, however, is popular at the seaward edge of the reef while gillnet fishermen, thrownet fisherman, and seaweed harvesters frequent shallower portions of the reef.

Physical Characteristics of the Selected Route

There are several small sand deposits on the reef flat off the central and north parts of the golf course, but most terminate on hard bottom or the 60-foot ledge, which parallels much of the windward coast off Kauai. The recommended route is located in the only sand channel found that bisects the ledge and the reef and extends into deeper water. The bottom is sand from the shoreline to at least the 120-foot depth, the seaward limit of the visual inspection. There is hard bottom, with the typical 60 foot ledge, both north and south of this sand channel. The 60-foot depth contour is located 2200 feet from shore. From that point seaward, the bottom slope becomes steeper, and the 110 foot depth contour is located only 2600 feet offshore. The sand deposit was not probed, but it appears to be thick. The sand is medium to coarse grained, with pronounced sand waves in shallow water, due to wave action. There are no visible outcrops of coral or rock along the route.

OCEANOGRAPHIC CONDITIONS

This landing site is on the windward side of the island, and is directly exposed to the prevailing tradewinds and the tradewind generated waves. The tradewind waves occur throughout the year, but are most consistent between April and September. Typical heights range from 4 to 10 feet, and periods from 5 to 8 seconds. During northeast gales wave heights of up to 25 feet can occur. Both south swell and north Pacific swell could refract into this area, but tradewind waves are the predominant source of wave energy.

There is a wide breaker zone along this coast. At the site of the proposed route, the 20 foot contour is 1400 feet offshore, and during moderate to strong trade winds, the breaker zone extends out to this depth. On the first day of the R.M. Towill hydrographic survey of this site, the 30-foot survey vessel could not proceed inshore of the 20 foot contour due to the shoaling waves.

Currents along the Kapaa-Wailua coast are dominated by the tidal flow, and generally are oscillatory; flood currents flow to the south, and ebb currents flow to the north. The currents tend to parallel the coastline or bottom contours. Studies conducted by Sunn, Low, Tom, and Hara, Inc. (1972) indicated that currents in the waters off the golf course were weaker than those in the Kapaa area, and did not correlate as consistently with the tide stage. Currents were predominantly to the south, with inconsistent flow to the north during ebb tide.

The waters along this stretch of coastline are classified "A" in State Department of Health water quality regulations.

The estimated 50 and 100 year tsunami elevations for this coast are 7.2 and 10.5 feet above mean sea level.

DESCRIPTION OF THE PROPOSED PROJECT

Construction and diving activities related to the cable landing should be relatively straightforward, given the very favorable physical characteristics of the selected route. Preparing the shoreline and backshore area will be the most significant work item. A portion of the existing revetment will have to be removed. As this revetment is at or above the normal high tide reach of the waves, there should be little or no turbidity generated at this stage of the work. A trench to receive the cable will also have to be cut across the beach. Depending upon the depth of excavation, temporary sheetpiling may or may not be used to stabilize the trench sides. It is anticipated that a sand "dam" will be left in place at the seaward end of the trench to prevent the generation of turbidity in the nearshore waters. Duration of this preliminary work should not exceed two weeks.

The cable ship should be able to approach to about the 50 foot water depth, or approximately 2500 feet from shore. After the cable is pulled to shore and secured, the floats will be cut by divers, and the cable will sink to the bottom. The sand "dam" at the shoreline will then be excavated or the cable will be waterjetted down to the desired elevation. The sheetpile will then be removed and the beach restored to its natural condition. The revetment will also be reconstructed.

No offshore protection, anchoring or trenching is anticipated.

MARINE BIOLOGICAL SETTING

The qualitative reconnaissance of the waters fronting the Wailua County Golf Course was carried out in June 1991. Because the substratum of the entire corridor was found to be sand, no quantitative sampling of the marine communities was carried out at this site. The qualitative survey extended from shore to about the 100 foot isobath approximately 2,800 feet from shore. In this area only one zone or biotope was defined, the biotope of sand.

The Biotope of Sand

The biotope of sand lies covers the entire project site. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Other species will swim above the substratum (e.g., fish) to avoid abrasion. Thus many species in the sand biotope are either cryptic and difficult to see or will just pass through sand environments well off the bottom; among the cryptic species are many of the molluscs and crustaceans such as the Kona crab (Ranina serrata). Hence, without considerable time spent searching, many species in the sand habitat will not be seen. The fauna of the biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant.

Benthic communities on sand substrates usually have their greatest development at depths below which wave impact occurs (below 100 feet). Because of constraints with bottom time at these depths and the general lack of meaningful results from quantitative surveys in shallower water over sand, only a qualitative survey was done. Species commonly seen in the deeper regions of the biotope of sand include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), the Kona crab (Rania serrata), opelu or mackerel scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), uku or snapper (Aprion virescens), hihimanu or sting ray (Dasyatis hawaiiensis) and the weke or white goatfish (Mulloides flavolineatus). In our qualitative reconnaissance, the only species seen in water of less than

30 feet in depth was a school of newly settled juvenile gobies of a species not determined. These fishes were transparent with only the eyes apparent and were about 18-20mm in length. These fishes were seen at a depth of about 8 feet near the shoreline of the proposed cable site. Undoubtedly, with greater searching, many more fish species would be encountered in this biotope. Most of these species become less evident in the shallower portions of this biotope.

The intertidal region at this proposed cable landing site is sand; a short inspection of the beach noted ghost crab holes (Ocypode ceratophthalma) and several sand crabs (Emerita pacifica).

No green turtles (Chelonia mydas) were seen during our survey work in the waters fronting the Wailua County Golf Course. Additionally, we found no macroalgae in the vicinity of the cable alignment or shelter that may be appropriate as green turtle resting sites. The lack of these components is due to a lack of hard substratum. We have found no information to suggest that nesting of sea turtles in the vicinity of the Wailua County Golf Course has occurred in historical times.

The biological survey of the proposed cable alignment at offshore of Wailua County Golf Course did not find any rare or unusual species or communities. Another protected species, the humpback whale (Megaptera novaeangliae), was not seen offshore of the study area during the period of our field effort, but whales are known to be seasonally present along the windward coast of Kauai.

POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts with Construction

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment passes through the biotope of sand prior to landfall. As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom (e.g.,corals and many of the associated invertebrates). Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever-changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur in low abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since many of these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will "sink into" the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

It is expected that the cable will be buried in the sand at the shoreline. This will probably entail a combination of trenching across the backshore of the beach and water jetting the cable to grade in the vicinity of the waterline. This will temporarily generate some level of turbidity that could impact hard substratum communities if in close proximity to the proposed project site. However, we are not aware of any well developed hard bottom communities close to the proposed cable alignment.

With any construction is the concern over possible impact to corals due to their sessile nature and usual slow growth characteristics. Because there is no hard substratum in the alignment path (or near it) in shallow water, we do not expect that corals will be directly impacted by this activity. Additionally, the small scale of this project suggests that the turbidity levels generated will be considerable less than the those caused by two natural occurrences: 1) turbidity input from the Wailua River that empties into the ocean about 7,000 feet to the north, particularly following heavy rainfall, and 2) turbidity due to resuspension of sand in the Wailua area due to the frequently rough sea conditions. The episodic input of stormwater runoff has probably been an important parameter in structuring benthic communities in this area; this coupled with storm surf and the movement of sand that scours the bottom will retard benthic community development.

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales (Megaptera novaeangliae). As far as the impact to humpback whales is concerned, if construction activities are restricted to the period between April through October, there would be no impacts because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when the whales are present in Hawaiian waters, it is anticipated that the impacts would be minimal. The cable laying ship should not be on site more than one or two days. The most probable source of impact to whales would be noise generation by the cable ship, the support tugs and the small boats used for the cable landing. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981; Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if extensive turbidity is generated and if turtles are present in the area. However, the generation of fine particulate material from dredging did not appear to hinder the green turtle in one Hawaiian study; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about one 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Fishery Considerations

Fishermen and other beach users have lateral access to the shoreline fronting the Wailua County Golf Course. This section of coastline has probably been used since prehistoric times. Although we did not see anyone using this beach during the period of our sampling, it is probable that fishermen fish this area both from shore as well as offshore from small boats. Some commercial fishing may occur offshore of the proposed cable alignment. We are unaware of any individuals that specifically and exclusively use the beach fronting the Wailua County Golf Course for subsistence fisheries. Probably most of the fishing activity in and around this beach is by recreational fishermen.

With most Hawaiian recreational fisheries, species targeted include papio and ulua (family Carangidae), o'io or bonefish (Abula vulpes), moi (Polydactylus sexfilis), goatfishes (family Mullidae), snappers (family Lutjanidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and a host of smaller species such as the aholehole (Kuhlia sandvicensis), aweoweo (Priacanthus cruentatus) and menpachi (Myripristes amaenus). Fishing methods used include nets, spears, traps as well as hook and line.

The qualitative reconnaissance did not note any fishes of commercial or recreational interest at depths less than 30 feet. This is probably related to the lack of hard bottom and shelter in the vicinity of the proposed cable alignment. However, many of the species noted above are frequently caught in sand bottom areas as they wander through in search of prey; in many instances encounters with these fishes over sand bottom may be considered a random or chance event.

The standing crop of fishes on coral reefs is usually in the range from less than 2 to about 200g/m^2 (Brock 1954, Goldman and Talbot 1975, Brock et al. 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, or to chance encounters, the variation in standing crop appears to be related to the variation in local topographical complexity of the substratum. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fish (>2 to 20g/m^2). Goldman and Talbot (1975) note that the upper limit to fish biomass on coral reefs is about 200g/m^2. Thus the few fishes encountered in this qualitative reconnaissance of the sand flats fronting the Wailua County Golf Course is not unexpected.

Water Quality Considerations

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This may occur through natural events such as storm surf resuspending fine material that had previously come into the area through natural events and settled, or by human activities including the directing of storm water runoff into the ocean or by underwater/shore line construction activities. These activities will generate fine particulate material that could impact corals. The generation of fine sedimentary material could have a negative impact to corals and other benthic forms if it occurs in sufficient quantity over sufficient time. Studies (e.g., Dollar and Grigg 1981) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the trenching activities that would be necessary to protect the cable across the sand beach at Wailua would probably produce little sediment. The small scale and anticipated short duration of the project suggest a minimal impact. High water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats thus assisting in the advection of this material out of these areas (less than 300 feet in depth) where corals are found.

The lack of hard substratum has precluded the development of the usual coral reef communities in the vicinity of the proposed cable alignment. The input of considerable freshwater and occasional sediment via storm runoff from the nearby Wailua River has played a role in the local development of benthic communities. Occasional high surf coupled with the movement of sand will scour adjacent hard substratum retarding benthic community development. Nowhere in the vicinity of the proposed cable alignment were any diverse benthic communities noted and this is probably related to the above factors. The proposed cable alignment was selected to avoid hard substratum thus the deployment of the cable on this alignment should not result in any significant impact to marine communities.

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APPENDIX B

Marine Environmental Analysis of Selected Landing Sites Kahe Point Beach Park, Oahu

IV. KAHE POINT BEACH PARK, OAHU

ALTERNATIVES CONSIDERED

The coastal sector considered for a potential landing site initially extended from Pokai Bay to the Barbers Point Naval Air Station, a distance of approximately 14 miles. The coastline south of Kahe Point was excluded from further consideration during the office study due to extensive resort, commercial shipping, industrial and military use. Activities include a major resort development, a deep draft harbor, and offshore oil moorings and associated underwater pipelines. This existing usage precludes a cable landing anywhere along the coastline between Kahe Point and Ewa Beach.

Figure IV-1 shows the coastline from Barbers Point Harbor to Pokai Bay, along with the known sand deposits and existing uses of the area. In general, the offshore use of even this section of coastline is surprisingly heavy. Existing facilities which limit the selection of cable route areas include cooling water intakes and discharges for the Kahe Generating Station, a U.S. Navy underwater test range, an ocean outfall for domestic sewage, and a small boat harbor. Kahe Point was the selected site and is described in detail in the following sections of this report. The other candidate sites investigated during the field and office studies are described below.

1. Nanakuli Beach: Nanakuli Beach Park offers ideal conditions for a cable landing, with a sand channel extending from the beach out to an extensive offshore deposit. The bottom is sand out to at least the 100 foot depth. There are some scattered coral formations at the 50 to 60 foot depth, but they are not extensive, and a cable route could be selected which misses the coral. The U.S. Navy, however, operates a submarine test range (FORACS Range) in the area. One of the receiving towers is located at the south end of Nanakuli Beach, and several subsea cables connect the tower to a series of underwater hydrophones. Discussions with the range manager indicated that the Navy would not permit placement of a cable across their existing cables, due to their requirements for cable maintenance and possible expansion of the range. An incoming fiber optic cable would cross most, if not all, of the hydrophone cables. This site was therefore eliminated from further consideration.

2. Ulehawa Beach Park: A sand channel off the beach park corresponds to the mouth of Ulehawa Stream (see Figure IV-1). Inshore the sand channel is winding and irregular, with a typical width of 150 to 200 feet. The sand channel terminates approximately 300 feet offshore. The bottom between the inshore limit of the sand channel and the beach is scoured limestone shelf, with pronounced surge channels and ridges. The irregularity of the bottom in this zone increases with distance toward shore. Because of the bottom conditions and the shape of the sand channel, cable protection would probably be required out to the 40 foot water depth, 2000 feet offshore. At this point, the channel opens into a large sand deposit. The area just off the beach would present a particular problem due to the vertical relief, and fairly

GTE Hawaiian Tel
Interisland Fiber Optic Cable System

MARINE ENVIRONMENTAL ANALYSIS OF SELECTED LANDING SITES

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I. INTRODUCTION

GENERAL

GTE Hawaiian Tel is planning the installation of an Interisland Fiber Optic Cable System linking the islands of Kauai, Oahu, Maui and Hawaii. The site selection and evaluation process has been underway since early 1991, and Sea Engineering, Inc. has been retained over that period by the R.M. Towill Corporation to evaluate the marine considerations for potential landing sites and to assist in the preparation of the Environmental Assessments for the recommended landing sites. Dr. Richard Brock of the Environmental Assessment Company, a subconsultant to Sea Engineering, Inc., was responsible for characterizing the nearshore marine biological conditions along the cable routes and also assisted with the impact evaluation.

This report describes the nearshore marine selection process, the alternatives considered, the physical and biological characteristics of the nearshore cable routes, and the anticipated marine environmental impacts.

Figure I-1 shows the interisland cable configuration and the recommended landing sites.

ROUTE SELECTION PROCESS

This report describes only the nearshore marine considerations of the selection process. Other considerations included land suitability, deep ocean conditions, public usage and terrestrial and marine impacts. A series of two Working Papers, prepared by the R.M. Towill Corporation (1991), describe in detail the overall selection process, the alternatives considered, and the rationale for the recommended routes.

The coastal sector boundaries for the potential cable landing sites were initially defined by two primary constraints:

1. The total cable length between central offices was limited to a maximum of 200 kilometers, and preferably to less than 185 km. Cable lengths over 200 km would require an expensive subsea repeater.

2. Proximity of the cable landing site to a central office was desirable, along with relatively easy access to the central office via available pole lines, duct lines, or other GTE infrastructure.

Given these constraints, sectors of coastline were delineated which bounded the potential landing areas. An office evaluation of each coastal sector was then completed, utilizing existing literature, color aerial photographs, marine charts, coastal inventories prepared by state and Federal agencies, and personal knowledge of nearshore physical and biological

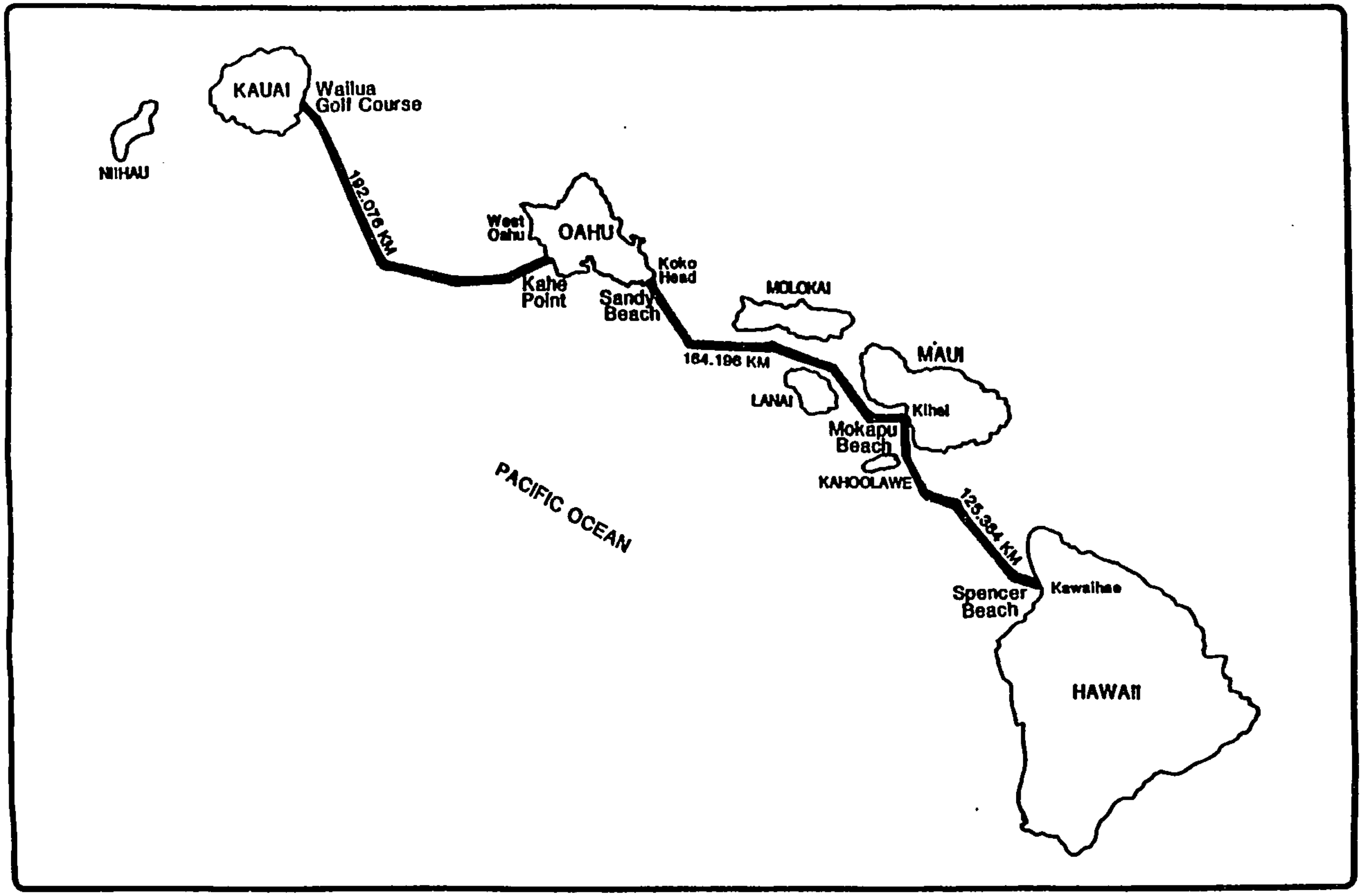


FIGURE I-1. SUMMARY OF RECOMMENDED GTE HAWAIIAN TEL FIBER OPTIC LANDING SITES – STATE OF HAWAII

characteristics and uses. A one day field reconnaissance was then conducted in each sector to select three potential landing sites in each sector. If no suitable sites were found within the sector limits, the sector was enlarged as required.

Following the consolidation of all planning considerations mentioned above (terrestrial and marine) a more detailed field study was conducted at each site by an ocean engineer and marine biologist. The objective of this phase was to select the primary and secondary route alternatives.The marine biologist was incorporated into this phase of the study to conduct a preliminary assessment of the selected alternatives and to ensure that there were no overriding environmental constraints.

After initial approval by the client of the recommended route, a detailed bathymetric survey was conducted at each site. During this survey, while accurate positioning equipment was available, a diver was towed along the route centerline, and his visual observations were correlated with the track line and the water depth. This step provided valuable information about the precise conditions along the route, and also ensured that there were no unexpected conditions in the nearshore area.

One additional field trip was made to each site, for the express purpose of describing the physical and biological characteristics of the route and adjacent areas, and to evaluate the potential environmental impacts.

The limit of the diving surveys was the 100 foot depth contour. However, the diving support vessels were equipped with fathometers, and track lines were run to the 180 foot depth to ensure that no steep ledges were encountered beyond the limit of the visual survey.

MARINE SELECTION CRITERIA FOR NEARSHORE CABLE ROUTE EVALUATION

Throughout the cable route selection and evaluation process the primary objective was to find a suitable, safe cable route which would also result in the minimum environmental impacts possible in that sector.

Specific selection criteria included the following:

1. Sandy bottoms and coastlines were preferred, both for integrity of the cable and to minimize environmental impacts. Experience at other cable landing sites on Oahu (Makua Beach, Makaha Beach and Nanakuli Beach) indicates that cables on sandy bottoms tend to sink into the sand. No cable cross section is exposed, and wave forces on the cables are therefore minimal. In most of these areas, the winter surf and shorebreak can be very large, yet the numerous cables making landfall there have remained stable.

   Hawaii beaches are usually in a dynamic balance with a large offshore sand deposit, and the two are frequently linked by a continuous sand channel, thus providing the ideal configuration for a cable route. In addition to the engineering advantages, the environmental effects of a placing a cable on a sandy bottom are much less than placing one across a diverse coral community.

2. Minimizing the horizontal distance from the shoreline to the 60 foot depth was another important factor. This is the zone of maximum wave forces, and the assumption was made that some form of cable protection or anchoring would be required when crossing any hard bottom inshore of the 60 foot contour. This distance is also an important factor in the cable landing process. The cable ship can approach shore to approximately the 50 or 60 foot depth, where it is then held in place by tugs. As the cable is towed to shore by a small boat or tug, floats are attached to the cable as it is paid out, so that it floats on the surface until the shore connection is secured. During this time, the cable position must be maintained along the route centerline. Strong currents or long distances make this process more difficult. The goal was to select a route where the distance from shore to the 60 foot contour was less than 4000 feet.

3. There is a semi-continuous ledge which drops off from the 60 foot contour, and extends through many of the coastal sectors of Hawaii. This ledge was formed during an ancient stand of the sea, and typically has a vertical drop of 30 feet or more. This ledge was present in the Kauai sector, both Oahu sectors and the Maui sector. It was therefore important to find a route which either avoided the ledge or passed through a channel in the ledge. Fortunately, the sand channels connecting the beaches to the deeper offshore deposits often bisect the ledge.

4. Routes were selected to avoid, to the maximum extent possible, environmentally sensitive areas or areas frequented by rare or endangered species. A specific example was the avoidance of areas used by green sea turtles for resting or forage. The marine biological consultant was an early participant in the study, so that environmental input was received during the initial route evaluations.

II. GENERAL OCEANOGRAPHIC CHARACTERISTICS

WINDS

The predominant winds in the Hawaiian Islands are the northeast trades, which are present approximately 70 percent of the time with an average speed of 13 mph. The frequency of tradewinds varies greatly with the season. They occur 90-percent of the time during the months of April to October. The winter season (November to March) is defined by a weakening of the high pressure system generating the tradewinds, and the frequency of occurrence decreases to approximately 50-percent. During the winter season, low pressure systems periodically displace the tradewinds, resulting in south or southwest winds known as "Kona" winds. Kona winds, which occur rarely in summer and 17-percent of the time in the winter, range from light and variable to gale or hurricane force.

PREVAILING WAVE CLIMATE

The general Hawaiian wave climate can be described by four primary wave types; the northeast tradewind waves, south swell, North Pacific swell and kona storm waves. These wave types and their general approach direction are shown on Figure II-2.

Tradewind waves may be present in Hawaiian waters throughout the year, but are most frequent in the summer season, between April and September, when they usually dominate the Hawaiian wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Typical deepwater tradewind waves have periods of 5 to 8 seconds and heights of 4 to 10 feet. During gale conditions tradewind waves may reach heights in excess of 20 feet.

South swell is generated by southern hemisphere storms, and is most prevalent during the months of April through October. These long, low waves approach from the southeast through southwest, with typical periods of 12 to 20 seconds and deepwater heights of 1 to 4 feet. Although their deepwater height is relatively low, the long period results in considerable shoaling near shore with resultant large breaker heights. The surf along the exposed south shores of the islands occasionally reaches heights of 15 feet.

North Pacific swell is produced by winter storms in the North Pacific Ocean and by mid-latitude low pressure areas. North swell may arrive in the Hawaiian Islands throughout the year, but is largest and most frequent during the winter months of October through March. North Pacific swell typically has periods of 12 to 20 seconds and deepwater heights of 5 to 15 feet. The approach direction is typically from the west-northwest through north-northeast. North Pacific swell results in some of the largest waves in Hawaiian waters.For example, breaking wave heights approaching 50 feet were observed in December 1969.

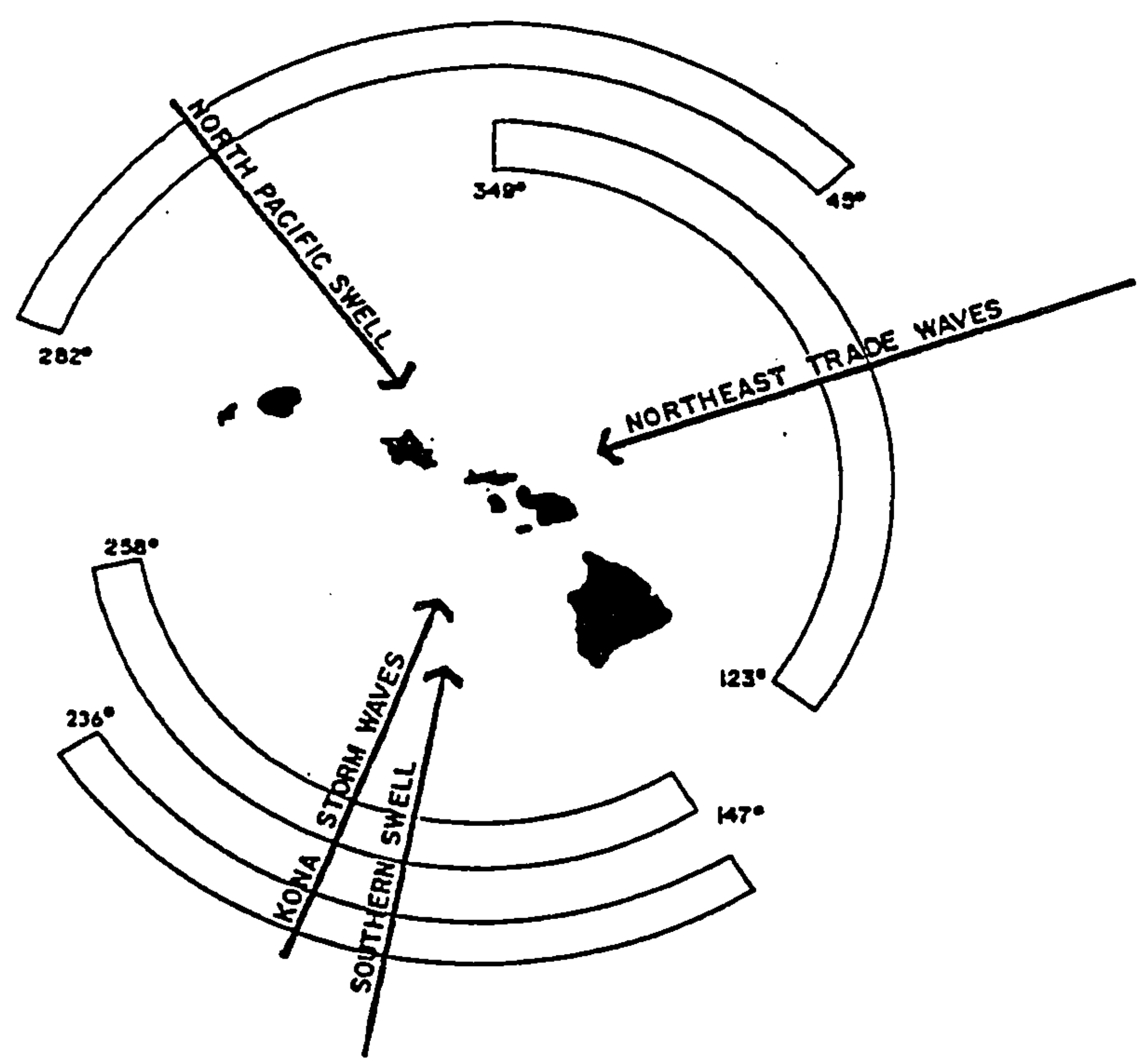


FIGURE II-1.
GENERALIZED WAVE TYPES
(Adapted From The Atlas of Hawaii)

Kona storm waves are generated by intense winds associated with local fronts or low pressure systems and typically have periods ranging from 6 to 10 seconds and typical heights up to 10 feet, but during severe storms heights can approach 20 feet. These waves are most common in late winter and early spring, approaching from the south to southwest.

Hurricane Storm Waves

Hurricanes form near the equator, and in the central North Pacific usually move toward the west or northwest. The primary hurricane season is July through September. These tropical storms or hurricanes usually pass south of the Hawaiian Islands, with a northward curvature near the islands. Late season tropical storms and hurricanes follow a somewhat different track, forming south of Hawaii and moving north toward the islands.

There are many recorded tropical storms or hurricanes which have approached the Hawaiian Islands during the past 35 years, and hurricane waves are generally selected as the design criteria for coastal projects. Most of these storms passed well south or west of the islands, or weakened in intensity as they reach Hawaii, but there have been notable exceptions. Hurricanes Hiki, Della, Nina and Fico passed within about 200 miles of the islands, Dot passed over Kauai, and Iwa passed with 30 miles of Kauai.
The report Hurricanes in Hawaii (Haraguchi, 1984), prepared for the U.S. Army Corps of Engineers presents hypothetical model hurricanes for the Hawaiian Islands. The model Hawaiian Hurricane is defined as the probable hurricane that will strike the Hawaiian Islands in the future. The characteristics of the model hurricane are based on the characteristics of hurricanes Dot and Iwa. The predicted wave height and period for the model hurricane are calculated to be 31 feet and 12.0 seconds.

This is a worst case scenario; the actual likelihood of this occurring at one particular site is very low. It is more likely that the storm would pass at some distance, thus the wave height at a particular site would depend on the storm track and decay distance over which the waves travel.

TIDES

The tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e. two tidal cycles per day with the range of water levels being unequal). The average daily tidal range is approximately 2 feet, the maximum range is 2.8 feet.

COASTAL CURRENTS

Coastal currents in Hawaii are influenced by several factors: large scale oceanic currents, tidal currents, wind-driven currents, waves, and island topography. Hawaii is located in the region of the Pacific North Equatorial current, which generally flows to the west with north current speeds ranging from 0.1 to 1 knot. The current direction may vary from west southwest to north-northwest, and the average speed is estimated to be approximately 0.5 knots. Eddies may form in this current as it passes through the islands. Large scale eddies may also be caused by wind circulation patterns around the large mountains on the islands, and small scale eddies may be caused by local landforms.

In most nearshore locations in Hawaii, the tidal flow is the primary current component. Tidal currents are reversing and generally follow bathymetric contours. The maximum tidal current speed in most locations is 2 knots, with speeds of 0.3 to 1.0 knot being typical. Surface currents are modified by the prevailing winds. Past studies around Oahu have indicated that the top 5 to 15 feet of the water column is influenced during moderate trade wind conditions.

The circulation at any particular location is due to a combination of the above factors.

TSUNAMIS

Tsunami, or seismic sea waves, are primarily generated by submarine earthquakes and earth movement with magnitudes greater than about 6.5 on the Richter scale. Coastal and submarine landslides and volcanic eruptions can also generate tsunamis. The Hawaiian Islands are directly exposed to the major tsunami wave generating areas in the Pacific Ocean: the Kuril-Kamchatka-Aleutian region of the north and northwestern Pacific, the west coast of South America, and the seismically active southwest Pacific. Over 80 tsunamis have been observed in the Hawaiian Islands since 1813, and 22 of them resulted in significant damage. The most damaging occurred in 1946 when an earthquake in the East Aleutian Islands generated a tsunami which killed 173 people in Hawaii and caused $26 million in property damage in Hilo alone.

Tsunami wave periods vary from 5 minutes to over 1 hour. Tsunami wave heights in the deep ocean are only a foot or two and their passage is generally not noticeable. However, in coastal regions, the tsunami wave may be subject to extensive transformation by the shallow water processes of refraction and shoaling, and also resonance in bays and harbors, and it may result in a much amplified wave height at the shoreline. Procedures have been developed for the U.S. Army Corps of Engineers, Pacific Ocean Division to determine tsunami wave elevations along the coastlines of Hawaii for various frequencies of occurrence (Manual For Determining Tsunami Runup Profiles on Coastal Areas of Hawaii, 1978). Tsunami runup elevations computed for 50 and 100 year tsunamis in the landing site areas are presented in later sections of this report.

III. METHODOLOGY FOR MARINE BIOLOGICAL SURVEYS

GENERAL

The quantitative sampling of macrofauna of marine communities presents a number of problems; many of these are related to the scale on which one wishes to quantitatively enumerate organism abundance. Marine communities in the areas surveyed for this surveyed may be spatially defined in a range on the order of a few hundred square centimeters (such as the community residing in a Pocillopora meandrina coral head) to major biotopes covering many hectares. Recognizing this ecological characteristic, the sampling program was designed to delineate all major communities in the limits of the study areas and to quantitatively describe these communities. Thus a number of methods were used.

To obtain an overall perspective on the extent of the major communities or "zones" occurring in the study area, divers were slowly towed behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. This exercise allowed the qualitative delineation of major biotopes based partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each of these, stations were established and quantitative studies were conducted, including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrants. Besides these quantitative measures, a qualitative reconnaissance was made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments were carried out using SCUBA.

Biotopes are defined by physical characteristics including water depth, relative exposure to wave and current action, and the major structural elements present in benthic communities. The latter include the amount of sand, hard substratum, and vertical relief present as well as the biological attributes of relative coral coverage, fish abundance, and dominant species of the coral community. Biotopes are named for the distinctive features of the zone. It should be noted that the boundaries of each zone are not sharp but rather grade from one to another; these are ecotones or zones of transition.

The locations of stations were subjectively chosen as being representative of a given biotope. Immediately following station selection, a visual census of fishes was undertaken to estimate their abundance. These censuses were conducted over a 4 x 25 meter corridor and all fishes within this area from the bottom to the water surface were counted. Data collected included the number of individuals of each species as well as an estimate of individual lengths of all fishes seen; the length data were later utilized in estimating the standing crop of fishes present at each station using linear regression techniques (Ricker 1975, Brock and Norris 1989). A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 25m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

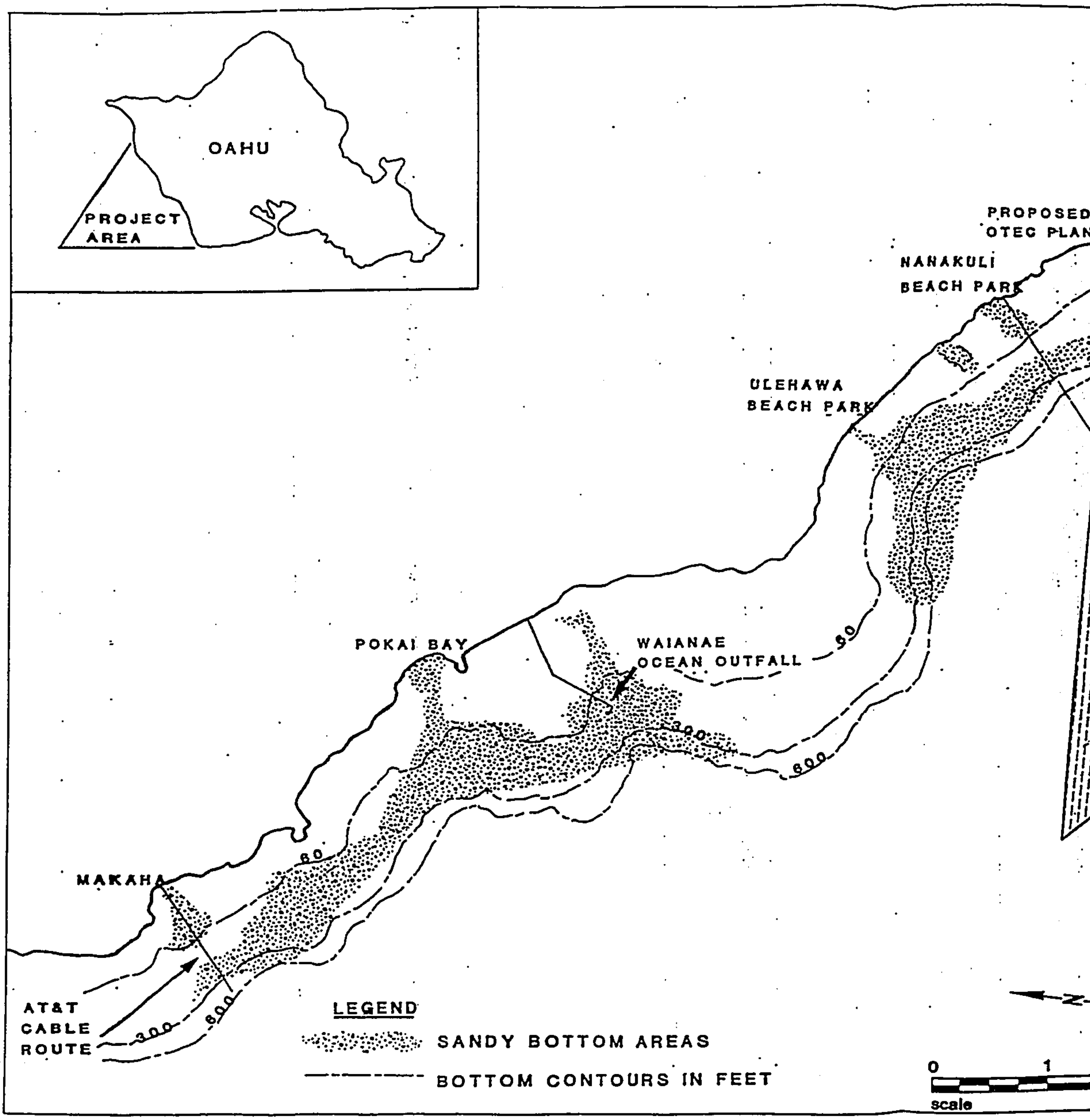
Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels or puhis (family Muraenidae) and nocturnal species, e.g., squirrelfishes or ala'ihis (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., *the nohus or rockfishes, family* Scorpaenidae; the flat fishes or paki'is, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparisons between surveys. In the present study, one individual carried out all of the visual censuses. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2cm in some dimension (without disturbing the substratum) were censured in a 4 x 25m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some sea urchins and sea cucumbers). Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censuring technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae were quantitatively surveyed by use of quadrants and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points were assessed (once every 50cm). These data have been converted to percentages. Quadrant sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in six one-meter square frames placed at five-meter intervals along the transect line established for fish censuring (at 0, 5, 10, 15, 20 and 25m).

If macrothalloid algae were encountered in the 1 x 1m quadrants or under one of the 50 points, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats.

During the course of the fieldwork notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near to the study area. With green turtles, efforts were made to record the size (straight line carapace length) of the individuals seen as well as the presence of tags, tumors or any deformities. We also attempted to note the presence of appropriate resting and foraging areas for green turtles.


OAHU
PROJECT AREA
PROPOSED OTEC PLAN
NANAKULI BEACH PARK
ULEHAWA BEACH PARK
POKAI BAY
WAIANAE OCEAN OUTFALL
60
300
600
MAKAHA
AT&T CABLE ROUTE
LEGEND
SANDY BOTTOM AREAS
BOTTOM CONTOURS IN FEET
0
1
scale

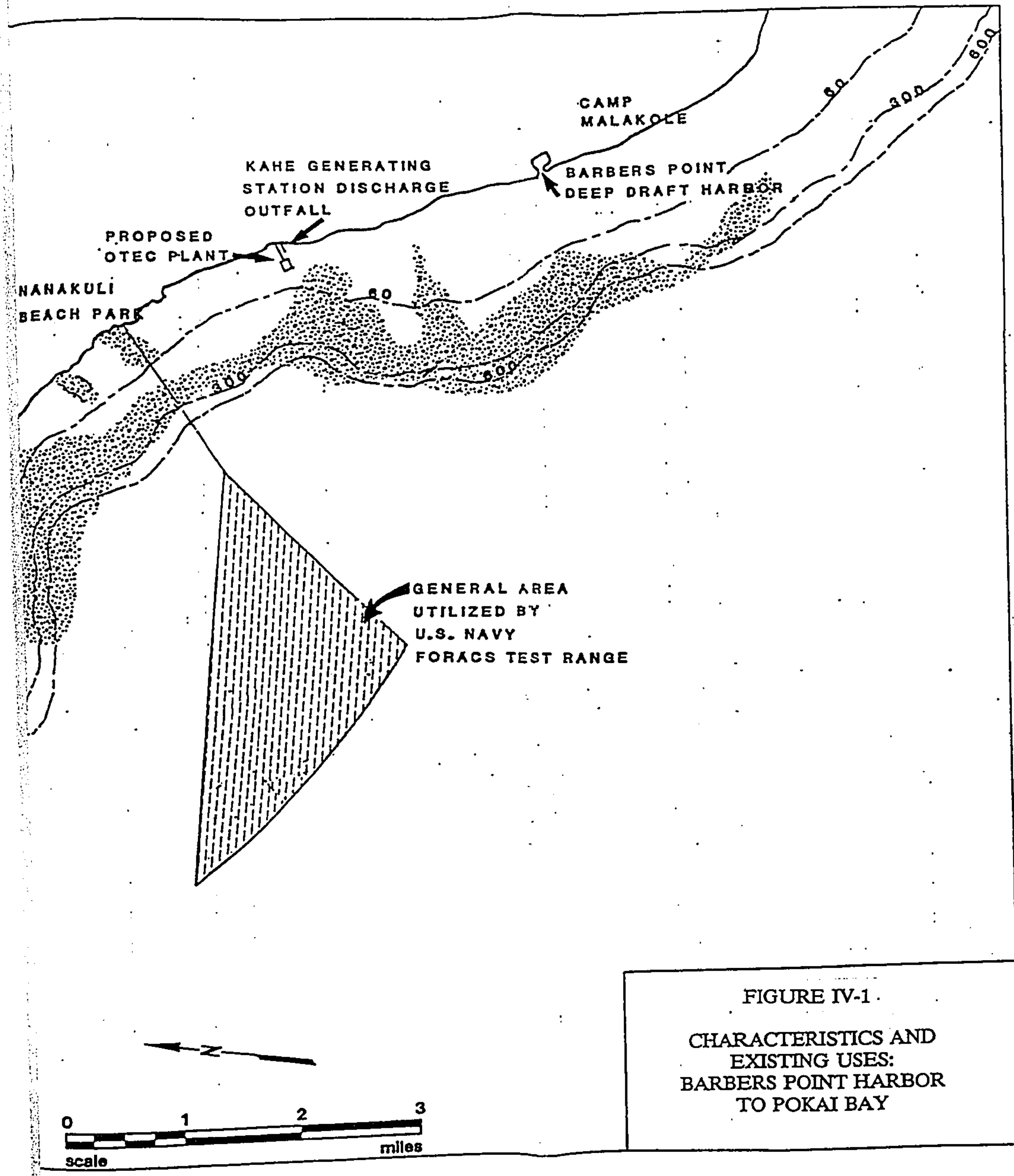


FIGURE IV-1

CHARACTERISTICS AND EXISTING USES: BARBERS POINT HARBOR TO POKAI BAY extensive trenching would probably be required to prevent "bridging" of the cable across the surge channels.

3. Pokai Bay: Pokai Bay is a former small boat harbor, which has been replaced by the Waianae Small Boat Harbor, located one-half mile to the north. Pokai Bay is now a recreational beach, administered as a public park by the City and County of Honolulu. The large offshore sand deposit shown on Figure VI-1, is connected to the sand beach by a well defined sand channel. There are a few scattered limestone outcrops inside the old breakwater, but the vertical relief is low. The physical characteristics of this site are excellent, and a fiber optic cable would require little or no protection on the sand bottom.

   Pokai Bay, however, is a heavily used recreational area. The north half of the beach is restricted to military personnel, and there are three surf sites off the military beach. The waters in the south half of the bay are calm due to the protection offered by the breakwater. According to AECOS (1978), Pokai Bay Beach Park has the best protected and most stable sand beach along the entire Waianae coast. Activities include swimming, wading and canoe paddling. The heavy recreational use of the bay has resulted in past conflicts between swimmers and boaters. State boating regulations now separate the two activities. In spite of the physical advantages, Pokai Bay was not selected as the recommended site due to its heavy recreational usage, the distance from the Central Office as compared to Kahe Point, and potential archaeological sensitivity of the backshore area.

DESCRIPTION OF THE SELECTED ROUTE

General Description

The Kahe Point landing site is located in Kahe Point Beach Park on the southwest coast of Oahu, north of Barbers Point. The shoreline in this area is rocky, consisting primarily of low limestone seacliffs approximately 15 to 20 feet high. There are large pieces of fallen limestone at the base of the cliffs. Also at the foot of the cliffs, at the waterline, there is a narrow limestone bench that terminates in a vertical drop into 3 to 5 feet of water. There is easy access to the ocean only in a small rocky cove at the southern end of the park. The nearshore bottom off Kahe Point Beach Park is irregular with areas of hard rock bottom, alternating with patches of sand. Further offshore, a sandy bottom predominates. The Kahe Generating Station is located immediately north of the park. The ocean water used for cooling by the generating station is discharged through two twelve foot diameter pipelines. The outfall terminates in a water depth of 27 feet. North of the station, there is a 2500 foot long sand beach known as Kahe Beach.

Shoreline History

The coast at the landing site is composed of limestone seacliffs approximately 15 to 20 feet high that are not subject to the typical processes of coastal erosion and accretion. The shoreline therefore has been stable in recent history.

Existing Usage

Kahe Point Beach Park occupies the backshore of the landing site area. Facilities at the beach park include two comfort stations, a pavilion, camping and picnic equipment, and 14 marked camping sites with parking. Access to the ocean for swimming is possible only in a small rocky cove south of the park area and immediately south of the power plant intake basin. This cove is also a popular surf break for novice surfers. The park is primarily used for picnicking, pole fishing, diving, and snorkeling.

Immediately to the north lies the Hawaiian Electric Power Plant and Hawaiian Electric Beach Park. The plant discharges cooling water through dual 12 foot diameter pipes extending 600 feet offshore to the 25 foot water depth. The cable landing site is located approximately 600 feet south of this outfall. A major resort, Ko Olina, is being developed along the coastline between the beach park and Barbers Point Harbor. The shoreline consists primarily of low limestone seacliffs and benches. There is one natural swimming cove in the resort area, and four man made swimming lagoons and beaches have been constructed in the limestone shoreline.

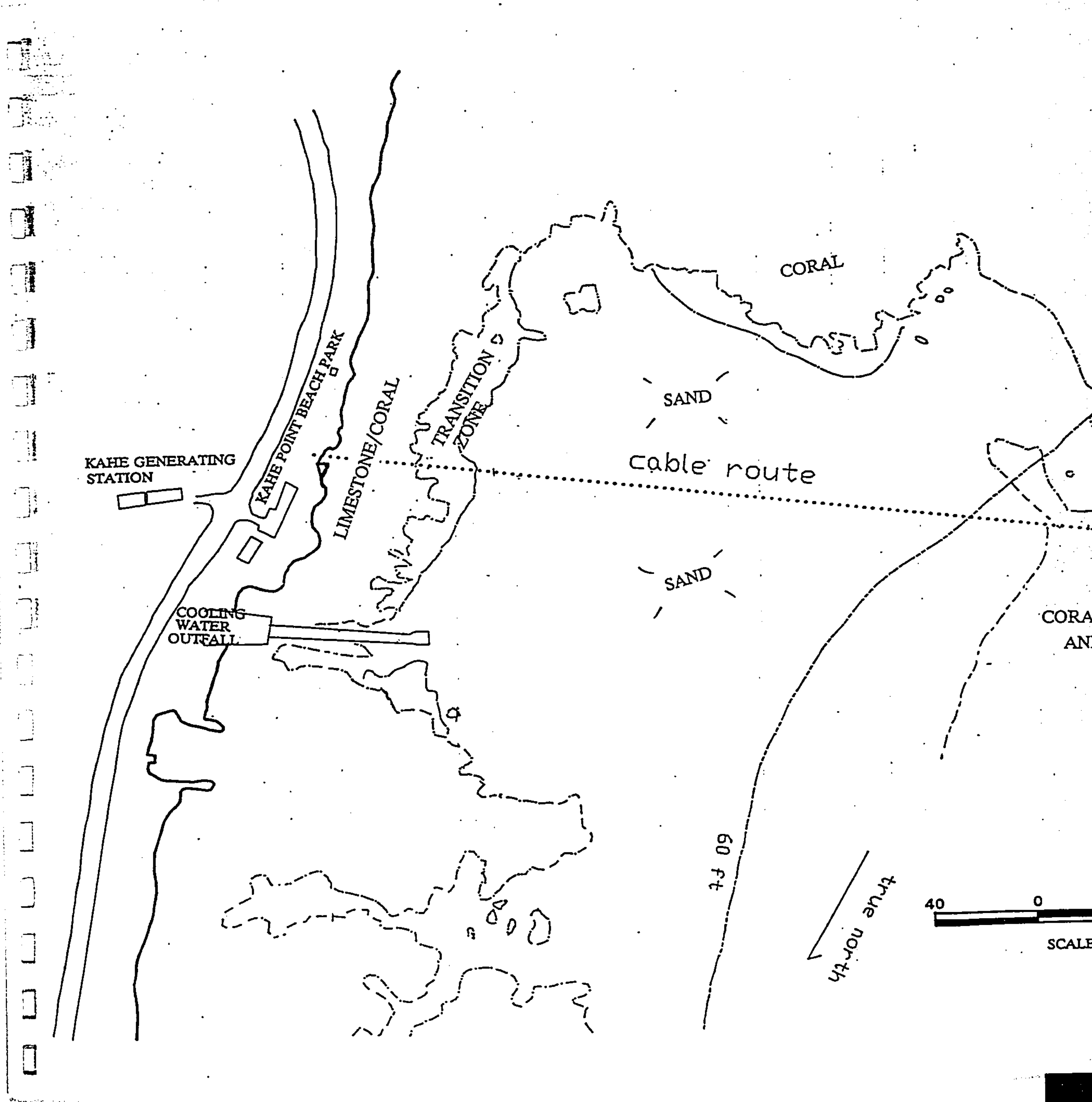
Physical Characteristics of the Selected Route

The bottom characteristics of the selected route and the surrounding area are shown in Figure IV-2. Immediately offshore, there is a 380 foot wide zone of hard bottom, consisting of alternating ridges and channels, with scattered boulders and coral. Vertical relief is roughly 3 to 4 feet. The water depth at the seaward end of this band is approximately 15 feet. The inshore half of this band has less coral and less vertical relief, with more exposed and scoured limestone bottom. Photo 5 shows the bottom characteristics of the inshore half of this zone. Photo 6 shows a ridge and channel formation typical of the seaward half of this zone. The channels are typically scoured limestone and the ridges have moderate to extensive coral growth.

Seaward of the inshore zone, there is a 100 foot wide transition zone, with the bottom consisting of a flat sand bottom with interspersed limestone and coral outcrops. Vertical relief through this zone is 2 to 4 feet. The water depth at the seaward end of the transition zone is 18 to 20 feet. Photo 7 shows typical conditions in the transition zone, with the coral formations rising 2 to 4 feet above the surrounding sand bottom. The percentage of sand in the transition zone increases with distance seaward.

The inshore boundary of an extensive sand deposit is located approximately 500 feet offshore. From this point to the 70 foot depth, a distance of approximately 2,200 feet, the bottom consists of medium grained calcareous sand. There are no exposed outcrops of limestone or coral in the deposit.

From the 70 foot depth to at least the 100 foot depth (the seaward limit of the diving reconnaissance) the bottom consists of limestone, scattered coral, and coral rubble with sand. Vertical relief is on the order of 1 to 3 feet. Typical conditions are shown in Photo 8. At approximately 80 feet, there is a limestone outcrop which protrudes into the area from the Barbers Point side of the route. This outcrop rises 10 to 15 feet above the flat bottom, and the proposed route was oriented to avoid this obstacle. The route shown misses this ledge by approximately 200 feet. It is anticipated that a side scan sonar survey will be conducted by the cable vendor prior to cable placement, and the precise route for the area where the water depth exceeds 70 feet will be selected to avoid as much of the hard bottom in this zone as possible. The cable could be shifted slightly to the north in this zone; it is unlikely that it will be shifted any closer to the ledge.



KAHE GENERATING STATION
KAHE POINT BEACH PARK
LIMESTONE/CORAL
TRANSITION ZONE
CORAL
SAND
cable route
SAND
COOLING WATER OUTFALL
60 ft
true north
40
0
SCALE

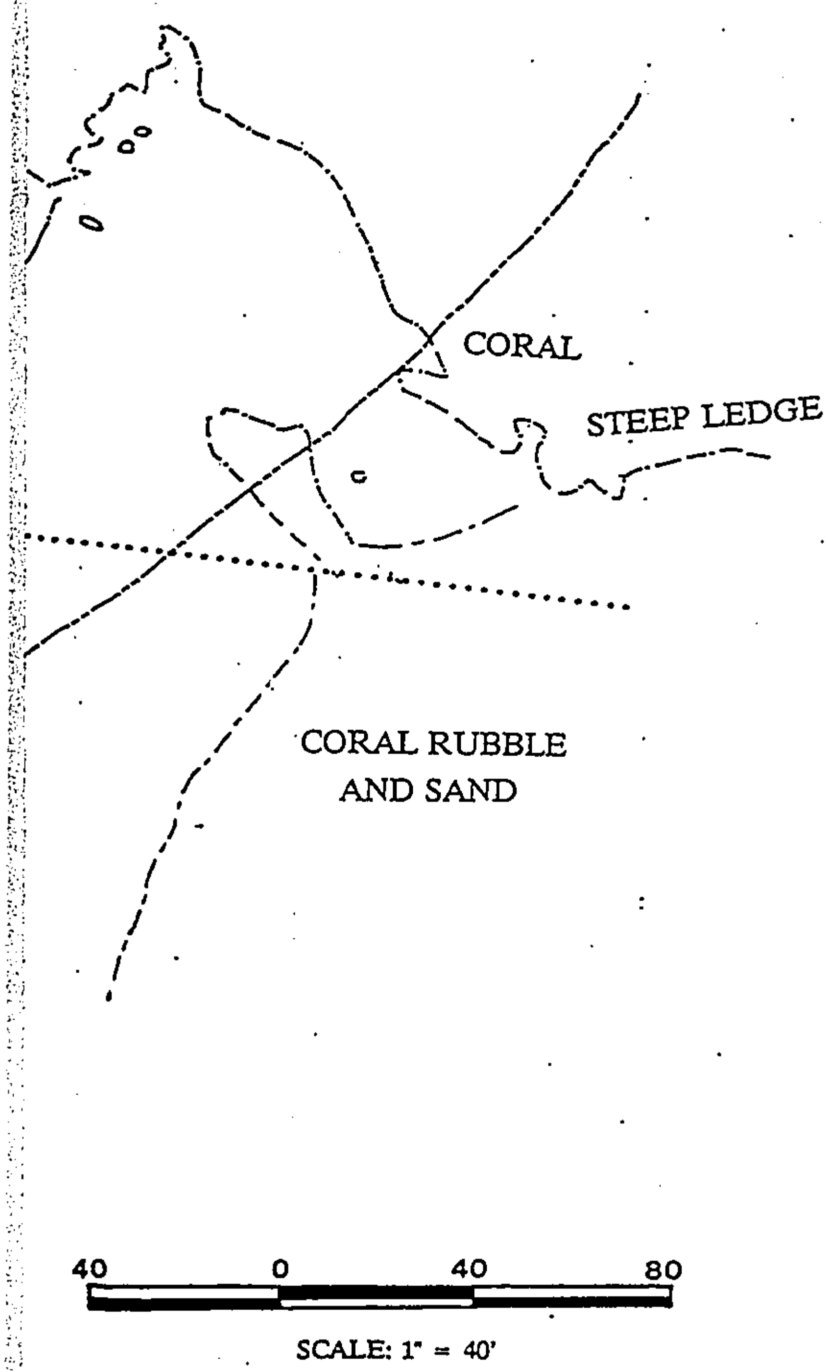


FIGURE IV-2
BOTTOM CHARACTERISTICS ALONG
SELECTED CABLE ROUTE

PHOTO 5. NEARSHORE CONDITIONS: SCOURED LIMESTONE, SCATTERED BOULDERS AND CORAL FORMATIONS. WATER DEPTH IS APPROX. 10-FEET.

PHOTO 6. TYPICAL CONDITIONS IN SEAWARD HALF OF THE HARD BOTTOM ZONE; RIDGE AND CHANNEL FORMATION. WATER DEPTH IS APPROX. 15-FEET.

PHOTO 7. TYPICAL VIEW OF INSHORE TRANSITION ZONE, WHERE THE LIMESTONE AND CORAL BOTTOM GIVES WAY TO SAND DEPOSIT DEPTH IS APPROX. 20-FEET.

PHOTO 8. TYPICAL BOTTOM CONDITIONS IN THE OFFSHORE ZONE OF CORAL RUBBLE. WATER DEPTH IS APPROX. 80-FEET.

OCEANOGRAPHIC CONDITIONS

Kahe Point is located west of the Waianae mountain range in southwest Oahu. The mountains are large enough to form a lee from the tradewinds, and the effect of the tradewinds is moderate.

Currents along this coast are dominated by reversing tidal flows, that usually flow parallel to the nearshore bottom contours. Currents flow to the south during flood tide, and to the north during ebb tide. The tidal currents, however, do not always reverse and may flow in the same direction for several tidal cycles. Surface currents may be modified by prevailing winds. Tradewinds tend to deflect surface currents offshore, while Kona winds would direct surface currents onshore. The typical currents are strong along this coast, frequently exceeding one knot.

This coastline is directly exposed to south swell, kona storm waves, and westerly north Pacific swell. Design wave heights would occur during the passage of hurricanes to the south of Oahu. The leeward coast of Oahu suffered extensive property damage during the passage of Hurricane Iwa in 1982.

This area is also subject to tsunami inundation. Runup from the 1946 and 1957 tsunamis reached 12 and 11 feet above sea level at Kahe Beach, north of the power plant. The estimated inundations 200 feet inland for 50 and 100 year tsunamis are 8 and 11 feet above mean sea level for this coastal area.

Nearshore waters are class "A" in the Department of Health water quality regulations.

DESCRIPTION OF THE PROPOSED PROJECT

The fiber optic cable will be double armored in the nearshore zone to resist chafing and abrasion. Additional protection will be required from the shoreline out to a water depth of 20 feet, located 500 feet offshore, where the cable enters the extensive offshore sand deposit. The exact protection method used will depend upon the selected cable vendor, but one of the two following work sequences is most likely:

1. Complete the initial shore landing with no preparatory work on the bottom. Divers would then remove localized high spots and other obstructions to obtain a relatively uniform channel next to the cable. The cable would then be shifted into this channel, and split pipe casing installed around the inshore 500 feet of the cable. This casing is supplied in 39-inch lengths and is bolted in place around the cable. Sections are connected by articulated ball joints to allow conformance to varying bottom terrain. The casing will also be bolted to the bottom at intervals to prevent movement. This method would involve the use of a small work boat and a dive team equipped with either hydraulic or pneumatic tools. Since the excavation would be done by hand, and only where needed, this method would result in the minimum environmental impact.

2. The second method would utilize a barge equipped with a crane and clamshell bucket to remove high spots, boulders and other obstructions prior to the cable landing. The cable would then be laid in the prepared channel, and divers would install the split pipe casing and bolt it to the bottom as described above. The use of a clamshell bucket would clear a wider path (approximately 5 feet) than the above method, and the associated environmental effects would be correspondingly greater.

No blasting or extensive trenching will be required during the cable protection process. It is assumed that no cable protection will be required beyond the 25 foot water depth.

The estimated duration of the nearshore protection work is 15 to 20 working days, at an approximate cost of $120,000.

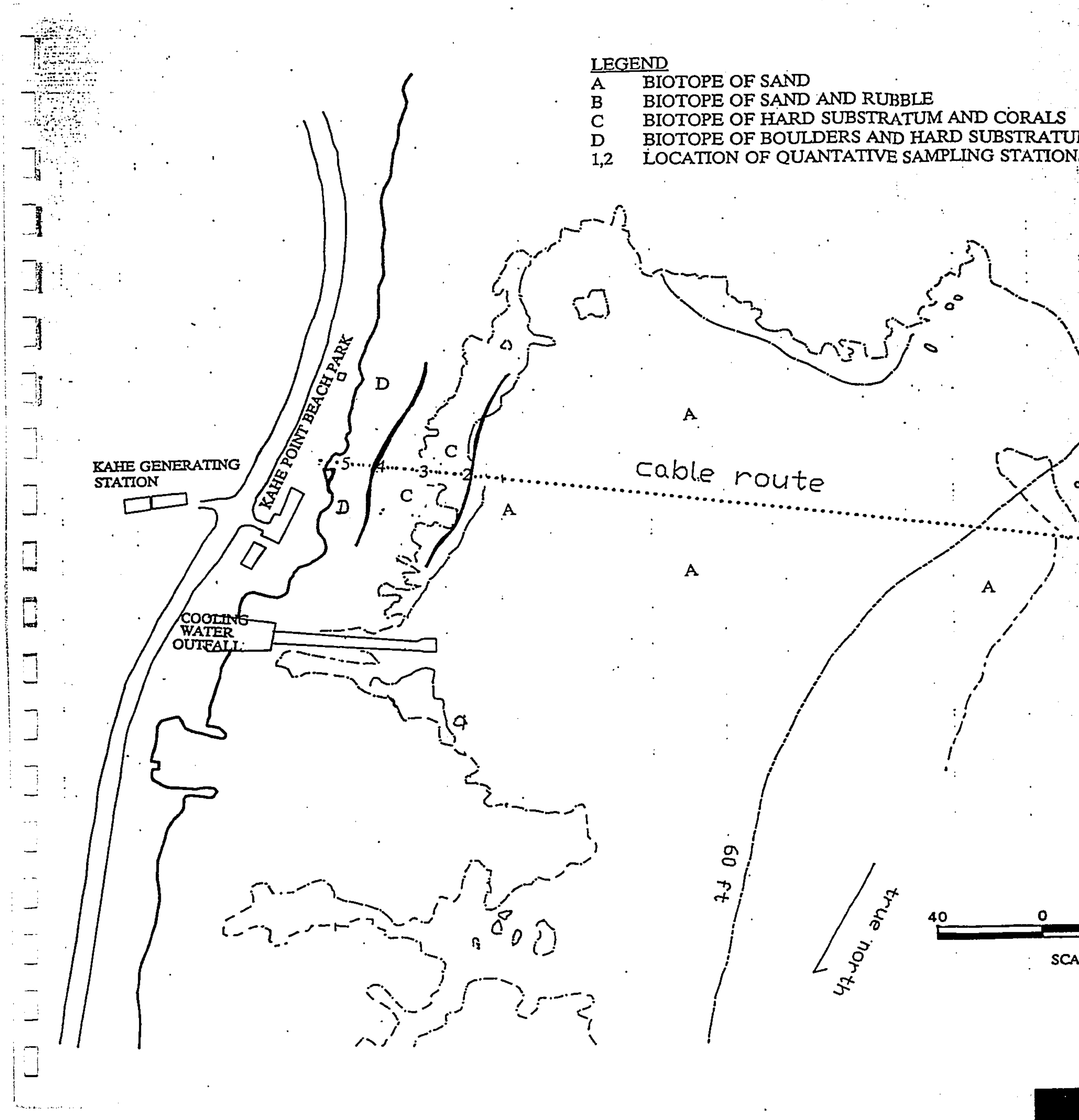
MARINE BIOLOGICAL SETTING

The qualitative reconnaissance of Kahe Point Beach Park was carried out on 21 June 1991 and the quantitative sampling 6 December 1991. The qualitative survey extended from shore to about the 90 foot isobath approximately 4,000 feet from shore. In this area four zones or biotopes were defined. The biotopes recognized in the vicinity of the proposed cable alignment at Kahe Point Beach Park are the biotope of sand, the biotope of sand and rubble, the biotope of emergent hard bottom and corals, and the biotope of boulders and hard substratum adjacent to the shoreline. The boundaries of these biotopes are shown in Figure IV-3.

The biotope of sand dominates the area of the proposed project coming to within 500 feet of the shoreline. The biotope of rubble and sand occurs as a band that commences at about the 75 foot water depth and continues to about 100 feet in the vicinity of the proposed cable alignment. Seaward of the biotope of sand and rubble one again encounters the biotope of sand at depths beyond the scope of this survey. Shoreward of the biotope of sand is the biotope of emergent hard substratum and corals; this substratum appears to primarily be limestone. Sandwiched between this biotope and the rocky shoreline is the biotope of boulders and hard bottom.

The Biotope of Sand

The biotope of sand lies principally seaward of the project site but extends to within 500 feet of the shoreline in the vicinity of the proposed alignment (Figure IV-3). As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat


LEGEND
A BIOTOPE OF SAND
B BIOTOPE OF SAND AND RUBBLE
C BIOTOPE OF HARD SUBSTRATUM AND CORALS
D BIOTOPE OF BOULDERS AND HARD SUBSTRATU
1,2 LOCATION OF QUANTATIVE SAMPLING STATION
KAHE POINT BEACH PARK
KAHE GENERATING STATION
COOLING WATER OUTFALL
cable route
60 ft
true north
40
0
SCA

ƷBLE
ATUM AND CORALS
D HARD SUBSTRATUM
SAMPLING STATIONS

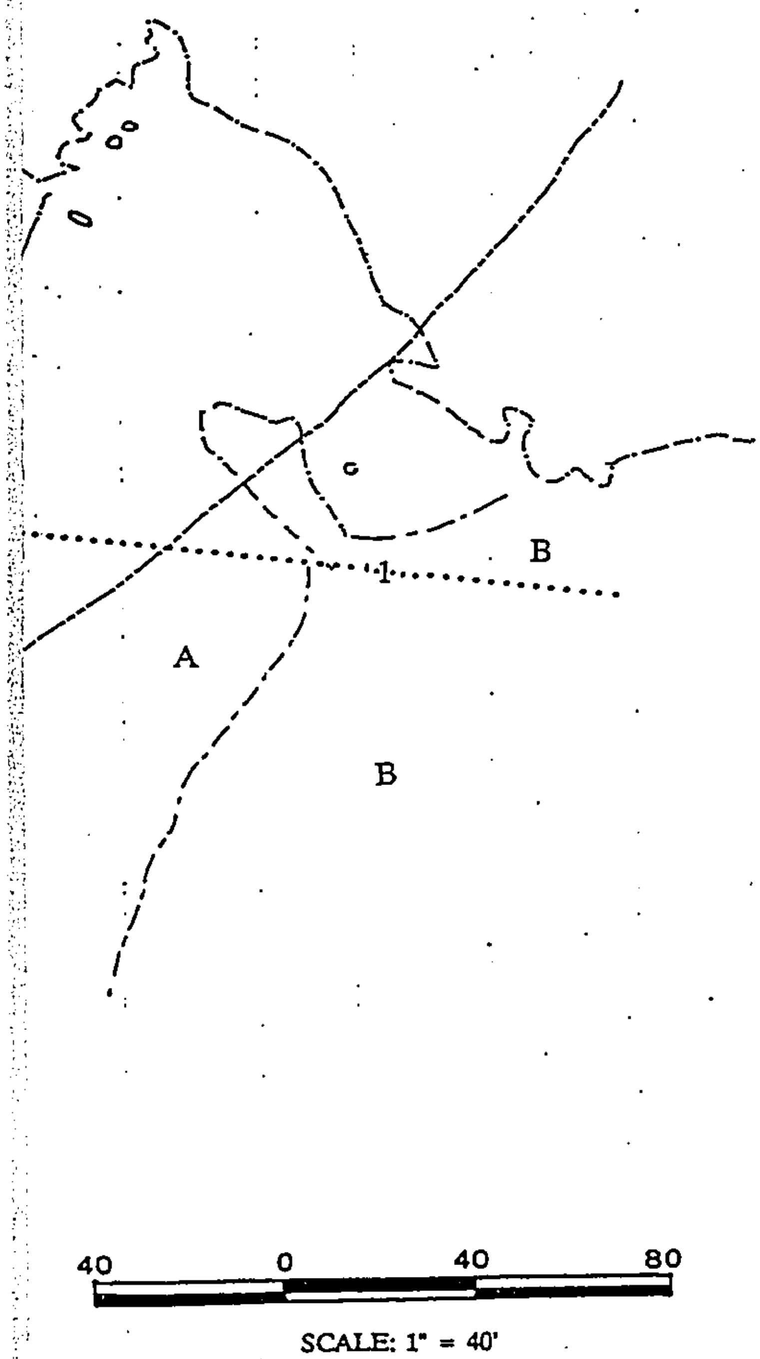


FIGURE IV-3
BIOTOPES ALONG SELECTED
CABLE ALIGNMENT

will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Thus many species in the sand biotope are cryptic and difficult to see; among those are many of the molluscs and crustaceans such as the Kona crab (Ranina serrata). Hence, without considerable time spent searching in the sand many species in the sand habitat will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant. Benthic communities on sand substrates usually have their greatest development at depths below which wave impact occurs (below 100 feet). Because of constraints with bottom time at these depths, only a qualitative survey was done. Species commonly seen in the deeper regions of the biotope of sand include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), the Kona crab (Rania serrata), opelu or mackerel scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), uku or snapper (Aprion virescens), hihimanu or sting ray (Dasyatis hawaiiensis) and the weke or white goatfish (Mulloides flavolineatus). Undoubtedly, with greater searching, many more fish species would be encountered in this biotope. Most of these species become less evident in the shallower portions of this biotope.

The Biotope of Rubble and Sand

The biotope of rubble and sand is situated in a "band" or zone that is encountered at depths from 75 to about 100 feet and about 2,900 to 4,000 feet offshore. The substratum in this biotope is a mix of sand and coral rubble; larger rubble pieces have some coral growth present. The mean size of the rubble in this biotope is about 8 inches in diameter; the largest pieces were on the order of about 2 feet in diameter. About 200 feet south of Station 1 is a limestone "bench" that rises 15 to 20 feet from the seafloor. This bench continues almost uninterrupted to the Barbers Point Harbor entrance channel. Station 1 was established in 72 to 75 feet of water to sample this biotope approximately 3,400 feet offshore and about 200 feet north of the massive lime- stone bench noted above. The orientation of the transect line at this station was approximately parallel to shore. The results of the quantitative survey are presented in Table IV-1. The quadrant survey noted one coral species present on the rubble in the transect site having a mean coverage of 0.05 percent. Two macroinvertebrate species were present; these were the Chinese horn shell (Cerithium sinensis) and the long-spine sea urchin or wana (Echinothrix diadema). Because of a general lack of cover, only seven species of fishes (409 individuals) were encountered at Station 1; these are detailed in Appendix A. However, a school of approximately 400 mackerel scad or opelu (Decapterus macarellus) was in the transect area. These fish comprised 99.4 percent of the standing crop which was estimated to be 771 g/m^2.

TABLE IV-1.

Summary of the benthic survey conducted in the biotope of rubble and sand approximately 3,400 feet offshore of Kahe Point Beach Park, Oahu on 6 December 1991. Results of the $6m^2$ quadrant sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Pact C. A short summary of the fish census is given in Part D. Water depth is 72 to 75 feet; mean coral coverage is 0.05 percent (quadrant method).

A. Quadrant Survey

	Quadrant Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Neomeris annulata				0.1		
Corals						
Montipora verrucosa	0.3					
Sand	66.7	100	93	69.9	96	96
Rubble	3		7	30	4	4
Hard Substratum	30					

B. 50-Point Analysis

Species	Percent of the Total
Sand	92
Rubble	8

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Cerithium sinensis	1
Phylum Echinodermata	
Echinothrix diadema	1

(TABLE CONTINUED ON NEXT PAGE)

D. **Fish Census (4 x 25m)**

7 Species
409 Individuals
Estimated Biomass = 771g/m^2

In the vicinity of Station 1 near the projecting limestone bench were seen kala holo (Naso hexacanthus), orangeband surgeonfish or na'ena'e (Acanthurus olivaceus), threespot chromis (Chromis verator), snapper or uku (Aprion virescens), sergeant major or mamo (Abudefduf abdominalis), yellowfin goatfish or weke'ula (Mulloides vanicolensis) and the blue goatfish or moano kea (Parupeneus cyclostomus). In the rubble and sand were seen small coral colonies (Pocillopora meandrina and Porites lobata), the arc-eye hawksfish or piliko'a (Paracirrhites arcatus), lei triggerfish or humuhumu lei (Sufflamen bursa) and the bridled triggerfish or humuhumu mimi (Sufflamen fraenatus).

The Biotope of Emergent Hard Substratum and Corals

Along the shoreline fronting the project site is the biotope of emergent hard substratum and corals. This biotope commences about 500 feet offshore in water 21 to 23 feet in depth and continues as a "band" about 400 feet wide terminating about 100 feet from shore in water about 8 feet deep. This biotope may be characterized by emergent hard substratum that rises from 3 to 6 feet above the sand. On the seaward edge the hard substratum occurs as "spurs" or fingers that project up to 30 feet seaward into the sand.

The substratum in the biotope of emergent hard substratum and corals is comprised of limestone. The spurs along the seaward edge of this biotope continue shoreward as ridges; these ridges are from 3 to 15 feet in width and from 6 to 30 feet in length where they project out into the sand. In the sand the spurs are spaced from 3 to 75 feet apart. These ridges continue in a shoreward direction where small, hard substratum channels occur between the ridges. The channels have a general orientation that is perpendicular to shore and are from 4 to 15 feet in width, 2 to 4 feet in depth and are up to 40 feet in length.

Station 2 was established approximately 400 feet offshore in the zone of transition between the biotope of sand and the biotope of emergent hard bottom and corals. The area is characterized by a mix of sand and hard substratum occurring as ridges projecting seaward as described above. The transect line at this station had an orientation perpendicular to shore. Table IV-2 presents the results of the quantitative study carried out at Station 2. The quadrant survey noted one algal species (Desmia hornemannii), a soft coral (Palythoa tuberculosa) and five coral species (Porites lobata, Montipora verrucosa, M. patula, Leptastrea purpurea and Pocillopora meandrina) having a mean coverage of 9.3 percent. The dominant coral in this area is Porites lobata in terms of coverage. The macroinvertebrate census noted four species including one polychaete (Spribranchus giganteus and three echinoderms (the black sea urchin or Tripneustes gratilla, the green sea

TABLE IV-2.

Summary of the benthic survey conducted in the ecotone between the biotope of emergent hard bottom and corals and the more seaward biotope of sand approximately 400 feet offshore of Kahe Point Beach Park, Oahu on 6 December 1991. Results of the $6m^2$ quadrant sampling of the benthic community (expressed in per- cent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 18 to 23 feet; mean coral coverage is 9.3 percent (quadrant method).

A. Quadrant Survey

	Quadrant Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Desmia hornemannii	0.5					
Soft Corals						
Palythoa tuberculosa				1		
Corals						
Porites lobata	19			26		
Montipora verrucosa	1			0.3		
M. patula	3					
Leptastrea purpurea	0.8			0.7		
Pocillopora meandrina	0.1			5		
Sand		100	100		94	100
Hard Substratum	74.6			67		

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	12
Porites compressa	2
Montipora verrucosa	4
Hard Substratum	82

(TABLE CONTINUED ON NEXT PAGE)

TABLE IV-2.
Continued.

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Annelida	
Spirobranchus giganteus	18
Phylum Echinodermata	
Echinometra mathaei	26
Culcita novaeguineae	2
Tripneustes gratilla	9

D. Fish Census (4 x 25m)

28 Species
181 Individuals
Estimated Biomass = 35 g/m^2

urchin or Echinometra mathaei and the cushion starfish or Culcita novaeguineae. Twenty-eight fish species (181 individuals) were censured at Station 2. The results of this census are presented in Appendix A. Common fishes at Station 2 include the damselfish (Chromis vanderbilti), saddleback wrasse or hinalea lauwili (Thalassoma duperrey) and the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus). The standing crop of fishes at this station was estimated to be 35 g/m^2; species contributing heavily to this biomass include the many bar goatfish or moano (Parupeneus multifasciatus), saddleback wrasse or hinalea lauwili (Thalassoma duperrey), brown surgeon- fish or ma'i'i'i (Acanthurus nigrofuscus), parrotfish or uhu (Scarus sordidus), pinktail triggerfish or humuhumu hi'ukole (Melichthys vidua) and the lei triggerfish or humuhumu lei (Sufflamen bursa). In the vicinity of Station 2 were seen the mackerel scad or opelu (Decapterus macarellus), moorish idol or kihikihi (Zanclus cornutus), ringtail wrasse or po'ou (Chelinus rhodochrous), long spine sea urchin or wana (Echinothrix diadema) and the coral (Pavona varians).

Station 3 was established about 25 feet shoreward of the terminal end of the transect line for Station 2. The orientation of the transect line at Station 3 was again perpendicular to shore, commencing in water approximately 18 feet deep (about 290 feet offshore) and terminating at a depth of 10 feet approximately 210 feet offshore. This station was situated in the area of greatest coral growth in the biotope of emergent hard substratum and corals. Table IV-3 presents the results of the quantitative survey carried out at Station 3. The quadrant survey noted two algal species (Amansia glomerata and Desmia hornemannii) with a mean coverage of 0.7 percent. One soft coral (Palythoa tuberculosa) and six coral species

TABLE IV-3.

Summary of the benthic survey conducted in the biotope of emergent hard bottom and corals approximately 290 feet offshore of Kahe Point Beach Park, Oahu on 6 December 1991. Results of the $6m^2$ quadrant sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 10 to 18 feet; mean coral coverage is 30.2 percent (quadrant method).

A. Quadrant Survey

	Quadrant Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Desmia horemannii	2					
Amansia glomerata						2
Soft Corals						
Palythoa tuberculosa		1			0.2	1
Corals						
Porites lobata	42	27	7.5	7	1	10
Montipora verrucosa	3	3	14		13	0.8
M. patula	2		8		9	1.5
M. flabellata	1	2.5		11		
Pocillopora meandrina		5.5	2	5	3.5	
Leptastrea purpurea					0.8	
Sand					5	
Rubble		3				
Hard Substratum	50	58	68.5	77	67.5	84.7

B. 50-Point Analysis

Species	Percent of the Total
Soft Corals	
Palythoa tuberculosa	2

(TABLE CONTINUED ON NEXT PAGE)

TABLE 3.
Continued.

Species	Percent of the Total
Corals	
Pocillopora meandrina	2
Porites evermanni	2
P. lobata	14
Montipora flabellata	2
M. patula	4
M. verrucosa	8
Hard Substratum	66

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Conus ebreus	1
Pinctado marginifera	1
Phylum Echinodermata	
Echinostrephus aciculatum	17
Tripneustes gratilla	22
Echinothrix diadema	2
Echinometra mathaei	59

D. Fish Census (4 x 25m)

29 Species
289 Individuals
Estimated Biomass = 52 g/m^2

were also encountered. The coral coverage was estimated to be 30.2 percent. The census of macroinvertebrates noted six species including two molluscs the pearl oyster (Pinctado marginifera) and the hebrew cone (Conus ebreus) and four echinoderms including the boring sea urchin (Echinostrephus aciculatum), the black urchin (Tripneustes gratilla), the long-spine urchin or wana (Echinothrix diadema) and the green urchin (Echinometra mathaei). In the fish census 29 species (289 individuals) were seen. The most abundant species include the manybar goatfish or moano (Parupeneus multifasciatus), the damselfish (Chromis vanderbilti), the saddleback wrasse or hinalea lauwili (Thalassoma duperrey) and the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus). The biomass of fish at Station 3 was estimated to be 52 g/m^2 and the species contributing heavily to this standing crop include the manybar goatfish or moano (Parupeneus multifasciatus), the saddleback wrasse or hinalea lauwili (Thalassoma duperrey), the redlip parrotfish or palukaluka (Scarus rubroviolaceus) and the orangebar surgeonfish or na'ena'e (Acanthurus olivaceus). In the vicinity of Station 3 were seen the corals (Pavona duerdeni and P. varians), the brown sea cucumber (Actinopyge mauritana) and the christmas wrasse or 'awela (Thalassoma fuscum).Station 4 was established to sample the inshore reaches of the biotope of emergent hard substratum and corals. The transect at this station was laid perpendicular to the shoreline commencing about 25 feet shoreward of the previous station (about 185 feet offshore in water approximately 10 feet deep) and terminating in water about 8 feet deep at a distance of 104 feet from shore. There are fewer corals present in this inshore area probably due to the greater wave impact that occurs in shallower water. Thus the substratum has a more "barren" appearance as one approaches the shoreline.

Table IV-4 presents the results of the quantitative survey carried out at Station 4. One algal species (Desmia hornemannii) was found in the quadrant survey as well as a soft coral (Palythoa tuberculosa); neither contributed more than 0.2 percent to the benthic cover. Seven coral species (Porites lobata, Pocillopora meandrina, Montipora verrucosa, M. flabellata, M. patula, Leptastrea purpurea and Cyphastrea ocellina) were found in the quadrant survey. These corals contributed 8.9 percent to mean benthic coverage. The invertebrate census noted four echinoderm species; these were the black boring urchin (Echinometra oblongata), the green urchin (Echinometra mathaei), the black sea urchin (Tripneustes gratilla) and the boring urchin (Echinostrephus aciculatum). The most abundant macroinvertebrate species was the green sea urchin (Echinometra mathaei - 2.7 individuals/m^2). The results of the fish census are presented in Appendix A. In total 25 species (147 individuals) were censured and the most common species include the manybar goatfish or moano (Parupeneus multifasciatus), the saddleback wrasse or hinalea lauwili (Thalassoma duperrey) and the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus). The biomass of fish at Station 4 was estimated to be 89 g/m^2 and three species (the manybar goatfish or moano - Parupeneus multifasciatus, the spectacled parrotfish or uhu uliuli-

TABLE IV-4.

Summary of the benthic survey conducted in the biotope of emergent hard bottom and corals commencing approximately 186 feet offshore of Kahe Point Beach Park, Oahu on 6 December 1991. Results of the $6m^2$ quadrant sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 8 to 10 feet; mean coral coverage is 8.9 percent (quadrant method).

A. Quadrant Survey

	Quadrant Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Desmia hornemannii				0.1		
Soft Corals						
Palythoa tuberculosa	1					
Corals						
Porites lobata	4.5	7	4	3	2.5	
Pocillopora meandrina		0.3	1.5	3.5		1
Montipora verrucosa	0.3		1	2		
M. flabellata			1	2		
M. patula		3				
Leptastrea purpurea			8	4.5	2.5	1.5
Cyphastrea ocellina		0.2				
Hard Substratum	94.2	89.5	84.5	84.9	95	97.5

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Montipora flabellata	2
M. verrucosa	2
Leptastrea purpurea	2
Pocillopora meandrina	2
Porites lobata	8

(TABLE CONTINUED ON NEXT PAGE)

TABLE IV-4.
Continued.

C. Invertebrate Census (4 x 25m)

Species	Number
Hard Substratum	84
Phylum Echinodermata	
Echinometra oblongata	1
Echinometra mathaei	274
Tripneustes gratilla	11
Echinostrephus aciculatum	4

D. Fish Census (4 x 25m)

25 Species
147 Individuals
Estimated Biomass = 89 g/m^2

Scarus perspicillatus and the orange bar surgeonfish or na'ena'e - Acanthurus olivaceus) contributed heavily to this standing crop. Species encountered in the vicinity of Station 4 include the cone shell (Conus lividus), coral (Pavona varians), wrasse (Macropharyngodon geoffroy) and blenny (Cirripectus vanderbilti).

The Biotope of Boulders and Hard Bottom

As the name implies, the substratum of this biotope is comprised of limestone over which boulders are scattered. These boulders are both round (mean diameter about 2.5-3 feet) and in the form of slabs which have a mean size of about 2 feet wide, 4 feet long and about 1 foot thick. Across the limestone substratum are potholes or depressions with a mean diameter of about 2 feet spaced from 5 to 18 feet apart; also present are shallow channels from 2 to 8 feet in width, up to 25 feet in length and to about 1 foot in depth. These channels are spaced from 10 to 35 feet apart and have a general orientation that is perpendicular to shore.

Station 5 was established approximately 50 feet offshore in water from 4 to 6 feet in depth to sample the biotope of boulders and hard bottom. The transect line for this station was established parallel to shore along the 4 to 6 foot isobath. The results of the quantitative survey carried out at Station 5 are presented in Table IV-5. The quadrant survey noted one algal species (Amansia glomerata) and one soft coral colony (Palythoa tuberculosa) as well

TABLE IV-5.

Summary of the benthic survey conducted in the biotope of hard bottom and boulders commencing approximately 50 feet offshore of Kahe Point Beach Park, Oahu on 6 December 1991. Results of the $6m^2$ quadrant sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth ranges from 4 to 6 feet; mean coral coverage is 0.05 percent (quadrant method).

A. Quadrant Survey

Species	Quadrant Number					
	0m	5m	10m	15m	20m	25m
Algae						
Amansia glomerata		2	3			
Soft Corals						
Palythoa tuberculosa			0.1			
Corals						
Pocillopora meandrina	0.1				0.1	
Montipora verrucosa					0.1	
Rubble			1			
Hard Substratum	99.9	98	98.9	97	99.8	100

B. 50-Point Analysis

Species	Percent of the Total
Hard Substratum	100

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mosllusca	
Drupa morum	1
Conus lividus	1

(TABLE CONTINUED ON NEXT PAGE)

TABLE IV-5.
Continued.

Species	Number
Phylum Echinodermata	
Echinometra oblongata	9
E. mathaei	97
Actinopyge mauritana	1

D. Fish Census (4 x 25m)

25 Species
142 Individuals
Estimated Biomass = 79 g/m^2

as two coral species (Pocillopora meandrina and Montipora verrucosa). The mean coverage by corals was estimated to be 0.05 percent. The invertebrate census noted two molluscs, the drupe (Drupa morum) and the cone shell (Conus lividus) as well as three echnioderm species (the black boring urchin - Echinometra oblongata, the green urchin - Echinometra mathaei and the brown sea cucumber - Actinopyge mauritana. The fish census encountered 25 species and 142 individual fishes in the 4 x 25m census area. The most common fishes were the manybar goatfish or moano (Parupeneus multifasciatus), the brown damselfish (Stegastes fasciolatus) and the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus). The standing crop of fishes at Station 5 was estimated to be 79 g/m^2 and the most important species contributing to this biomass were the saddleback wrasse or hinalea lauwili (Thalassoma duperrey), the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus), the brown damselfish (Stegastes fasciolatus) and the manybar goatfish or moano (Parupeneus multifasciatus). In the vicinity of Station 5 were seen the unicornfish or kala (Naso unicornis) and the blackspot sergeant or kupipi (Abudefduf sordidus).

The intertidal region at this proposed cable landing site is situated on a limestone bench with large boulders present; the boulders are from 4 to 8 feet in diameter. Just shoreward of the boulders that lie on the bench is a steep, near vertical cliff of limestone that is about 15 feet in height. Only a short reconnaissance was made of the intertidal at this site. This qualitative inspection noted the algae (Pterocladia capillacea and Sargassum polyphyllum) along with the snails Nerita picea and Littorina pintado. Other species present include the chiton (Acanthochiton armata).

No green turtles were seen during our survey work in the waters fronting the Kahe Point Beach Park. To the south of the beach park (i.e., offshore of Paradise Cove and West Beach) are known concentrations of green sea turtles (Brock 1990a). Some shelter (caves, ledges and undercuts) at sizes and scales appropriate for green sea turtle resting areas were seen in the region adjacent to shore (i.e., the biotope of emergent hard substratum and corals) and macroalgal species were encountered both subtidally (Amansia glomerata) and intertidally (Pterocladia capillacea and Sargassum porphyllum) which are known forage for green turtles (Balazs, 1980, Balazs et al. 1987) yet no turtles were encountered. We have found no information to suggest that nesting of sea turtles in the vicinity of Kahe Point Beach Park has occurred in historical times.

The biological survey of the proposed cable alignment at Kahe Point Beach Park did not find any rare or unusual species or communities. Another protected species, the humpback whale (Megaptera novaeangliae), was not seen offshore of the study area during the period of our field effort, but they are known to at least pass through the area. As noted by Herman (1979), humpback whales tend to be found in regions remote from human activities and the proposed Kahe Point cable alignment is in relatively close proximity to the Barbers Point Harbor which is becoming an important commercial port for Oahu.

POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts with Construction

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment
enters the shallows through the biotope of sand as well as the biotope of sand and rubble. As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom (e.g.,corals and many of the associated invertebrates). Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur in low abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since many of these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will "sink into" the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

As the cable is brought into the shallows offshore of Kahe Point Beach Park, the cable will first encounter hard substratum about 500 feet offshore; from this point shoreward, the deployment of the cable will present a greater opportunity for impact to benthic and fish communities. The construction techniques selected to protect the cable will play a large role in the range of impacts possibly encountered; at one end of the spectrum would be the development of an excavated channel in which the cable is laid and covered with stone and/or tremie concrete and at the other would be the "no action" alternative. At this site it is expected that the subtidal construction of a trench would entail excavation using hand techniques and only across the intertidal would excavation be undertaken with a backhoe and bucket. Impacts to marine communities with these activities will include those associated with the removal of benthic communities in the trench path and the generation of turbidity which may impact surrounding communities. The utilization of hand techniques lessens direct impact to benthic communities because trench width can be carefully controlled.

With any construction is the concern are over possible impacts to corals because of their sessile nature and usual slow growth characteristics. One potential impact to corals would be the removal of the entire benthic community in the alignment path by trenching. If trenching were to occur over all hard substratum in water less than 100 feet in depth, how much coral would be lost? Table IV-6 presents an estimate of the actual loss of coral (expressed in the number of square meters lost) in the alignment path if all hard substratum were to be trenched. This estimate is based on the measured linear distance of hard substratum crossed by the cable on the proposed alignment and the known percent coverage by coral in the biotopes crossed where corals exist. These losses are calculated for four arbitrary trench widths which are 0.3m wide trench = 5.5 square meters of coral lost, 0.5m widetrench = 9.3 square meters of coral lost, 1.0m wide trench = 18.4 square meters of coral lost and with a 1.5m wide trench 27.5 square meters of coral would be lost.

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales (Megaptera novaeangliae). As far as the impact to humpback whales is concerned, if construction activities are restricted to the period between April through October, the impacts are minimal because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when whales are present in Hawaiian waters, impacts should be non-existent or minimal. The cable ship will not be on site more than one or two days. After departure of the cable ship, all work will be within 500 feet of shore. There will be no blasting during the construction of the cable protection.

TABLE IV-6.

Table estimating the loss of living coral on hard sub- stratum (expressed in square meters) if the proposed alignment at Kahe Point Beach Park, Oahu is trenched at one of four arbitrary widths (0.3m, 0.5m, 1m and 1.5m). These calculations are based on the estimates of coral cover derived from this study and measured linear distances that the cable would cross hard substratum in water between shore and the 100 foot isobath. Calculated losses for each trench width are given in the body of the table in terms of square meters.

Biotope	Mean Percent Coral Cover	Distance Traversed on Hard Substrate	Arbitrary Width of Destruction			
			0.3m	0.5m	1.0m	1.5m
Biotope of Sand and Rubble	0.05	27m	0.04	0.07	0.1	0.2
Biotope of Sand	0	0m				
Biotope of Emergent Hard Substratum and Corals						
a. Outer	9.3	55m	1.5	2.6	5.1	7.7
b. Middle	30.2	33m	3.0	5.0	10.0	14.9
c. Inner	8.9	34m	0.9	1.5	3.0	4.5
Biotope of Boulders and Hard Bottom	0.05	31m	0.05	0.08	0.2	0.2
Total Destruction of Coral in m^2			5.5	9.3	18.4	27.5

The most probable source of local impact to whales would be noise generation by the cable laying ship, the support tugs and the small boats. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981; Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area. The potential impacts should be considered in light of the proximity of the cable landing site to the Barbers Point Deep Draft Harbor and the Kahe Generating Station.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if it entails dredging. The generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about one 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Any trenching activity performed by dredge will generate fine particulate material that serves to lower light levels and in the extreme, bury benthic communities. Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light level resulting in a lowering of primary productivity. When light levels are sufficiently decreased, hermatypic corals (i.e., the majority of the corals found on coral reefs) will eject their symbiotic unicellular algae (zooxanthallae) on which they depend as source of nutrition. However, in nature corals will eject their zooxanthallae and survive (by later acquiring more zooxanthallae) if the stress is not a chronic (longterm) perturbation.

Perhaps a greater threat would be the simple burial of benthic communities that may occur with high sediment loading and concurrent low water movement. Many benthic species including corals are capable of removing sediment settling on them by ciliary action and the production of mucous, but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual becomes buried. However, the impact of sedimentation on Hawaiian reefs may be overstated. Sedimentation from land derived sources (usually the most massive source) is a natural phenomenon usually associated with high rainfall events. Dollar and Grigg (1981) studied the fate of benthic communities at French Frigate Shoals in the Northwest Hawaiian Islands following the accidental spill of 2200mt of kaolin clay. These authors found that after two weeks there was no damage to the reef corals and associated communities except where the organisms were actually buried by the clay deposits for a period of more than two weeks.

Fishery Considerations

Access to the shoreline at Kahe Point Beach Park is possible but there is a 12 to 20 foot high limestone "cliff" and/or boulders that one must cross before entering the water in the immediate vicinity of the proposed cable landing site. Despite this impediment, many people climb down on to the limestone bench and either fish or enter the sea. This section of coastline has probably been used since prehistoric times. The beach park is heavily used by people interested in beachgoing, SCUBA shore diving, surfing (on the northern end of the beach park (when the swell is present) as well as fishing. Fishermen catch fish both from shore as well as offshore from small boats. In all probability, some commercial fishing occurs offshore of the proposed cable alignment. We are unaware of any individuals that specifically and exclusively use Kahe Point Beach Park area for subsistence fisheries. Probably most of the fishing activity in and around Kahe Point Beach Park is by recreational fishermen. With most Hawaiian recreational fisheries, species targeted include papio and ulua (family Carangidae), o'io or bonefish (Abula vulpes), moi (Polydactylus sexfilis), goatfishes (family Mullidae), snappers (family Lutjanidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and a host of smaller species such as the aholehole (Kuhlia sandvicensis), aweoweo (Priacanthus cruentatus) and menpachi (Myripristes amaenus). Fishing methods used include nets, spears, traps as well as hook and line.

This survey noted a general paucity of fishes of commercial or recreational interest in the inshore waters at sizes appropriate for exploitation. Many of the individual fish encountered were small suggesting that the Kahe Point area may receive considerable fishing pressure. The encounter of a school of mackerel scad or opelu (Decapterus macarellus) at Station 1 is a "chance encounter" because opelu are a coastal pelagic species that wander over large areas and encountering such a school in a $100m^2$ transect site is not a common event. This chance encounter increased the estimated standing crop at Station 1 from 4 g/m^2 to 771 g/m^2.

The standing crop of fishes on coral reefs is usually in the range of 2 to $200g/m^2$ (Brock 1954, Goldman and Talbot 1975, Brock et al. 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, or to chance encounters such as happened at Station 1, the variation in standing crop appears to be related to the variation in local topographical complexity of the substratum. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fish (2 to $20g/m^2$). Goldman and Talbot (1975) note that the upper limit to fish biomass on coral reefs is about $200g/m^2$. The present study found estimated standing crops in ranges frequently seen at other Hawaiian reef localities (i.e., from 40 to 80 g/m^2).

Water Quality Considerations

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This may occur through natural events such as storm surf resuspending fine material that had previously come into the area through natural events and settled, or by human activities including the directing of storm water runoff into the ocean or by underwater construction activities. Underwater construction (principally dredging) will generate fine particulate material that could impact corals. The generation of fine sedimentary material could have a negative impact to corals and other benthic forms if it occurs in sufficient quantity over sufficient time. Studies (e.g., Dollar and Grigg 1981 noted above) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the trenching activities that would be necessary to protect the cable in shallow water (if used) would probably produce little sediment. The turbidity generated by the construction activities will be short in duration and relatively small in quantity. This statement is supported by the fact that at a maximum, less than 590 lineal feet of hard substratum would be disturbed. The small scale and anticipated short duration of the project suggest a minimal impact. Other than where substratum was completely removed (i.e., in the path of the dredge) impacts to benthic communities from dredging at the West Beach project (within a kilometer of the present proposed cable landing site) that took 19 months to complete were minimal (Brock 1990b).

High water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats thus assisting in the advection of this material out of these areas (less than 300 feet in depth) where corals are found.

Turbidity is a an optical property that is related to the scattering of light by the suspended particles in the water column. The finer the particles, the longer they may remain in suspension (Ekern 1976) and if fine materials are associated with much water motion (waves, currents) the actual deposition rates in these turbid waters may be quite low. However, if the suspended particles (i.e., turbidity) is great enough to reduce light levels, impacts to corals may occur.

The deposition of sediment on coral reefs has been measured and correlated with the "condition" of the reef corals. Loya (1976) defined a "high" sedimentation rate as 15mg/cm^2/day and a "low" rate as 3mg/cm^2/day for Puerto Rican reefs. Low cover and species diversity were associated with reefs exposed to "high" sediment deposition rates. In contrast, "high" sediment deposition rates on Guamian reefs was defined in the range of 160-200mg/cm^2/day and this rate of deposition limited coral cover and diversity (here less than 10 species and 2% cover; Randall and Birkeland 1978). A "low" rate was defined as 32mg/cm^2/day and was associated with rich coral communities (more than 100 species and 12%+ coral cover). These comparisons demonstrate the relative nature of sedimentation rates; the rate considered to be low in Guam is more than twice the high rate from Puerto Rico. Reasons for this disparity relate to differences in how rates are measured (i.e., lack of a standardized methodology) as well as difficulty in relating environmental factors such as water motion and sediment deposition in sediment traps. Water motion may mitigate or enhance the deleterious effects of sedimentation on the diversity and cover of corals in a given area. Hopley and Woesik (1988) note a chronic sedimentation rate of 129mg/cm^2/day (7 month mean) did not negatively impact an Australian coral reef with high cover and species diversity.

These data suggest that if needed as a means for protecting the proposed fiber optic cable in shallow water, the short term disturbance (probably less than two weeks) created by small-scale trenching (probably removing less than 10m^2 of coral) will be a minor impact.

APPENDIX D.

Results of the quantitative visual censuses conduct- ed at five locations offshore of Kahe Point Beach Park, Oahu on 6 December 1991. Each entry in the body of the table represents the total number of individuals of each species seen; totals are presented at the foot of the table along with an estimate of the standing crop (g/m^2) of fishes present at each location.

FAMILY AND SPECIES	STATION NUMBER 1	2	3	4	5
MURAENIDAE					
Gymnothorax meleagris	1	1			
SYNODONTIDAE					
Saurida gracilis		1			
AULOSTOMIDAE					
Aulostomus chinensis			1		
FISTULARIIDAE					
Fistularia commersoni					1
CARANGIDAE					
Decapterus macarellus		400			
Scomberoides laysan					1
MULLIDAE					
Mulloides flavolineatus				7	1
Parupeneus pleurostigma				2	1
P. multifasciatus		6	14	30	34
P. cyclostomus			1		1
CHAETODONTIDAE					
Forcipiger flavissimus		1			
Chaetodon fremblii			1		
C. unimaculatus				2	
C. lunula					1
C. ornatissimus					1
C. multicinctus		2	7	2	

APPENDIX D.
Continued.

FAMILY AND SPECIES	STATION NUMBER 1	2	3	4	5
POMACANTHIDAE					
Centropyge potteri		1			
POMACENTRIDAE					
Dascyllus albisella	8				
Plectroglyphidodon imparipennis					3
P. johnstonianus	4	6			
Chromis vanderbilti	85	167			
Stegastes fasciolatus				1	18
CIRRHITIDAE					
Paracirrhites arcatus	2	4	4	2	
P. forsteri		1			
Cirrhitops fasciatus		3	3		
LABRIDAE					
Cheilinus rhodochrous			1		
C. bimacula		1			
Hemipterontus baldwini		1			
Thalassoma duperrey	14	22	19	15	
T. ballieui		1			
Gomphosus varius	1		1	1	
Coris venusta		1			
Stethojulis balteata			1	1	
Macropharyngodon geoffroy			1		
SCARIDAE					
Calotomus carolinus		1	1	2	
Scarus perspicillatus				11	
S. sordidus		2			
S. psittaceus					3
S. rubroviolaceus		1	1		
BLENNIIDAE					
Exallis brevis				1	

APPENDIX D - Continued

FAMILY AND SPECIES	STATION NUMBER 1	2	3	4	5
GOBIIDAE					
Gnathelepis anjerensis	1				
PARAPERCIDAE					
Parapercis schauslandi	3				
ACANTHURIDAE					
Acanthurus triostegus				1	1
A. leucoparieus					5
A. nigrofuscus		32	37	45	39
A. olivaceus			5	4	
A. dussumieri		1	1		1
A. mata					1
Ctenochaetus strigosus		1	1	8	3
Zebrasoma flavescens				1	5
Naso lituratus		1	2	1	1
N. unicornis			1		
ZANCLIDAE					
Zanclus cornutus			1	1	2
BOTHIDAE					
Bothus pantherinus	1				
BALISTIDAE					
Rhinecanthus rectangulus			1	1	1
Melichthys vidua		1	1		
Sufflamen bursa	1	2	1	1	
SCORPAENIDAE					
Scorpaenopsis diabolus				1	
MONACANTHIDAE					
Pervagor melanocephalus			1		
Cantherhines sandwichiensis		1			
OSTRACIIDAE					
Ostracion meleagris		1			
CANTHIGASTERIDAE					
Canthigaster jactator		3	2	1	1
C. amboinensis					1
Total Number of Species	7	28	29	25	25
Total Number of Individuals	409	181	289	147	142
Estimated Biomass (g/m^2)	771	35	52	89	79

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APPENDIX C

Marine Environmental Analysis of Selected Landing Sites Sandy Beach Park, Oahu

GTE Hawaiian Tel
Interisland Fiber Optic Cable System

MARINE ENVIRONMENTAL ANALYSIS OF SELECTED LANDING SITES

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March 1992

91-85

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I. INTRODUCTION

GENERAL

GTE Hawaiian Tel is planning the installation of an Interisland Fiber Optic Cable System linking the islands of Kauai, Oahu, Maui and Hawaii. The site selection and evaluation process has been underway since early 1991, and Sea Engineering, Inc. has been retained over that period by the R.M. Towill Corporation to evaluate the marine considerations for potential landing sites and to assist in the preparation of the Environmental Assessments for the recommended landing sites. Dr. Richard Brock of the Environmental Assessment Company, a subconsultant to Sea Engineering, Inc., was responsible for characterizing the nearshore marine biological conditions along the cable routes and also assisted with the impact evaluation.

This report describes the nearshore marine selection process, the alternatives considered, the physical and biological characteristics of the nearshore cable routes, and the anticipated marine environmental impacts.

Figure 1 shows the interisland cable configuration and the recommended landing sites.

ROUTE SELECTION PROCESS

This report describes only the nearshore marine considerations of the selection process. Other considerations included land suitability, deep ocean conditions, public usage and terrestrial and marine impacts. A series of two Working Papers, prepared by the R.M. Towill Corporation (1991), describe in detail the overall selection process, the alternatives considered, and the rationale for the recommended routes.

The coastal sector boundaries for the potential cable landing sites were initially defined by two primary constraints:

1. The total cable length between central offices was limited to a maximum of 200 kilometers, and preferably to less than 185 km. Cable lengths over 200 km would require an expensive subsea repeater.

2. Proximity of the cable landing site to a central office was desirable, along with relatively easy access to the central office via available polelines, duct lines, or other GTE infrastructure.

Given these constraints, sectors of coastline were delineated which bounded the potential landing areas. An office evaluation of each coastal sector was then completed, utilizing existing literature, color aerial photographs, marine charts, coastal inventories prepared by state and federal agencies, and personal knowledge of nearshore physical and biological

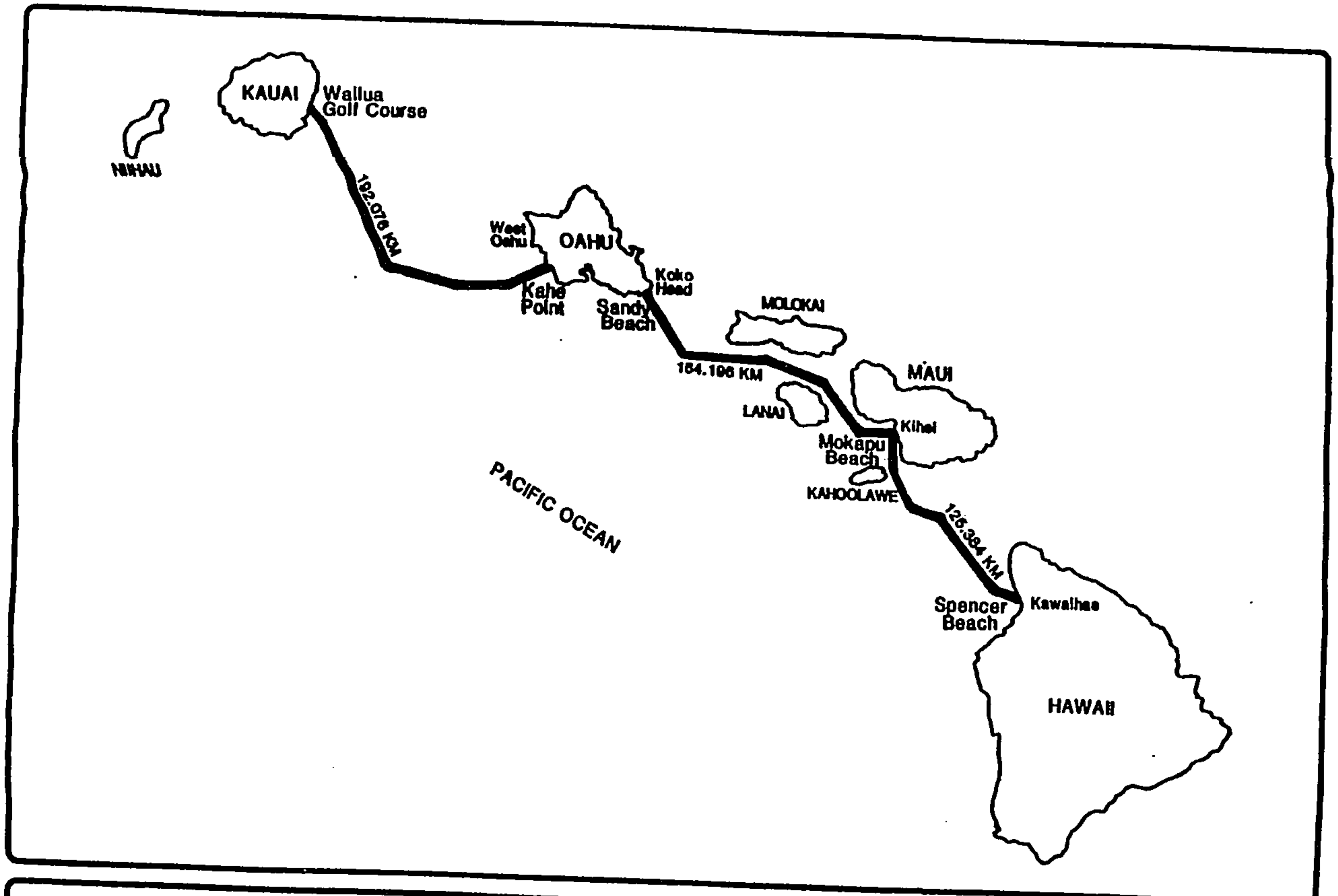


FIGURE 1. SUMMARY OF RECOMMENDED GTE HAWAIIAN TEL FIBER OPTIC LANDING SITES - STATE OF HAWAII

characteristics and uses. A one day field reconnaissance was then conducted in each sector to select three potential landing sites in each sector. If no suitable sites were found within the sector limits, the sector was enlarged as required.

Following the consolidation of all planning considerations mentioned above (terrestrial and marine) a more detailed field study was conducted at each site by an ocean engineer and marine biologist. The objective of this phase was to select the primary and secondary route alternatives.The marine biologist was incorporated into this phase of the study to conduct a preliminary assessment of the selected alternatives and to ensure that there were no overriding environmental constraints.

After initial approval by the client of the recommended route, a detailed bathymetric survey was conducted at each site. During this survey, while accurate positioning equipment was available, a diver was towed along the route centerline, and his visual observations were correlated with the track line and the water depth. This step provided valuable information about the precise conditions along the route, and also ensured that there were no unexpected conditions in the nearshore area.

One additional field trip was made to each site, for the express purpose of describing the physical and biological characteristics of the route and adjacent areas, and to evaluate the potential environmental impacts.

The limit of the diving surveys was the 100 foot depth contour. However, the diving support vessels were equipped with fathometers, and preliminary track lines were run to approximately the 180 foot depth to ensure that no steep ledges were encountered beyond the limit of the visual survey.

MARINE SELECTION CRITERIA FOR NEARSHORE CABLE ROUTE EVALUATION

Throughout the cable route selection and evaluation process the primary objective was to find a suitable, safe cable route which would also result in the minimum environmental impacts for in that sector.

Specific selection criteria included the following:

1. Sandy bottoms and coastlines were preferred, both for integrity of the cable and to minimize environmental impacts. Experience at other cable landing sites on Oahu (Makua Beach, Makaha Beach and Nanakuli Beach) indicates that cables on sandy bottoms tend to sink into the sand. No cable cross section is exposed, and wave forces on the cables are therefore minimal. In most of these areas, the winter surf and shorebreak can be very large, yet the numerous cables making landfall there have remained stable.

   Hawaii beaches are usually in a dynamic balance with a large offshore sand deposit, and the two are frequently linked by a continuous sand channel, thus providing the ideal configuration for a cable route. In addition to the engineering advantages, the environmental effects of a placing a cable on a sandy bottom are much less than placing one across a diverse coral community.

2. Minimizing the horizontal distance from the shoreline to the 60 foot depth was another important factor. This is the zone of maximum wave forces, and the assumption was made that some form of cable protection or anchoring would be required when crossing any hard bottom inshore of the 60 foot contour. This distance also affects the cable landing process. The cable ship can approach shore to approximately the 50 or 60 foot depth, where it is then held in place by tug boats. As the cable is towed to shore by a small boat or tug, floats are attached to the cable as it is paid out, so that it floats on the surface until the shore connection is secured. During this time, the cable position must be maintained along the route centerline. Strong currents or long distances make this process more difficult. The goal was to select a route where the distance from shore to the 60 foot contour was less than 4000 feet.

3. There is a semi-continuous ledge which drops off from the 60 foot contour, and extends through many of the coastal sectors of Hawaii. This ledge was formed during an ancient stand of the sea, and typically has a vertical drop of 30 feet or more. This ledge was present in the Kauai sector, both Oahu sectors and the Maui sector. It was therefore important to find a route which either avoided the ledge or passed through a channel in the ledge. Fortunately, the sand channels connecting the beaches to the deeper offshore deposits often bisect the ledge.

4. Routes were selected to avoid, to the maximum extent possible, environmentally sensitive areas or areas frequented by rare or endangered species. A specific example was the avoidance of areas used by green sea turtles for resting or forage. The marine biological consultant was an early participant in the study, so that environmental input was received during the initial route evaluations.

II. GENERAL OCEANOGRAPHIC CHARACTERISTICS

WINDS

The predominant winds in the Hawaiian Islands are the northeast trades, which are present approximately 70 percent of the time with an average speed of 13 mph. The frequency of tradewinds varies greatly with the season. They occur 90 percent of the time during the months of April to October. The winter season (November to March) is defined by a weakening of the high pressure system generating the tradewinds, and the frequency of occurrence decreases to approximately 50 percent. During the winter season, low pressure systems periodically displace the tradewinds, resulting in south or southwest winds known as "Kona" winds. Kona winds, which occur rarely in summer and 17 percent of the time in the winter, range from light and variable to gale or hurricane force.

PREVAILING WAVE CLIMATE

The general Hawaiian wave climate can be described by four primary wave types; the northeast tradewind waves, south swell, North Pacific swell and kona storm waves. These wave types and their general approach direction are shown on Figure 2.

Tradewind waves may be present in Hawaiian waters throughout the year, but are most frequent in the summer season, between April and September, when they usually dominate the Hawaiian wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Typical deepwater tradewind waves have periods of 5 to 8 seconds and heights of 4 to 10 feet. During gale conditions tradewind waves may reach heights in excess of 20 feet.

South swell is generated by southern hemisphere storms, and is most prevalent during the months of April through October. These long, low waves approach from the southeast through southwest, with typical periods of 12 to 20 seconds and deepwater heights of 1 to 4 feet. Although their deepwater height is relatively low, the long period results in considerable shoaling near shore with resultant large breaker heights. The surf along the exposed south shores of the islands occasionally reaches heights of 15 feet.

North Pacific swell is produced by winter storms in the North Pacific Ocean and by mid-latitude low pressure areas. North swell may arrive in the Hawaiian Islands throughout the year, but is largest and most frequent during the winter months of October through March. North Pacific swell typically has periods of 12 to 20 seconds and deepwater heights of 5 to 15 feet. The approach direction is typically from the west-northwest through north-northeast. North Pacific swell results in some of the largest waves in Hawaiian waters. For example, breaking wave heights approaching 50 feet were observed in December 1969.

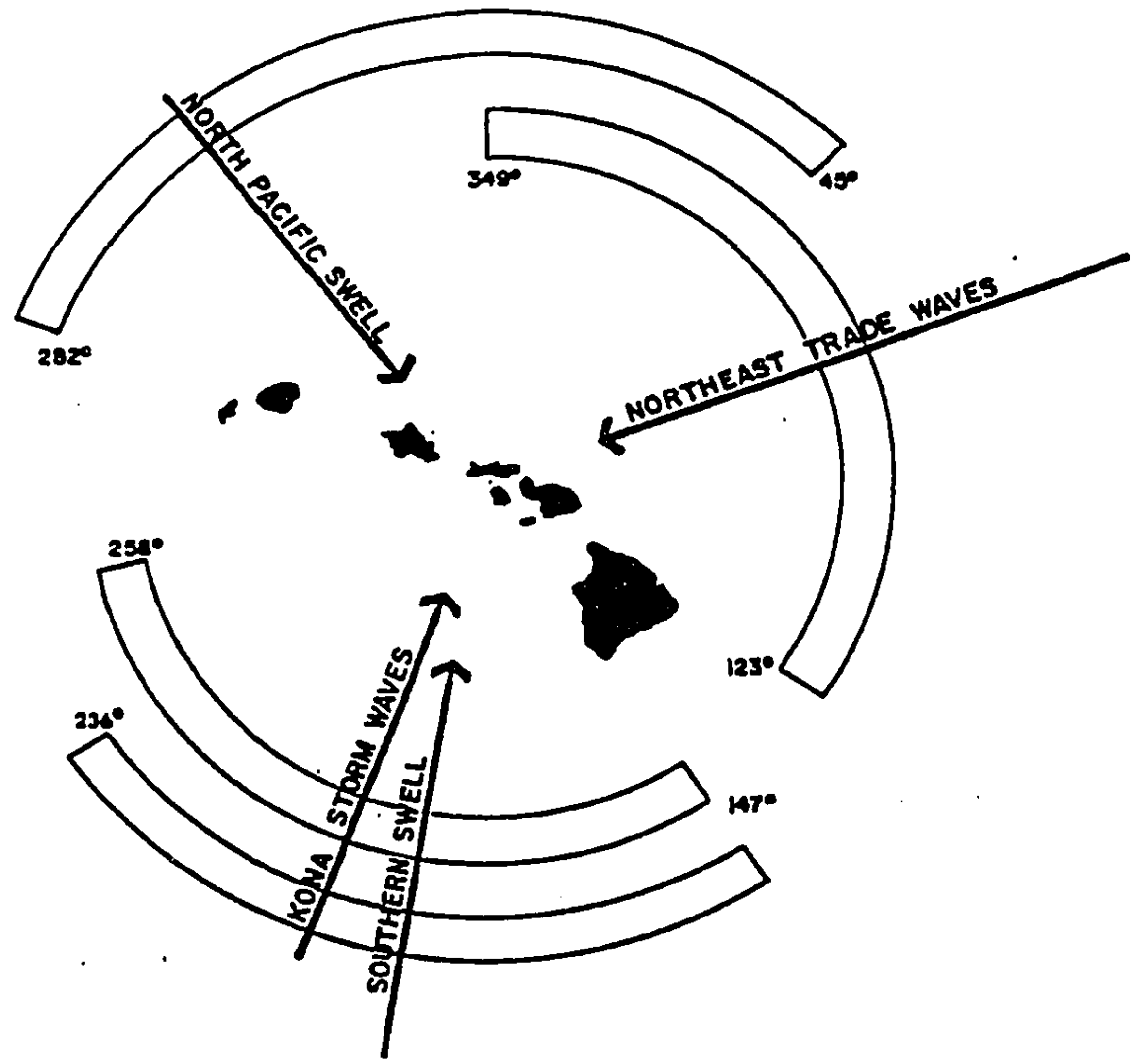


FIGURE II-1.
GENERALIZED WAVE TYPES
(Adapted From The Atlas of Hawaii)

Kona storm waves are generated by intense winds associated with local fronts or low pressure systems and typically have periods ranging from 6 to 10 seconds and typical heights up to 10 feet, but during severe storms heights can approach 20 feet. These waves are most common in late winter and early spring, approaching from the south to southwest.

Hurricane Storm Waves

Hurricanes form near the equator, and in the central North Pacific usually move toward the west or northwest. The primary hurricane season is July through September. These tropical storms or hurricanes usually pass south of the Hawaiian Islands, with a northward curvature near the islands. Late season tropical storms and hurricanes follow a somewhat different track, forming south of Hawaii and moving north toward the islands.

There are many recorded tropical storms or hurricanes which have approached the Hawaiian Islands during the past 35 years, and hurricane waves are generally selected as the design criteria for coastal projects. Most of these storms passed well south or west of the islands, or weakened in intensity as they reach Hawaii, but there have been notable exceptions. Hurricanes Hiki, Della, Nina and Fico passed within about 200 miles of the islands, Dot passed over Kauai, and Iwa passed with 30 miles of Kauai. Kauai.

The report Hurricanes in Hawaii (Haraguchi, 1984), prepared for the U.S. Army Corps of Engineers presents hypothetical model hurricanes for the Hawaiian Islands. The model Hawaiian Hurricane is defined as the probable hurricane that will strike the Hawaiian Islands in the future. The characteristics of the model hurricane are based on the characteristics of hurricanes Dot and Iwa. The predicted wave height and period for the model hurricane are calculated to be 31 feet and 12.0 seconds. This is a worst case scenario; the actual likelihood of this occurring at one particular site is very low. It is more likely that the storm would pass at some distance, thus the wave height at a particular site would depend on the storm track and decay distance over which the waves travel.

TIDES

The tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e. two tidal cycles per day with the range of water levels being unequal). The average daily tidal range is approximately 2 feet, and the maximum annual range is 2.8 feet.

COASTAL CURRENTS

Coastal currents in Hawaii are influenced by several factors: large scale oceanic currents, tidal currents, wind-driven currents, waves, and island topography. Hawaii is located in the region of the Pacific North Equatorial current, which generally flows to the west with current speeds ranging from 0.1 to 1 knot. The current direction may vary from west southwest to north-northwest, and the average speed is estimated to be approximately 0.5 knots. Eddies may form in this current as it passes through the islands. Large scale eddies may also be caused by wind circulation patterns around the large mountains on the islands, and small scale eddies may be caused by local landforms.

In most nearshore locations in Hawaii, the tidal flow is the primary current component. Tidal currents are reversing and generally follow bathymetric contours. The maximum tidal current speed in most locations is 2 knots, with speeds of 0.3 to 1.0 knot being typical. Surface currents are modified by the prevailing winds. Past studies around Oahu have indicated that the top 5 to 15 feet of the water column is influenced during moderate trade wind conditions.

The resultant circulation at any particular location is due to a combination of the above factors.

TSUNAMIS

Tsunamis, or seismic sea waves, are primarily generated by submarine earthquakes and earth movement with magnitudes greater than about 6.5 on the Richter scale. Coastal and submarine landslides and volcanic eruptions can also generate tsunamis. The Hawaiian Islands are directly exposed to the major tsunami wave generating areas in the Pacific Ocean: the Kuril-Kamchatka-Aleutian region of the north and northwestern Pacific, the west coast of South America, and the seismically active southwest Pacific. Over 80 tsunamis have been observed in the Hawaiian Islands since 1813, and 22 of them resulted in significant damage. The most damaging occurred in 1946 when an earthquake in the East Aleutian Islands generated a tsunami which killed 173 people in Hawaii and caused $26 million in property damage in Hilo alone.

Tsunami wave periods vary from 5 minutes to over 1 hour. Tsunami wave heights in the deep ocean are only a foot or two and their passage is generally not noticeable. However, in coastal regions, the tsunami wave may be subject to extensive transformation by the shallow water processes of refraction and shoaling, and also resonance in bays and harbors, and it may result in a much amplified wave height at the shoreline. A manual was developed for the U.S. Army Corps of Engineers, Pacific Ocean Division to determine tsunami wave elevations along the coastlines of Hawaii for various frequencies of occurrence (M & E Pacific, Inc., 1978). Tsunami runup elevations computed for 50 and 100 year tsunamis in the landing site areas are presented in later sections of this report, with the calculations based upon procedures in the manual.

III. METHODOLOGY FOR MARINE BIOLOGICAL SURVEYS

GENERAL

The quantitative sampling of macrofauna of marine communities presents a number of problems; many of these are related to the scale on which one wishes to quantitatively enumerate organism abundance. Marine communities in the areas surveyed for this project may be spatially defined in a range on the order of a few hundred square centimeters (such as the community residing in a Pocillopora meandrina coral head) to major biotopes covering many hectares. Recognizing this ecological characteristic, the sampling program was designed to delineate all major communities in the limits of the study areas and to quantitatively describe these communities. Thus a number of methods were used.

To obtain an overall perspective on the extent of the major communities or "zones" occurring in the study area, divers were slowly towed behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. This exercise allowed the qualitative delineation of major biotopes based partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each of these, stations were established and quantitative studies were conducted, including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrants. Besides these quantitative measures, a qualitative reconnaissance was made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments were carried out using SCUBA.

Biotopes are defined by physical characteristics including water depth, relative exposure to wave and current action, and the major structural elements present in benthic communities. The latter include the amount of sand, hard substratum, and vertical relief present as well as the biological attributes of relative coral coverage, fish abundance, and dominant species of the coral community. Biotopes are named for the distinctive features of the zone. It should be noted that the boundaries of each zone are not sharp but rather grade from one to another; these are ecotones or zones of transition.

The locations of stations were subjectively chosen as being representative of a given biotope. Immediately following station selection, a visual census of fishes was undertaken to estimate their abundance. These censuses were conducted over a 4 x 25 meter corridor and all fishes within this area from the bottom to the water surface were counted. Data collected included the number of individuals of each species as well as an estimate of individual lengths of all fishes seen; the length data were later utilized in estimating the standing crop of fishes present at each station using linear regression techniques (Ricker 1975, Brock and Norris 1989). A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 25m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels or puhis (family Muraenidae) and nocturnal species, e.g., squirrel fishes or ala'ihis (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus or rockfishes, family Scorpaenidae; the flat fishes or paki'is, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any comparisons between surveys. In the present study, one individual carried out all of the visual censuses. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2cm in some dimension (without disturbing the substratum) were censused in a 4 x 25m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some sea urchins and sea cucumbers). Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae were quantitatively surveyed by use of quadrants and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points were assessed (once every 50cm). These data have been converted to percentages. Quadrant sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in six one-meter square frames placed at five-meter intervals along the transect line established for fish censusing (at 0, 5, 10, 15, 20 and 25m).

If macrothalloid algae were encountered in the 1 x 1m quadrants or under one of the 50 points, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats.

During the course of the fieldwork notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near the study area. With green turtles, efforts were made to record the size (straight line carapace length) of the individuals seen as well as the presence of tags, tumors or any deformities. We also attempted to note the presence of appropriate resting and foraging areas for green turtles.

IV. SANDY BEACH

ALTERNATIVES CONSIDERED

The area initially considered for the east Oahu cable landing extended from the Hawaii Kai Marina entrance channel to the north end of Kailua Bay, a distance of approximately 18 miles. This sector is shown on Figure IV-1 and encompasses some of the most rugged coastline on Oahu. Potential cable landing sites along this coastline are limited, and none are ideal. The areas initially considered but not selected are discussed below:

1. Hawaii Kai: Disadvantages at this location include the lack of offshore sand deposits and sandy beaches to utilize for a cable landing. The fringing reef off Hawaii Kai is approximately 3500 feet wide and is environmentally sensitive. In addition, the 60 foot contour is located 9000 feet offshore. This would have necessitated a long length of protected cable and a long and difficult cable pull to shore during the initial installation.

2. Makapuu Beach: A sand channel extending seaward from the south side of the beach provides a potential cable route. However, extremely heavy recreational use and the difficulty of heavy equipment access to that part of the beach precluded further consideration of this site.

3. Makai Research Pier: An advantage of this site is that the cable could make landfall at the end of the pier, thereby shortening the ocean route by 900 feet, and eliminating passage through the surf zone. A cable route located between Rabbit Island and Black Rock just to the south would minimize the distance between the landfall and the 60 foot contour. The bottom from the pier to Rabbit Island is composed of hard substrate, but is relatively flat. At the 35 foot depth contour, located 5000 from the end of the pier, a 30 foot vertical ledge drops to the 60 to 70 foot water depth. The cable would require protection from the ledge shoreward.

4. Waimanalo and Kailua Bays: Both these areas were extensively investigated, but a major disadvantage of this entire sector is the distance from the 60 foot contour to the shoreline, and the absence of suitable sand channels. This distance to the 60 foot contour varies from 9000 to 10000 feet throughout this area. In Waimanalo Bay, potential routes were found where the inshore 3500 feet were predominantly sand, but cable protection would have been required for the remaining 5500 feet. A shallow reef defines the seaward boundary of Waimanalo Bay, and also marks the end of the sand bottom. The reef is 4 to 8 feet deep, and is very irregular, with vertical relief of up to 8 feet. This zone extends seaward for approximately 2000 feet, out to the 20 foot depth contour. This shallow reef would present a formidable obstacle to cable placement, since this zone is also subjected to significant wave energy. Seaward of the this zone, the bottom is limestone rock and coral.

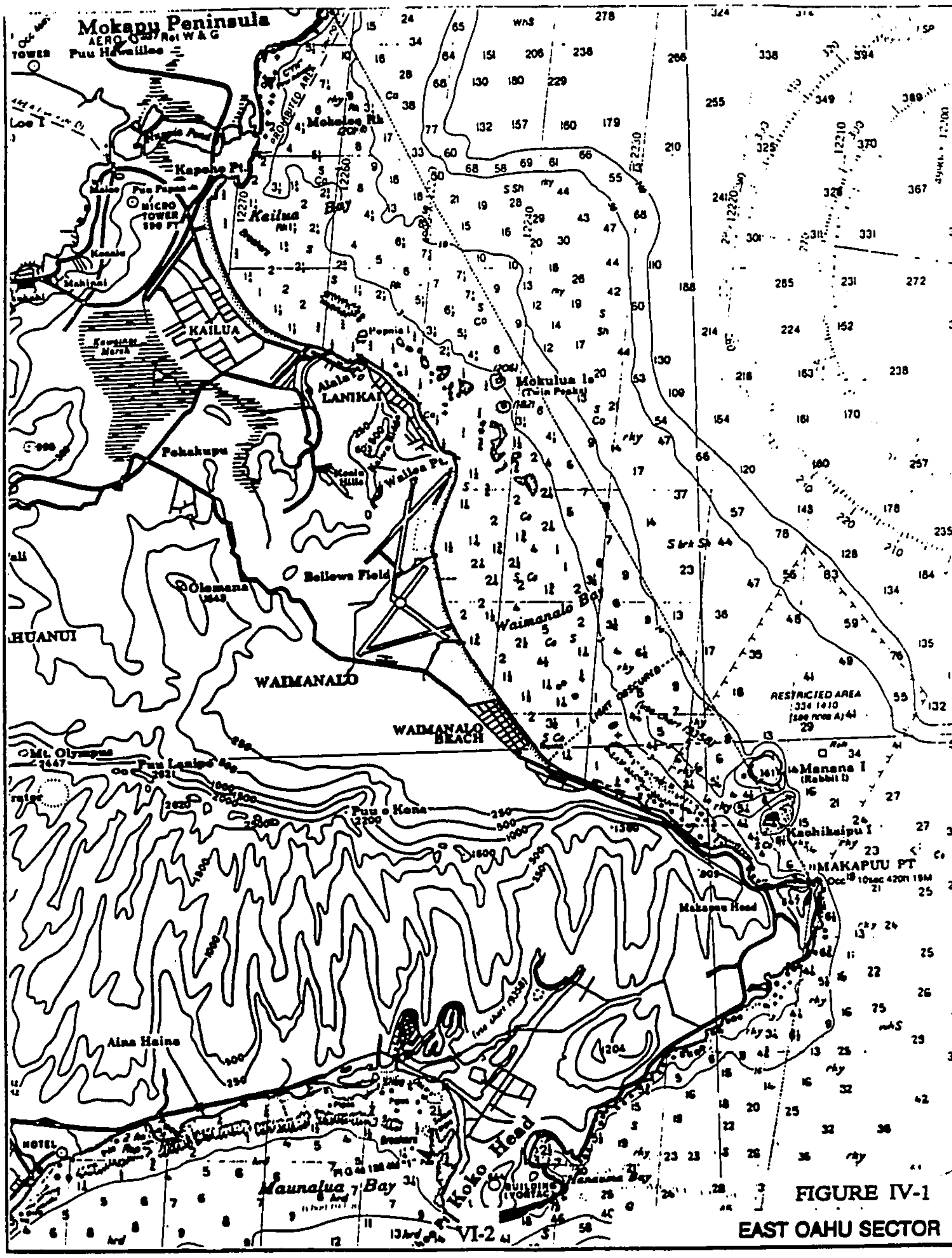


FIGURE IV-1
EAST OAHU SECTOR

There are no sand channels or deposits, but the bottom is relatively flat. Kailua Bay is very similar to Waimanalo Bay. There is one large offshore sand channel, but it is very irregular with steep ledges on its borders. A cable into Kailua Bay would cross predominately hard bottom and, in most areas, an irregular shallow reef just offshore.

DESCRIPTION OF THE SELECTED ROUTE

General

The recommended landing site is located at the eastern end of Sandy Beach in Keawaakio Cove. Figure IV-2, taken from the Oahu Coral Reef Inventory, shows details of the area. The Kalanianaole Highway bounds one side of the beach area. The waterline consists primarily of a rough basalt lava shelf and boulders that makes access to the water difficult. A narrow sand beach that is popular for sunbathing lies between the basalt shelf and the road. The beach is composed of medium grained, well sorted, calcareous sand. The nearshore bottom consists of hard rock. There is no fringing reef offshore; this shoreline is therefore fully exposed to storm waves and strong currents.

Shoreline History

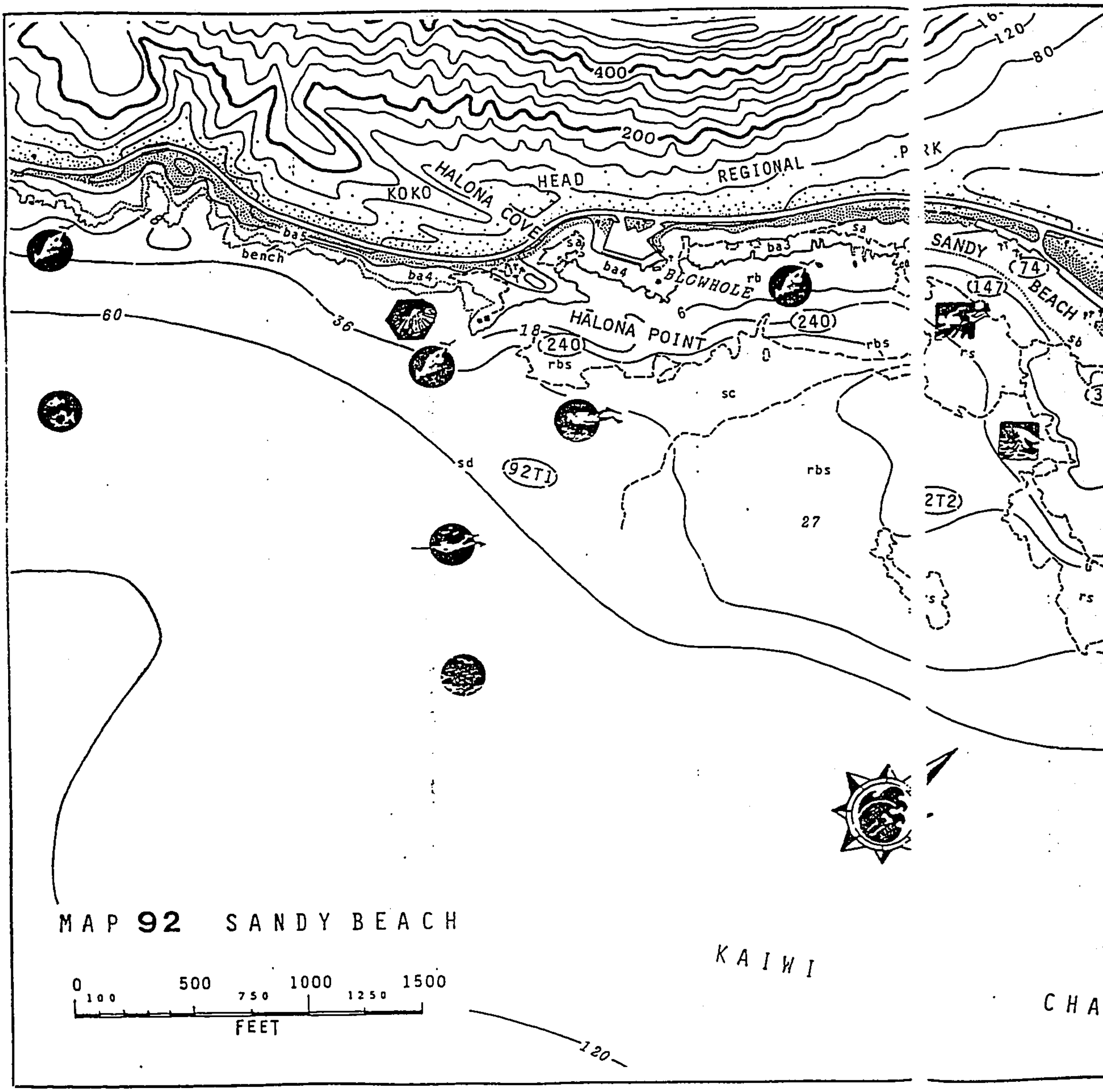
The beach at Keawaakio Cove lies landward of a basalt lava shelf located at the waterline. The lava shelf shelters the sandy areas from typical coastal processes that cause accretion and erosion. The beach has therefore remained relatively stable.

Existing Usage

The shoreline at Keawaakio Cove is heavily used because of its proximity to the comfort station and parking area. Because of the rocky shoreline and difficult ocean access, the recreational uses are primarily sunbathing and pole fishing. Experienced spear fishermen may enter the water at the cove, since there is less wave action here than at other locations within the park. There are no surf breaks within the cove. The main beach area of Sandy Beach begins 500 to 1000 feet to the west of the cove and is heavily used for beach and water activities. Additional facilities at Sandy Beach include another comfort stations, two lifeguard towers, and two other parking areas. The main beach area is heavily used for sunbathing, body surfing, and board surfing.

Physical Characteristics of the Selected Route

Figure IV-3 shows the orientation of the recommended cable route. The selection is based upon several localized factors:



MAP 92 SANDY BEACH

0 100 500 750 1000 1250 1500
FEET

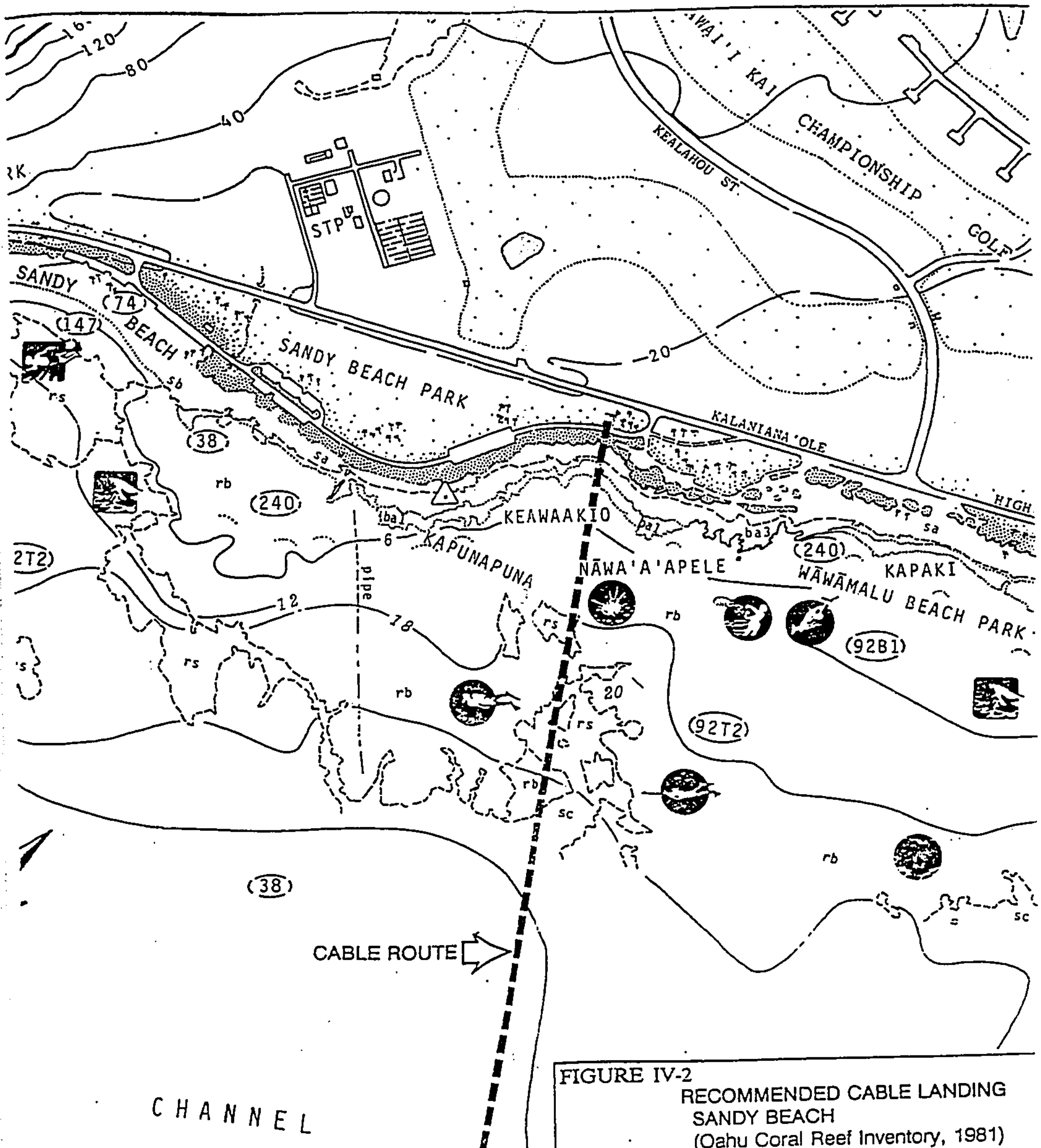


FIGURE IV-2
RECOMMENDED CABLE LANDING
SANDY BEACH
(Oahu Coral Reef Inventory, 1981)

1. This route avoids the 60 foot ledge that parallels much of the Sandy Beach coastline. This ledge has vertical drops of up to 30 feet, and presents a major obstacle to cable placement.

2. As shown in Figure IV-3, the route takes maximum advantage of the offshore sand channel, which has a finger extending toward the shoreline.

3. The route makes landfall on the east side of the cove, which has less inshore vertical relief than the west side.

4. The route is oriented along an azimuth of 147 degrees relative to true north. This route results in the cable reaching deep water over a shorter distance than a more easterly orientation would. Just east of the recommended route, the 60 foot contour curves seaward. The recommended route is a compromise between the use of the sand channel and reaching deep water as quickly as possible.

Figure IV-4 shows a schematic view of the bottom conditions encountered along the route out to water depths of 100 feet. The physical characteristics of the bottom can be described by five zones. Zone 1, which begins just seaward of the rock shelf at the shoreline, extends 500 feet seaward. The bottom in this zone consists of a relatively flat limestone shelf, with numerous small to medium sized boulders (1 to 2 foot diameter). There are some scattered larger boulders (3 to 4 foot diameter), particularly in the shallower water. Photo IV-1 shows typical bottom conditions in this zone. The water depth at the seaward end of this zone is approximately 15 to 18 feet.

In Zone 2, the limestone shelf continues seaward, but becomes noticeably more irregular, with ledges, surge channels, depressions and other irregularities with vertical relief on the order of 3 to 7 feet. Photo IV-2 shows typical conditions in this area, which is 100 to 150 feet wide.

Zone 3 is a 350 foot wide band of relatively flat exposed limestone shelf. There are scattered coral heads on the shelf and vertical relief is on the order of 1 to 2 feet. Photo IV-3 shows typical conditions in this zone. The water depth at the seaward end of this zone, 930 feet from shore, is approximately 32 feet.

From the seaward end of the limestone shelf to the 70 foot depth contour, located 2500 feet offshore, the bottom is primarily sand. Because the sand deposit is irregular, the cable will cross two limestone spurs in this zone (shown on Figure IV-4), with a total width of approximately 250 feet. The conditions on the two spurs are very similar to those in Zone 3, with scattered coral heads and some sand.

Seaward of the 70 foot depth, the bottom consists of coral rubble, scattered sand, and scattered limestone mounds and ledges. The rubble bottom is relatively flat, and relief in the areas of the mounds and ledges is typically 3 feet. Photo IV-4 is a typical view of the coral rubble bottom.

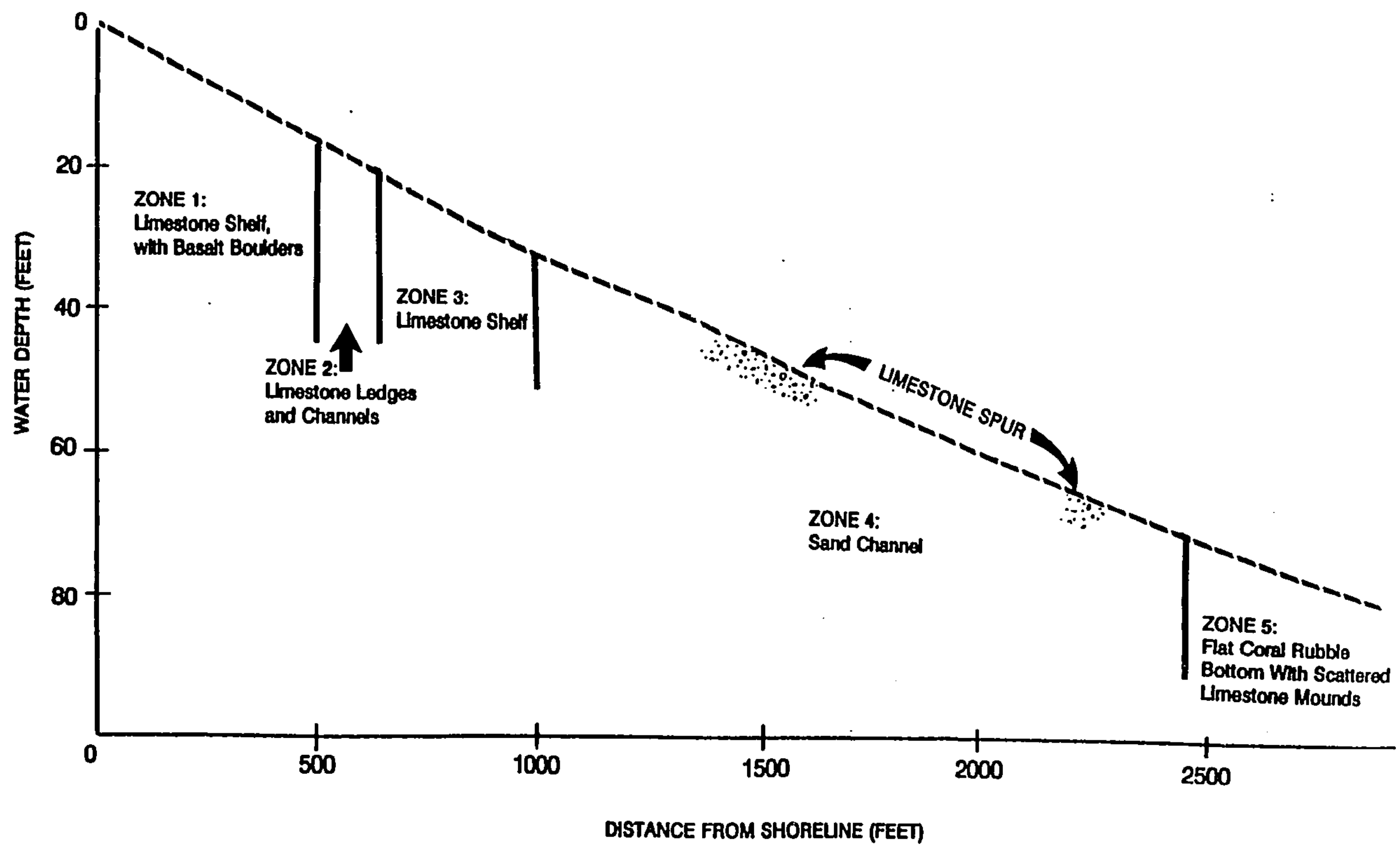
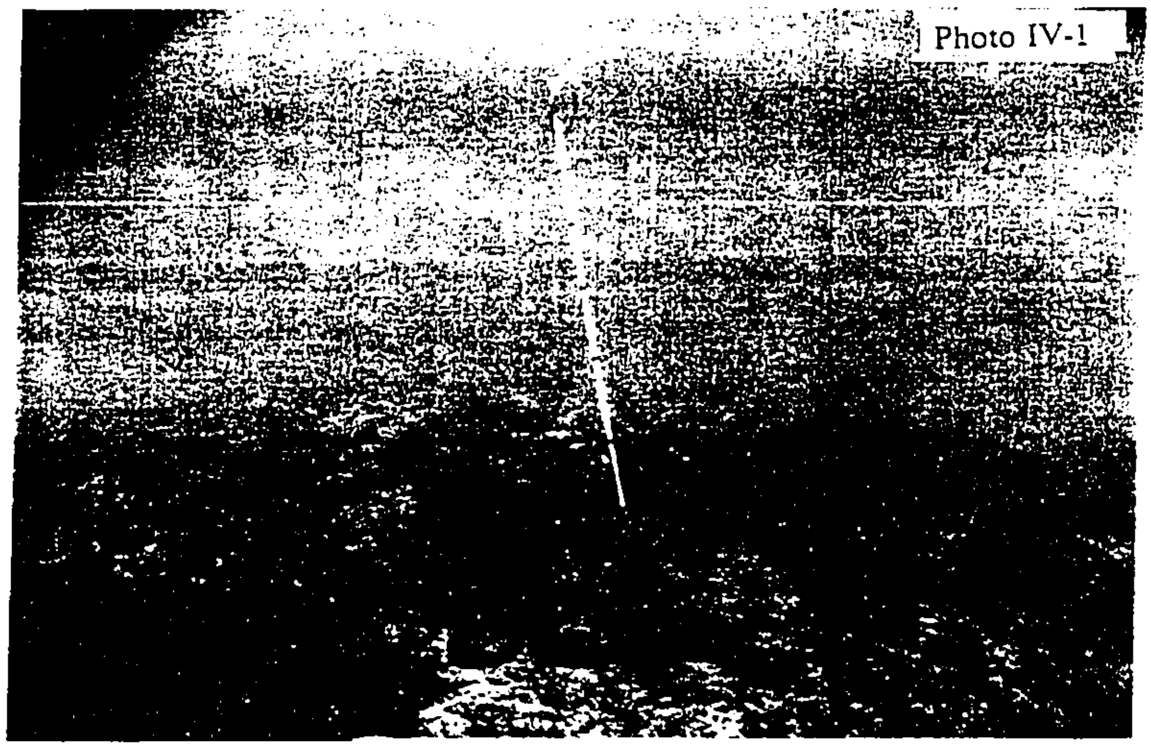


FIGURE IV-4

SCHEMATIC VIEW OF BOTTOM
CONDITIONS [PROPOSED ...]

Photo IV-1

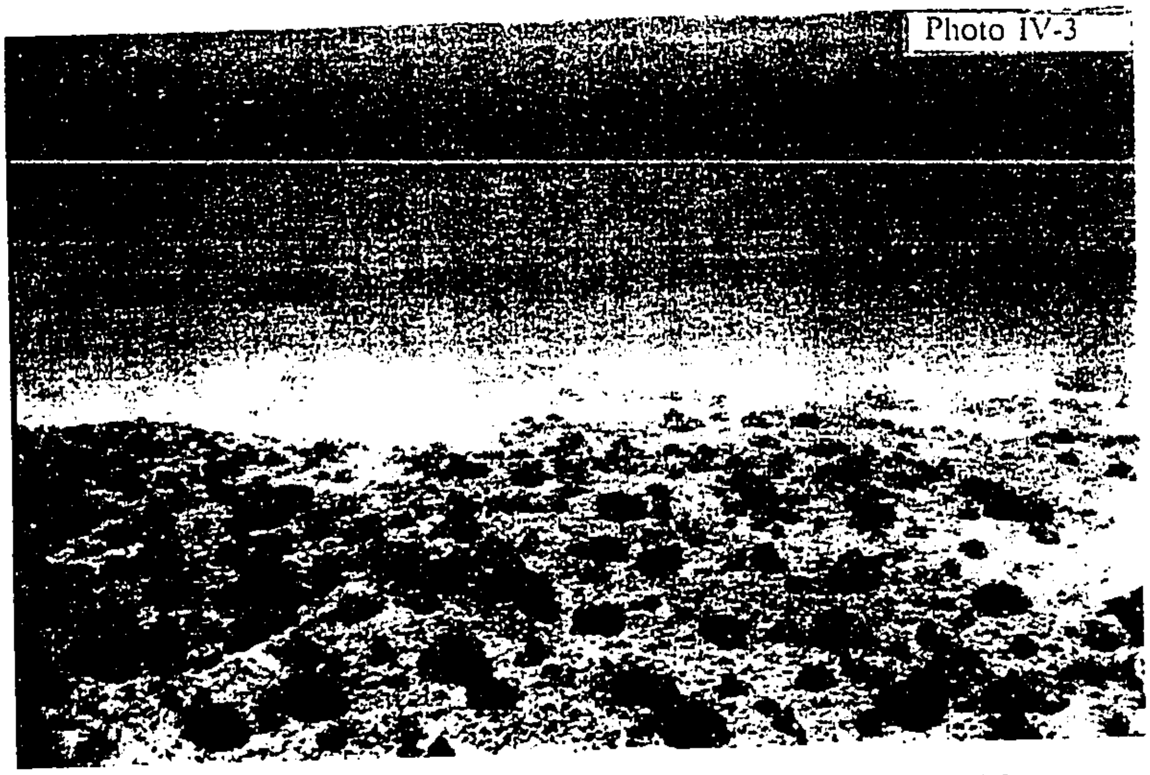


TYPICAL ZONE 1 (SHORELINE TO 20 FT) VIEW.
BOULDERS AND HARD SUBSTRATE VISIBLE IN PHOTO

Photo IV-2

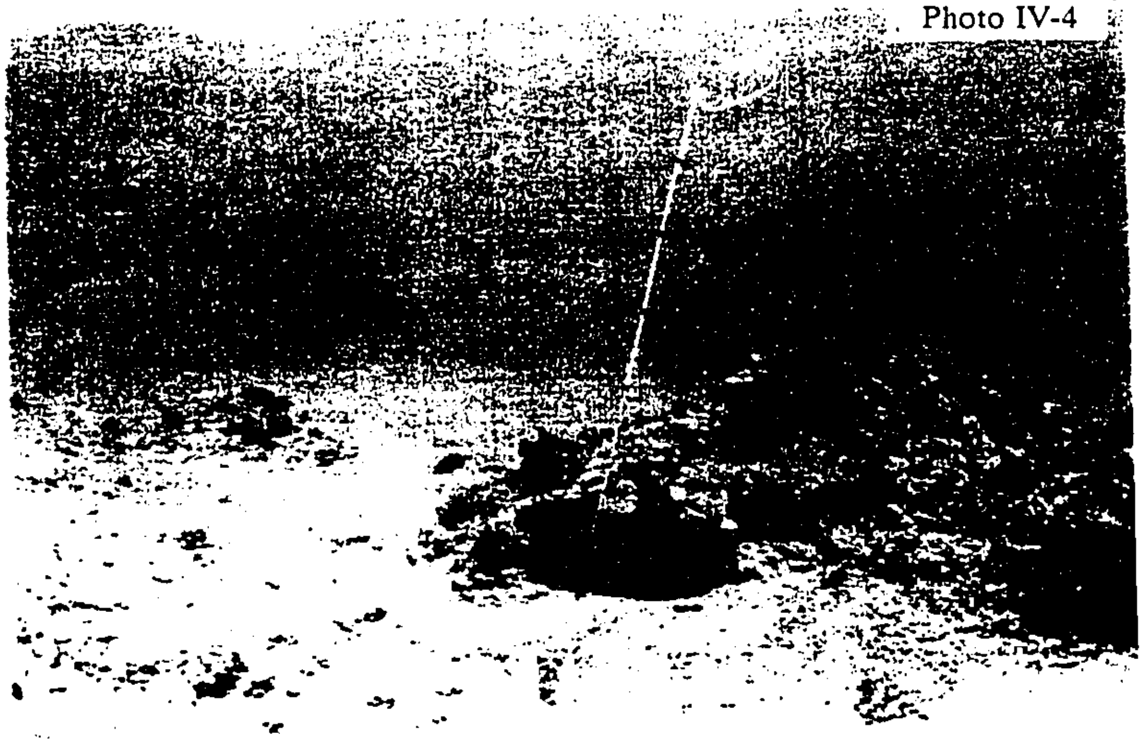
VIEW LOOKING SHOREWARD IN ZONE 2, THE NARROW BAND OF HIGH RELIEF

Photo IV-3



EMERGENT LIMESTONE SHELF, TYPICAL OF ZONE 3 AND THE TWO LIMESTONE SPURS IN ZONE 4. SAND DEPOSIT IN BACKGROUND

Photo IV-4



TYPICAL BOTTOM IN THE 80-100 FOOT DEPTH RANGE. LIMESTONE MOUND IN RIGHT FOREGROUND, WITH FLAT CORAL RUBBLE/SAND BOTTOM IN BACKGROUND

The discussion above describes conditions along the recommended route. It is possible, after completion of the cable vendor's subsequent side scan and subbottom surveys, that the route orientation could be slightly changed. Although the exact location of the limestone spurs in Zone 4 will change, as long as the cable makes landfall in Keawaakio Cove, and follows the general longitudinal axis of the sand channel, the above description will apply.

OCEANOGRAPHIC CONDITIONS

The waters in the vicinity of the Sandy Beach landing site are directly exposed to tradewind waves, Kona storm waves and south swell. The winter season north Pacific swell also refracts into the area. As a result, the Sandy Beach area is frequently rough. However, either because of the orientation of the bottom or the coastline configuration, the breaking wave climate in Keawaakio Cove is noticeably milder than at the adjacent Sandy Beach areas. There are popular surf sites both east and west of the cove, but none in the cove.

The site is directly exposed to hurricane generated waves, so the design wave height for the determination of cable protection requirements will be in the range of 25 to 30 feet, depending upon the acceptable degree of risk.

The offshore currents are strong, and often, but not always, reverse with the semidiurnal tide. The prevailing currents parallel the offshore bottom contours. Average current speed in the nearshore area is 0.3 to 0.4 knots, with an approximate maximum of 2.0 knots.

This reach of coast is subject to tsunami flooding. A runup of 23 feet was recorded just east of Halona Point during the 1946 tsunami. The estimated 50 and 100 year tsunami elevations for the Sandy Beach Area are 11.5 and 16 feet, respectively.

The offshore waters in the area have been classified as Class A waters by the Hawaii State Department of Health. An ocean outfall exits the shoreline between the main Sandy Beach area and Keawaakio Cove and discharges up to 5 million gallons per day of treated sewage. The outfall terminates 1400 feet offshore, in 46 feet of water.

DESCRIPTION OF THE PROPOSED PROJECT

A description of the cable landing process and the associated onshore work is described in the Environmental Assessment that accompanies this report. Accordingly, this section describes the work that will be required in the nearshore zone. The inshore section of the fiber optic cable will be double armored to resist chafing and abrasion. Additional protection, in the form of anchoring or trenching, is anticipated along at least the inshore 950 feet of the route, until the cable daylights into the sand channel at a depth of approximately 32 feet. The exact method will depend upon the selected vendor and the preferences and experience of that vendor, but one of the two following work sequences is the most likely:

1. Complete the initial shore landing with no preparatory work on the bottom. Divers would then remove localized high spots and other obstructions to obtain a relatively uniform channel next to the cable. The cable would then be shifted into this channel, and split pipe casing installed around the inshore 950 feet of cable. This casing is supplied in 39 inch lengths and is bolted in place around the cable. Sections are connected by articulated ball joints to allow conformance to the varying bottom terrain. The casing would also be bolted to the bottom to prevent movement. This methods would utilize a small work boat, and the divers would be equipped with either hydraulic or pneumatic tools. Since the excavation would be done by hand, and only where needed, this method would result in the least environmental impact.

2. This second method would involve clearing high spots, boulders and other obstructions prior to the cable landing. A barge equipped with a clamshell bucket would probably be used. The cable would then be laid in the prepared channel, and divers would then install the split pipe casing and bolt it to the bottom. The use of the clamshell bucket would clear a wider path (estimated at 5 feet) than in the above method, and the associated environmental effects would be correspondingly greater.

In addition to the inshore 950 feet, protection may also be required where the two limestone spurs cross Zone 4, for a total protected length of 1200 feet. Although limited manual probing indicated a relatively thin sand deposit in Zone 4, it is extensive enough so that the cable will eventually be covered and protected against wave forces. It is assumed that protection will not be required in the sand or in the rubble and limestone area (Zone 5) beyond the 70 foot depth.

Estimated duration of the follow up work after the initial cable landing is estimated to be 25 to 30 working days for either of the above two methods. The approximate cost of the in-water work is estimated to be $200,000.

No blasting or extensive trenching will be required during the cable protection process.

MARINE BIOLOGICAL SETTING

The qualitative reconnaissance of Sandy Beach cable route was carried out on 19 June 1991 and the quantitative sampling of this site was done on 7 January 1992. The qualitative survey extended to about the 100 foot depth approximately 2500 feet from shore. In this area four major biological zones or biotopes were defined. In general, the biotopes approximately parallel shore, but along the proposed cable alignment, the most seaward biotope (the biotope of sand) extends into shallow water towards the beach. As discussed previously, the presence of sand was an important factor in the selection of the route. The biotopes recognized in the vicinity of the proposed cable alignment at Sandy Beach are the biotope of sand, the biotope of emergent hard substratum, the biotope of small channels and the high energy cobble/boulder biotope. The boundaries of these biotopes are shown in Figure IV-5. These biotopes correspond very closely to the zones used to describe the physical characteristics of the bottom along the cable route (see Figure IV-4 for comparison).

The biotope of sand is situated primarily seaward of the project area but encroaches as small channels well into the study site to within 1000 feet of shore. Shoreward of the biotope of sand is the biotope of emergent hard substratum which is encountered at depths from about 40 feet (1200 feet offshore) to 80 feet (about 2000 feet offshore). The biotope of shallow channels is found in shallower water in depths from 20 to 40 feet. The high energy cobble/boulder biotope extends from shore to about the 20 foot depth 900 feet offshore.

The Biotope of Sand

The biotope of sand occurs as a pie shaped wedge pointed toward the shoreline in the area proposed for the cable alignment. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Thus many species in the sand biotope are cryptic and difficult to see; among those are many of the molluscs and crustaceans such as the kona crab (Ranina serrata). Hence, without considerable time spent searching in the sand many species will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant. Therefore, the inshore boundary of this biotope is arbitrarily shown well offshore in Figure IV-5 despite the presence of considerable sand shoreward of this point.

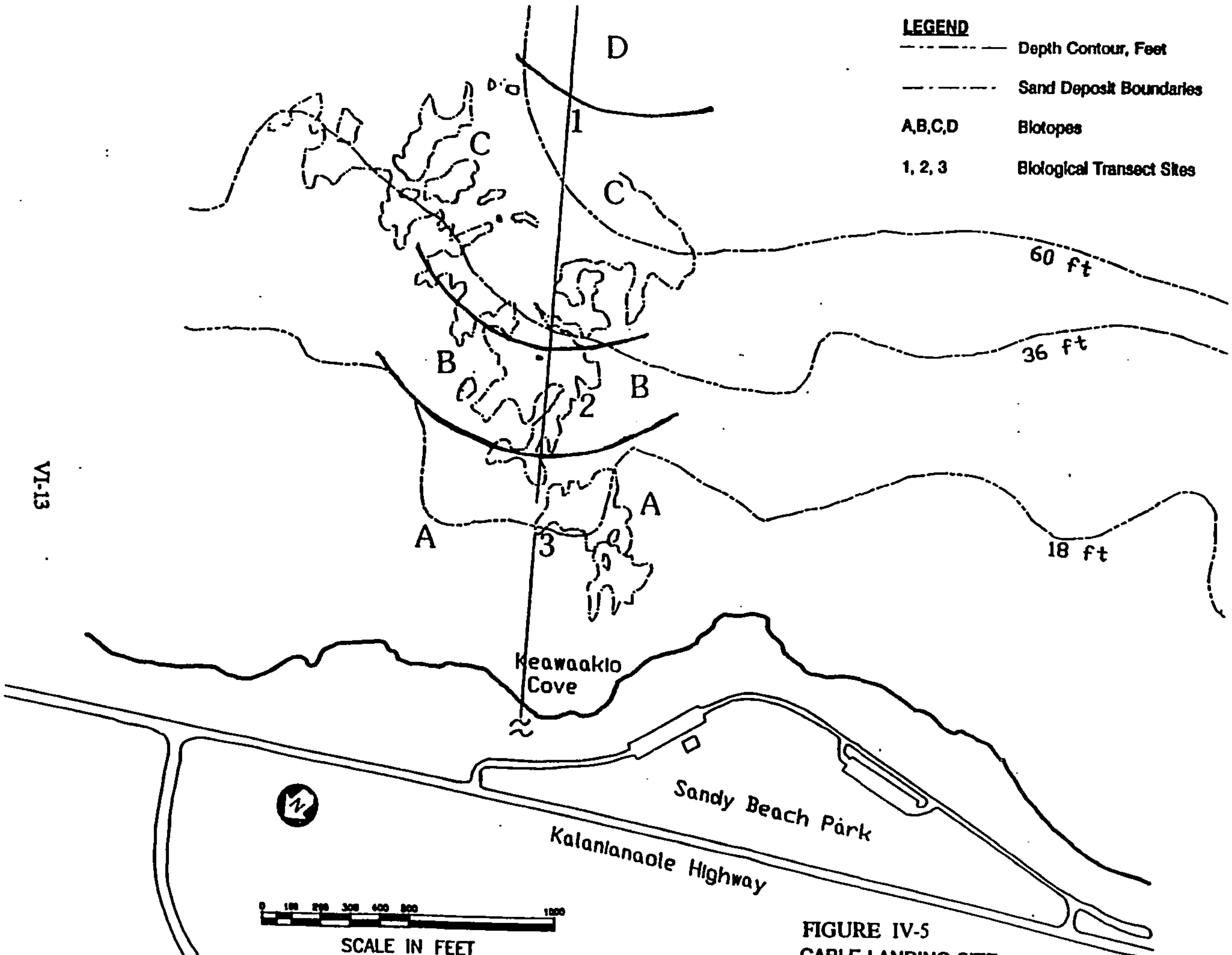


FIGURE IV-5
CABLE LANDING SITE,
SHOWING MARINE BIOLOGICAL BIOTOPES

Because of the depth at which the biotope of sand is found, only a qualitative reconnaissance was made of the habitat in waters from 80 to 100 feet. Species noted in this overview of the biotope include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra), T.crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), opelu or mackeral scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), uku or snapper (Aprion virescens) and the weke or white goatfish (Mulloides flavolineatus). With greater effort many more fish species would be encountered in this biotope.

The Biotope of Emergent Hard Substratum

Shoreward of the biotope of sand is the biotope of emergent hard substratum. The substratum in this biotope is a combination of rubble and sand with areas of emergent hard bottom. The hard substratum supports some coral cover not exceeding 20 percent; these areas of hard bottom are broken by patches of rubble and sand. The rubble/sand areas are from 25 by 50 feet up to 150 by 250 feet in size and they are spaced from 25 to 150 feet apart. The hard substratum has little elevation, not exceeding 3 feet above the sand and rubble. This biotope is situated in water from 40 to about 80 feet deep.

Station 1 was established in 80 feet of water to sample the communities in this biotope. The transect sampled both rubble as well as hard substratum. The hard substratum at this station appeared to be limestone and the rubble was comprised of coral fragments up to 25cm in diameter. The results of the quantitative survey carried out at Station 1 are presented in Table IV-1. The quadrant survey noted one algal species (Polysiphonia sp.) and two coral species (Porites lobata and Pocillopora meandrina) having a mean coverage of 8 percent. The invertebrate census found five species: the isabella cowry (Cypraea isabella), rock oyster (Spondylus tenebrosus), red hermit crab (Aniculus strigatus), boring sea urchin (Echinostrephus aciculatum) and the banded urchin (Echinothrix calamaris). The results of the fish census are presented in Appendix B. In total, 34 species (311 individuals) were observed. The most abundant species include damselfishes (Chromis hanui and C. vanderbilti), alo'ilo'i or black damselfish (Dascyllus albisella), moano or manybar goatfish (Parupeneus multifasciatus) and the malu or onespot goatfish (Parupeneus bifasciatus). The standing crop of fishes at Station 1 was estimated to be 44g/m^2; the species contributing heavily to this biomass include the moano or manybar goatfish (parupeneus multifasciatus) and a single filefish or o'il'i (Cantherhines dumerilii) as well as a puhi oni'o or white-mouth moray eel (Gymnothorax meleagris).

TABLE IV-1.

Summary of the benthic survey conducted in the biotope of emergent hard substratum approximately 580m offshore of Sandy Beach, Oahu on 7 January 1992. Results of the $6m^2$ quadrant sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Pact C. A short summary of the fish census is given in Part D. Water depth is 25m; mean coral coverage is 8.1 percent (quadrant method).

A. Quadrant Survey

	Quadrant Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Polysiphonia sp.	2				1	
Corals						
Porites lobata		2	4	3	2.5	4
Pocillopora meandrina				12		21
Sand	26	9		2	2	9
Rubble	72	14				14
Hard Substratum	75	96		83	94.5	52

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	6
Sand	16
Rubble	14
Hard Substratum	64

(TABLE IV-1 CONTINUED ON NEXT PAGE)

TABLE IV-1. Continued.

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Cypraea isabella	1
Spondylus tenebrosus	1
Phylum Arthropoda	
Aniculus strigatus	1
Phylum Echinodermata	
Echinostrephus aciculatum	1
Echinothrix calamaris	1

D. Fish Census (4 x 25m)

34 Species
311 Individuals
Estimated Biomass = $44 g/m^2$

In the vicinity of Station 1 were seen the bryozoan (Reteporellina denticulata), soft coral (Palythoa tuberculosa),coral (Pocillopora eydouxi), helmet shell (Cassis cornuta), spiny lobster or 'ula (Panulirus marginatus), the brown moray eel or puhi paka (Gymnothorax flavimarginatus), green head moray (Gymnothorax undulatus), uku or snapper (Aprion virescens) and the blenny (Plagiotremus ewaensis).

Biotope of Shallow Channels

The biotope of shallow channels lies shoreward of the biotope of emergent hard substratum in water from 20 to 40 feet deep. The characteristic feature of this biotope is the presence of hard substratum with small channels cut through the substratum. These channels are oriented perpendicular to shore and are from 3 to 15 feet wide, 6 to 75 feet long, and are up to 1 foot deep. On the bottom of some of the channels is a veneer of sand and rubble. The channels are spaced from 10 to 60 feet apart. Most of the hard substratum appears to be limestone but there are some areas of basalt (pahoehoe). The basalt becomes more evident on the shoreward side of the biotope.

Station 2 was established about 1000 feet offshore in 35 feet of water to sample the marine communities in this biotope. The results of the quantitative studies carried out at Station 2 are presented in Table IV-2. The quadrant survey noted 7 coral species (Porites lobata, P. evermanni, Pocillopora meandrina, Montipora verrucosa, M. patula, M. flabellata and M. verrilli) having a mean coverage of 15.3 percent. The invertebrate census found six species including two cones (Conus lividus and C. miliaris) and four sea urchin species: the black sea urchin (Tripneustes gratilla), the slate pencil urchin (Heterocentrotus mammillatus), the banded urchin (Echinthrix calamaris) and the ubiquitous green sea urchin (Echinometra mathaei). Thirty species of fishes (267 individuals) were encountered in the fish census. The most abundant species included the saddleback wrasse or hinalea lauwili (Thalassoma duperrey), the damselfish (Chromis vanderbilti) and the ma'i'i'i or brown surgeonfish (Acanthurus nigrofuscus). The standing crop of fishes was estimated to be 74g/m^2 and the species contributing heavily to this biomass include a single large zebra moray or puhi (Gymnomuraena zebra), ma'i'i'i or brown surgeonfish (Acanthurus nigrofuscus), hinalea lauwili or saddleback wrasse (Thalassoma duperrey) and a single a'awa or table boss (Bodianus bilunulatus).

In the vicinity of Station 2 were seen the algae or limu (Amansia glomerata) as well as the edible limu kohu (Asparagopsis taxiformis), soft coral (Palythoa tuberculosa), coral (Leptastrea purpurea), boring sea urchin (Ecninostrephus aciculatum), long spine urchin

TABLE IV-2.

Summary of the benthic survey conducted in the biotope of shallow channels approximately 320m offshore of Sandy Beach, Oahu on 7 January 1992. Results of the $6m^2$ quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Pact C. A short summary of the fish census is given in Part D. Water depth is 11m; mean coral coverage is 15.3 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Corals						
Porites lobata	4	15	7	4	10	5
Porites evermanni			2			
Pocillopora meandrina	1	1	1	0.2		2
Montipora verrucosa	5	5	4		2	2
Montipora flabellata						3
Montipora patula	3.5					
Montipora verrilli		12	3	0.1		
Sand					2	6
Hard Substratum	86.5	67	83	95.7	86	82

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	8
Pocillopora meandrina	2
Montipora verrucosa	2
Montipora verrilli	2
Montipora patula	2
Sand	4
Rubble	2
Hard Substratum	78

(TABLE CONTINUED ON NEXT PAGE)

TABLE IV-2. Continued.

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Conus lividus	1
Conus miliaris	1
Phylum Echinodermata	
Echinothrix calamaris	1
Heterocentrotus mammillatus	6
Tripneustes gratilla	9
Echinometra mathaei	54

D. Fish Census (4 x 25m)

30 Species
267 Individuals
Estimated Biomass = $74 g/m^2$

or wana (Echinothrix diadema), fourspot butterflyfish or kikakapu (Chaetodon-quadrimaculatus), yellow tang or lau'ipala (Zebrasoma flavescens), orangespine unicorn fish or umaumalei (Naso lituratus), boxfish or moa (Ostracion meleagris), hawkfishes (po'opa'a - Cirrhites pinnulatus; hilu piliko'a - paracirrhites forsteri) and squirrelfish or menpachi (Myripristes amaenus).

High Energy Cobble/Boulder Biotope

The high energy cobble/boulder biotope extends from the beach to approximately the 20 foot water depth, 900 feet offshore. This biotope is characterized by a hard substratum with depressions as well as water worn basalt cobble and boulders scattered over it. The depressions range in size from 6 to 60 feet in diameter; most are in complex configurations which lends considerable heterogeneity to the substratum. These depressions are up to 6 feet deep. The water worn basalt rock occurs in a scattered fashion in the more offshore part of the biotope; closer to shore (i.e., within 250 feet of the shoreline) the basalt rock forms a near continuous mat. The mean diameter of this rock is about 1.5 feet but individual boulders up to 5 feet are common. Coral coverage decreases near shore (i.e., the inner 300 feet); this is probably related to the scouring that must occur when surf impinges on this coast. Qualitative observations suggest that mean coral coverage is about 0.2 percent in the shallow areas less than 10 feet deep.

Station 3 was established approximately 450 feet offshore in 20 feet of water to sample the high energy cobble/boulder biotope. The results of the quantitative survey at Station 3 are presented in Table IV-3. Four algal species were noted in the quadrant survey having a mean coverage of 1.6 percent; the species seen were Cladymenia pacifica, Martensia fragilis, Amansia glomerata and Desmia hornemannii. Also present in the quadrant survey was the soft coral (Palythoa tuberculosa) as well as seven coral species (Porites lovbata, P. compressa, Montipora verrucosa, M. flabellata, M. patula, Leptastrea purpurea and Pocillopora meandrina) having a mean coverage of 9.1 percent in the seaward half the biotope. The invertebrate census noted 9 species including the cone shell (Conus lividus), the octopus or he'e (Octopus cyanea), the green sea urchin (Echinometra mathaei), black urchin (Tripneustes gratilla), boring urchin (Echinostrephus aciculatum), slate pencil urchin (Heterocentrotus mammillatus), wana or long spine urchin (Echinothrix diadema), black sea cucumber (Holothuria atra) and the brown sea cucumber (Bohadschia vitiensis). The results of the fish census are presented in Appendix B; twenty-two species (132 individuals) were counted. The most abundant fishes include the hinalea lauwili or saddleback wrasse (Thalasssoma duperrey), the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus) and the convict surgeonfish or manini (Acanthurus triostegus). The biomass of fishes at Station 3 was estimated to be 43g/m^2 and the species contributing heavily to this standing crop include the ma'i'i'i or brown surgeonfish (Acanthurus nigrofuscus), hinalea lauwili or saddleback wrasse (Thalassoma duperrey) and the manini or convict surgeonfish (Acanthurus triostegus).

TABLE IV-3.

Summary of the benthic survey conducted in the high energy cobble/boulder biotope approximately 135m offshore of Sandy Beach, Oahu on 7 January 1992. Results of the $6m^2$ quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Pact C. A short summary of the fish census is given in Part D. Water depth is 6m; mean coral coverage is 9.1 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Desmia hornemannii		0.1		0.4		
Cladymenia pacifica	0.1		4			
Amansia glomerata				1		
Martensia fragilis					0.2	3
Soft Corals						
Palythoa tuberculosa	1					
Corals						
Porites lobata	2	1	1		9	
Porites compressa				3		
Montipora verrucosa		5	7	2		
Montipora flabellata			2	11		
Montipora patula		3				
Pocillopora meandrina		1				
Leptastrea purpurea			1.5			
Sand				4	2	
Rubble	3					
Hard Substratum	94	89.8	90	77.1	88.8	93

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Montipora verrucosa	6
Montipora patula	4
Sand	4
Hard Substratum	86

TABLE IV-3. Continued.

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Conus lividus	1
Octopus cyanea	1
Phylum Echinodermata	
Tripneustes gratilla	13
Echinostrephus aciculatum	1
Heterocentrotus mammillatus	3
Echinothrix diadema	5
Echinometra mathaei	164
Holothuria atra	2
Bodaschadia--------	1

D. Fish Census (4 x 25m)

22 Species
132 Individuals
Estimated Biomass = $43 g/m^2$

In the vicinity of Station 3 were seen the coral (Leptastrea purpurea), cone shell (Conus leopardus), brown sea cucumber (Actinopyga mauritiana), na'ena'e or orangespot surgeonfish (Acanthurus olivaceus), red parrotfishes or palukaluka (Scarus rubroviolaceus) and uhu'ahu'ula (Scarus perspicillatus), moorish idol or kihikihi (Zancleus cornutus), milletseed butterflyfish or lau wiliwili (Chaetodon miliaris), doublebar goatfish or munu (Parupeneus bifasciatus) and cleaner wrasse (Labroides phthirophagus).

A short survey of the intertidal region was made in the area fronting the proposed cable landing site. The substratum along this shoreline is primarily a pahoehoe (basalt) bench broken in places by short stretches of basalt cobble and boulders that form small beaches. The intertidal in this area is subjected to occasional high energy conditions (waves). The high energy appears to keep the diversity low. On the emergent rocks were seen the grey littorine snail (Littorina pintado) and the prosobranch mollusc, Siphonaria normalis; slightly lower down on the rocks are the black snail or pipipi (Nerita picea). Algae seen include limu hulu'ilio (Giffordia breviarticulata) and the encrusting coralline alga (Porolithon onkodes). Also present are a number of unidentified microalgal species that form a fine "turf".

One small green sea turtle (Chelonia mydas) was seen in the high energy cobble/boulder biotope about 200 feet from shore in about 15 feet of water during the 7 January 1992 survey. This turtle was estimated to be about 50cm in carapace length (straight line) and appeared to be "passing through" the area. We saw no unusual features (i.e., tumors, tags or deformities) on this individual.

The Sandy Beach habitat appears to be appropriate for green turtles; there is a reasonable amount of cover or shelter (i.e., undercuts, ledges and caves) at a size and scale appropriate for green turtle resting areas as well as some macroalgae (such as Amansia glomerata) that are used as forage in other locations by green turtles (Balazs,1980, Balazs et al. 1987). However, our survey suggests that the shallow area (from shore to the 80 foot depth) is not heavily used by green turtles and we did not encounter any other turtles in the area. It should be noted that Balazs et al. (1987) noted two juvenile turtles present along the beach on 16 May 1985. These authors state (page 30) that "...surfers periodically report seeing turtles off Sandy Beach, but the area is not known to host a significant aggregation, nor is there a history of such an occurrence". We have found no information to suggest that nesting of sea turtles on Sandy Beach has occurred in historical times.

The biological survey of the proposed cable alignment at Sandy Beach did not find any rare or unusual species or communities other than the single threatened green sea turtle noted above. Another protected species , the humpback whale (Megapteranovaeangliae) was not seen offshore of the study area during the period of our field effort, but whales are known to frequent the area during the winter and spring. As noted by Herman (1979), humpback whales tend to be found in regions remote from human activities, thus relatively fewer numbers of whales are seen around Oahu as compared to the other islands. However, Norris and Reeves (1978) suggest that natural cycles and whaling activities may actually be responsible for the decline off Oahu.

POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts with Construction

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment enters the shallows through the biotope of sand. As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom (e.g.,corals and many of the associated invertebrates). Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever-changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur low in abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will sink into the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

In the shallower areas along the route, there are areas where the cable will cross hard substratum and there is a greater possibility of impact to benthic and fish communities.

The construction techniques selected to clear the inshore pathway for the cable will play a large role in the range of impacts possibly encountered. Impacts associated with these construction activities primarily include removal of benthic communities in the cable path, and the generation of turbidity which may impact surrounding communities.

With any construction is the concern over possible impacts to corals because of their sessile nature and usual slow growth characteristics. One potential impact to corals would be the removal of the entire benthic community in the alignment path. Table IV-4 presents an estimate of the actual loss of coral (expressed in the number of square meters lost) in the alignment path if the high vertical relief were removed from all the hard substratum within the 80 foot depth contour. This estimate is based on the measured linear distance of hard substratum crossed by the cable on the proposed alignment and the known percent coverage by coral in each biotope. These losses are calculated for four arbitrary channel widths; 0.3m wide trench = 5.3 square meters of coral lost, 0.5m wide trench = 8.6 square meters of coral lost, 1.0m wide trench = 17.2 square meters of coral lost and with a 1.5m wide trench 25.9 square meters of coral would be lost. The two extremes, the 0.3m and the 1.5m channels, correspond approximately to the two construction alternatives discussed previously.

TABLE IV-4.

Table estimating the loss of living coral on hard sub- stratum (expressed in square meters) if the proposed alignment at Sandy Beach, Oahu is trenched at one of four arbitary widths (0.3m, 0.5m, 1m and 1.5m). These calculations are based on the estimates of coral cover derived from this study and measured linear distances that the cable would cross hard substratum in water between shore and the 25m isobath. Calculated losses for each trench width are given in the body of the table in terms of square meters.

Biotope	Mean Percent Coral Cover	Distance Traversed on Hard Substrate	Arbitary Width of Destruction 0.3m	0.5m	1.0m	1.5m
Biotope of Sand	0	0m				
Biotope of Emergent Hard Substratum	8.1	15.2m	0.4	0.6	1.2	1.9
Biotope of Shallow Channels	15.3	38.1m	1.8	2.9	5.8	8.7
High Energy Cobble/Boulder Biotope a.	9.1*	110m	3.0	5.0	10.0	15.0
b.	0.2*	103m	0.06	0.1	0.2	0.3
Total Destruction of Coral in m^2			5.3	8.6	17.2	25.9

* Coral cover estimated from sampling at Station 3 for the outer half of the high energy cobble/boulder biotope; coral cover estimates for the inner half of this biotope are from a visual assessment.

The coral losses associated with the 0.3m channel correspond to the removal of high spots by divers working with hand tools, and the losses associated with the 1.5m channel correspond to preliminary levelling with the clamshell bucket.

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales (Megaptera novaeangliae). As far as the impact to the humpback whales is concerned, if construction activities are restricted to the period between April through October, the impacts are minimal because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when whales are present in Hawaiian waters, impacts should be non-existent or minimal. The cable ship will not be on site more than one or two days. After departure of the cable ship, all work will be within 1,000 feet of shore. There will be no blasting during the construction of the cable protection.

The most probable source of local impact to whales would be noise generation by the cable laying ship, the support tugs and the small boats. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981; Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact on whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if it entails dredging. The generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas in unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Any clearing activity whether performed by clamshell bucket or by divers, or a combination of the two, will generate fine particulate material that serves to lower light levels and in the extreme, bury benthic communities. Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light level resulting in a lowering of primary productivity. When light levels are sufficiently decreased, hermatypic corals (i.e., the majority of the corals found on coral reefs) will eject their symbiotic unicellular algae (zooxanthallae) on which they depend as source of nutrition. However, in nature corals will eject their zooxanthallae and survive (by later acquiring more zooxanthallae) if the stress is not a chronic (long term) perturbation.

Perhaps a greater threat would be the simple burial of benthic communities that could occur with high sediment loading and concurrent low water movement. Many benthic species including corals are capable of removing sediment settling on them by ciliary action and the production of mucous, but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual becomes buried. However, the impact of sedimentation on Hawaiian reefs may be overstated. Sedimentation from land derived sources (usually the most massive source) is a natural event usually associated with high rainfall events.

Dollar and Grigg (1981) studied the fate of benthic communities at French Frigate Shoals in the Northwest Hawaiian Islands following the accidental spill of 2200mt of kaolin clay. These authors found that after two weeks there was no damage to the reef corals and associated communities except where the organisms were actually buried by the clay deposits for a period of more than two weeks.

The method involving the absolute minimum of underwater construction involves just laying the cable directly on the substratum without any specific attachment. In this case, subsequent wave induced lateral movement of the cable may serve to abrade corals and other attached biota as well as the outer layer(s) of the cable.

An intermediate method of protecting the cable would involve casing the cable with split pipe, and then bolting the pipe to the bottom. This would reduce the impact to benthic communities over the alternative of clearing a level channel. However, although this alternative may have low initial impacts to marine communities it will have an obvious visual impact to any underwater observer where it "bridges" across high spots. If the channel clearing strategy is used, the cleared area will eventually colonized by corals, algae and other benthic forms.

Fishery Considerations

Access to the shoreline at Sandy Beach is excellent and has been so since the coastal road was developed in 1931 (Balazs et al. 1987); the beach is heavily used by people interested in beach going, body surfing and on the eastern end of the beach, fishing. Fishermen catch fish both from shore as well as offshore from small boats. Occasionally commercial fishermen capture akule or bigeye scad (Selar crumenophthalmus) with large surround nets in the vicinity of the proposed cable alignment. Other commercial fishermen utilize traps through the entire area and further offshore handline fishermen target bottomfish (snappers and groupers) that occur below 300 feet in areas of rugged undersea topography. We are unaware of any individuals that specifically and exclusively use Sandy Beach for subsistence fisheries. However, most of the fishing activity occurring at Sandy Beach is by private citizens who probably consume most of what they catch. Species targeted include papio and ulua (family Carangidae), o'io or bonefish (Abula vulpes), moi (Polydactylus sexfilis), goatfishes (family Mullidae), snappers (family Lutjanidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and a host of smaller species such as the aholehole (Kuhlia sandvicensis), aweoweo (Priacanthus cruentatus) and menpachi (Myripristes amaenus). Fishing methods used include nets, spears, traps as well as hook and line.

Water Quality Considerations

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This occurs through natural events such as storm surf resuspending fine material that had previously entered the area, through natural events or by human activities, including the directing of storm water runoff into the ocean, or by underwater construction activities. In this instance, underwater construction will generate some amount of fine particulate material that could have a negative impact on corals and other benthic forms if it occurs in sufficient quantity over sufficient time. While numerous studies have indicated a relationship between increased suspended or deposited sediment with reduced coral growth rates, cover and species diversity (Roy and Smith 1971, Maragos 1972, Loya 1976, Bak 1978, Randall and Birkeland 1978, Chansang et al. 1982, Cortes and Risk 1985, Grigg 1985, Hubbard and Scaturo 1985, Kuhlman 1985, Muzik 1985, Hubbard 1987), others (Glynn and Stewart, 1973) found no correlation between these parameters on reefs off the Pacific side of Panama. Other studies (e.g., Dollar and Grigg 1981 noted above) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the proposed activities that would be necessary to protect the cable in shallow water would produce little sediment, and over a relatively short duration. This statement is supported by the fact that much of the substratum in the high energy cobble/boulder biotope (the shallowest water and closest to shore) is comprised of a "mat" of water worn basalt stones which should not readily breakup if moved out of the alignment path but remain whole thus not generating much turbidity. Greater turbidity is usually generated with the cutting through solid limestone as was done at West Beach, Oahu. Even on that project, which took 19 months to complete, impacts to benthic communities from dredging were minimal (Brock 1990).

Sandy Beach is a high energy area due to the nearshore wave climate and the relatively strong currents. The resultant high water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats. It will also result in advection of this material out of the areas (less than 300 feet deep) where corals are found. The waters offshore of Sandy Beach are characterized by considerable water movement; easterly tradewinds cause a net current flow to the west and offshore from Sandy Beach (Bathen 1978). This attribute has allowed the nearby discharge of up to 5mgd of sewage since the early 1970's from the Hawaii Kai sewage treatment plant in 42 feet of water with little noticeable impact to nearby marine communities or shoreline areas.

The deposition of sediment on coral reefs has been measured and correlated with the "condition" of the reef corals. Loya (1976) defined a "high" sedimentation rate as $15 mg/cm^2/day$ and a "low" rate as $3 mg/cm^2/day$ for Puerto Rican reefs. Low cover and species diversity were associated with reefs exposed to "high" sediment deposition rates. In contrast, "high" sediment deposition rates on Guamian reefs was defined in the range of 160-200mg/cm^2/day and this rate of deposition limited coral cover and diversity (here less than 10 species and 2% cover; Randall and Birkeland 1978). A "low" rate was defined as 32mg/cm^2/day and was associated with rich coral communities (more than 100 species and 12%+ coral cover). These comparisons demonstrate the relative nature of sedimentation rates; the rate considered to be low in Guam is more than twice the high rate from Puerto Rico. Reasons for this disparity relate to differences in how rates are measured (i.e., lack of a standardized methodology) as well as difficulty in relating environmental factors such as water motion and sediment deposition in sediment traps. Water motion may mitigate or enhance the deleterious effects of sedimentation on the diversity and cover of corals in a given area. Hopley and Woesik (1988) note a chronic sedimentation rate of 129mg/cm^2/day (7 month mean) did not negatively impact an Australian coral reef with high cover and species diversity.

These data suggest that if needed as a means for protecting the proposed fiber optic cable in shallow water, the short term disturbance (probably less than two weeks for the channel clearing) will be a minor impact, especially when viewed in light of the nearby chronic disturbance to these benthic communities of sewage input that has occurred since the early 1970's.

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APPENDIX D

Marine Environmental Analysis of Selected Landing Sites Mokapu Beach, Maui

GTE Hawaiian Tel
Interisland Fiber Optic Cable System

MARINE ENVIRONMENTAL ANALYSIS OF SELECTED LANDING SITES

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I. INTRODUCTION

GENERAL

GTE Hawaiian Tel is planning the installation of an Interisland Fiber Optic Cable System linking the islands of Kauai, Oahu, Maui and Hawaii. The site selection and evaluation process has been underway since early 1991, and Sea Engineering, Inc. has been retained over that period by the R.M. Towill Corporation to evaluate the marine considerations for potential landing sites and to assist in the preparation of the Environmental Assessments for the recommended landing sites. Dr. Richard Brock of the Environmental Assessment Company, a subconsultant to Sea Engineering, Inc., was responsible for characterizing the nearshore marine biological conditions along the cable routes and also assisted with the impact evaluation.

This report describes the nearshore marine selection process, the alternatives considered, the physical and biological characteristics of the nearshore cable routes, and the anticipated marine environmental impacts.

Figure I-1 shows the interisland cable configuration and the recommended landing sites.

ROUTE SELECTION PROCESS

This report describes only the nearshore marine considerations of the selection process. Other considerations included land suitability, deep ocean conditions, public usage and terrestrial and marine impacts. A series of two Working Papers, prepared by the R.M. Towill Corporation (1991), describe in detail the overall selection process, the alternatives considered, and the rationale for the recommended routes.

The coastal sector boundaries for the potential cable landing sites were initially defined by two primary constraints:

1. The total cable length between central offices was limited to a maximum of 200 kilometers, and preferably to less than 185 km. Cable lengths over 200 km would require an expensive subsea repeater.

2. Proximity of the cable landing site to a central office was desirable, along with relatively easy access to the central office via available polelines, duct lines, or other GTE infrastructure.

Given these constraints, sectors of coastline were delineated which bounded the potential landing areas. An office evaluation of each coastal sector was then completed, utilizing existing literature, color aerial photographs, marine charts, coastal inventories prepared by state and Federal agencies, and personal knowledge of nearshore physical and biological

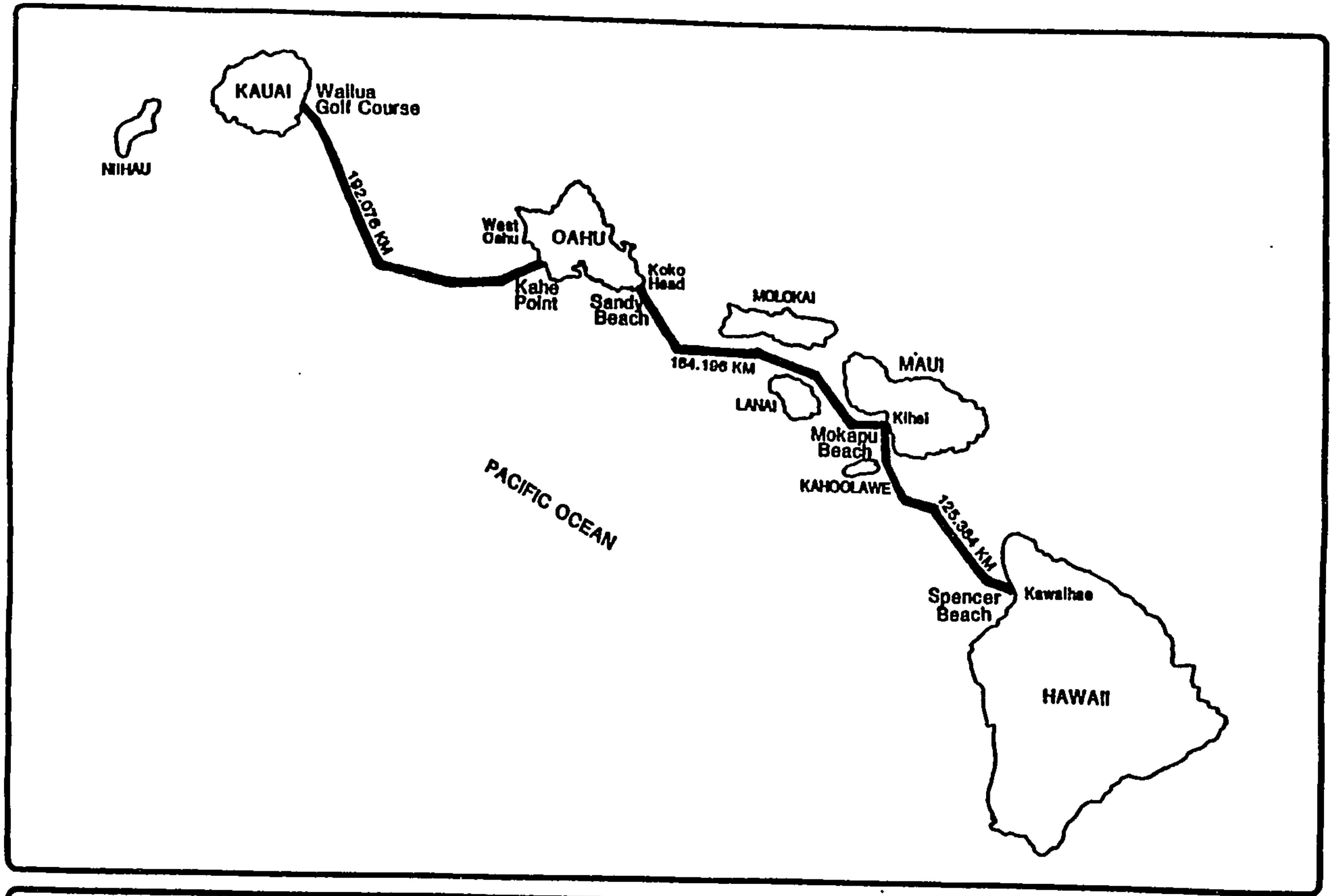

FIGURE I-1. SUMMARY OF RECOMMENDED GTE HAWAIIAN TEL FIBER OPTIC LANDING SITES - STATE OF HAWAII

characteristics and uses. A one day field reconnaissance was then conducted in each sector to select three potential landing sites in each sector. If no suitable sites were found within the sector limits, the sector was enlarged as required.

Following the consolidation of all planning considerations mentioned above (terrestrial and marine) a more detailed field study was conducted at each site by an ocean engineer and marine biologist. The objective of this phase was to select the primary and secondary route alternatives.The marine biologist was incorporated into this phase of the study to conduct a preliminary assessment of the selected alternatives and to ensure that there were no overriding environmental constraints.

After initial approval by the client of the recommended route, a detailed bathymetric survey was conducted at each site. During this survey, while accurate positioning equipment was available, a diver was towed along the route centerline, and his visual observations were correlated with the track line and the water depth. This step provided valuable information about the precise conditions along the route, and also ensured that there were no unexpected conditions in the nearshore area.

One additional field trip was made to each site, for the express purpose of describing the physical and biological characteristics of the route and adjacent areas, and to evaluate the potential environmental impacts.

The limit of the diving surveys was the 100 foot depth contour. However, the diving support vessels were equipped with fathometers, and tracklines were run to the 180 foot depth to ensure that no steep ledges were encountered beyond the limit of the visual survey.

MARINE SELECTION CRITERIA FOR NEARSHORE
CABLE ROUTE EVALUATION

Throughout the cable route selection and evaluation process the primary objective was to find a suitable, safe cable route which would also result in the minimum environmental impacts possible in that sector.

Specific selection criteria included the following:

1. Sandy bottoms and coastlines were preferred, both for integrity of the cable and to minimize environmental impacts. Experience at other cable landing sites on Oahu (Makua Beach, Makaha Beach and Nanakuli Beach) indicates that cables on sandy bottoms tend to sink into the sand. No cable cross section is exposed, and wave forces on the cables are therefore minimal. In most of these areas, the winter surf and shorebreak can be very large, yet the numerous cables making landfall there have remained stable.

   Hawaii beaches are usually in a dynamic balance with a large offshore sand deposit, and the two are frequently linked by a continuous sand channel, thus providing the ideal configuration for a cable route. In addition to the engineering advantages, the environmental effects of a placing a cable on a sandy bottom are much less than placing one across a diverse coral community.

2. Minimizing the horizontal distance from the shoreline to the 60 foot depth was another important factor. This is the zone of maximum wave forces, and the assumption was made that some form of cable protection or anchoring would be required when crossing any hard bottom inshore of the 60 foot contour. This distance is also an important factor in the cable landing process. The cable ship can approach shore to approximately the 50 or 60 foot depth, where it is then held in place by tugs. As the cable is towed to shore by a small boat or tug, floats are attached to the cable as it is paid out, so that it floats on the surface until the shore connection is secured. During this time, the cable position must be maintained along the route centerline. Strong currents or long distances make this process more difficult. The goal was to select a route where the distance from shore to the 60 foot contour was less than 4000 feet.

3. There is a semi-continuous ledge which drops off from the 60 foot contour, and extends through many of the coastal sectors of Hawaii. This ledge was formed during an ancient stand of the sea, and typically has a vertical drop of 30 feet or more. This ledge was present in the Kauai sector, both Oahu sectors and the Maui sector. It was therefore important to find a route which either avoided the ledge or passed through a channel in the ledge. Fortunately, the sand channels connecting the beaches to the deeper offshore deposits often bisect the ledge.

4. Routes were selected to avoid, to the maximum extent possible, environmentally sensitive areas or areas frequented by rare or endangered species. A specific example was the avoidance of areas used by green sea turtles for resting or forage. The marine biological consultant was an early participant in the study, so that environmental input was received during the initial route evaluations.

II. GENERAL OCEANOGRAPHIC CHARACTERISTICS

WINDS

The predominant winds in the Hawaiian Islands are the northeast trades, which are present approximately 70 percent of the time with an average speed of 13 mph. The frequency of tradewinds varies greatly with the season. They occur 90-percent of the time during the months of April to October. The winter season (November to March) is defined by a weakening of the high pressure system generating the tradewinds, and the frequency of occurrence decreases to approximately 50-percent. During the winter season, low pressure systems periodically displace the tradewinds, resulting in south or southwest winds known as "Kona" winds. Kona winds, which occur rarely in summer and 17-percent of the time in the winter, range from light and variable to gale or hurricane force.

PREVAILING WAVE CLIMATE

The general Hawaiian wave climate can be described by four primary wave types; the northeast tradewind waves, south swell, North Pacific swell and kona storm waves. These wave types and their general approach direction are shown on Figure II-1.

Tradewind waves may be present in Hawaiian waters throughout the year, but are most frequent in the summer season, between April and September, when they usually dominate the Hawaiian wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Typical deepwater tradewind waves have periods of 5 to 8 seconds and heights of 4 to 10 feet. During gale conditions tradewind waves may reach heights in excess of 20 feet.

South swell is generated by southern hemisphere storms, and is most prevalent during the months of April through October. These long, low waves approach from the southeast through southwest, with typical periods of 12 to 20 seconds and deepwater heights of 1 to 4 feet. Although their deepwater height is relatively low, the long period results in considerable shoaling near shore with resultant large breaker heights. The surf along the exposed south shores of the islands occasionally reaches heights of 15 feet.

North Pacific swell is produced by winter storms in the North Pacific Ocean and by mid-latitude low pressure areas. North swell may arrive in the Hawaiian Islands throughout the year, but is largest and most frequent during the winter months of October through March. North Pacific swell typically has periods of 12 to 20 seconds and deepwater heights of 5 to 15 feet. The approach direction is typically from the west-northwest through north-northeast. North Pacific swell results in some of the largest waves in Hawaiian waters.For example, breaking wave heights approaching 50 feet were observed in December 1969.

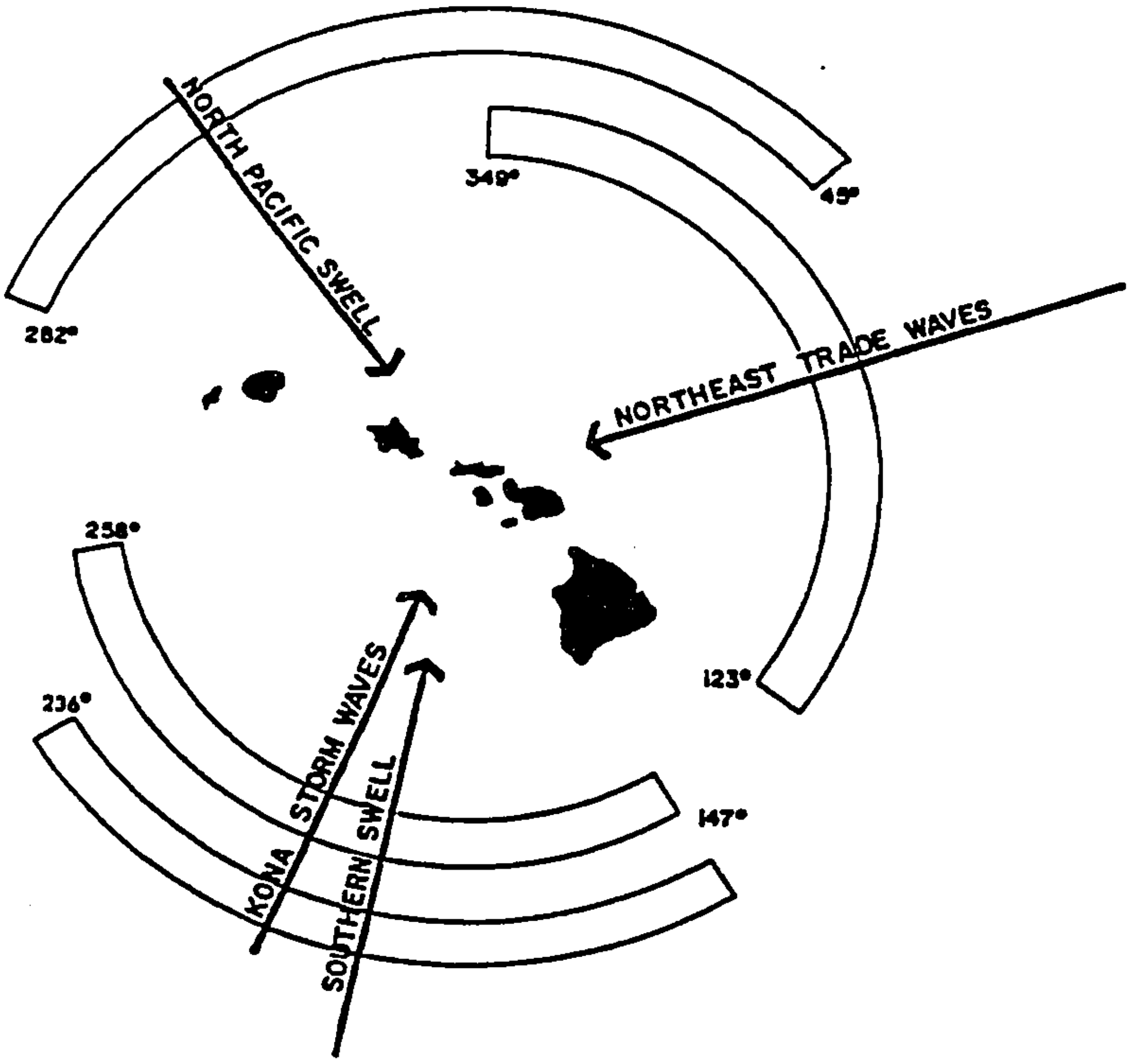

FIGURE II-1.
GENERALIZED WAVE TYPES
(Adapted From The Atlas of Hawaii)

Kona storm waves are generated by intense winds associated with local fronts or low pressure systems and typically have periods ranging from 6 to 10 seconds and typical heights up to 10 feet, but during severe storms heights can approach 20 feet. These waves are most common in late winter and early spring, approaching from the south to southwest.

Hurricane Storm Waves

Hurricanes form near the equator, and in the central North Pacific usually move toward the west or northwest. The primary hurricane season is July through September. These tropical storms or hurricanes usually pass south of the Hawaiian Islands, with a northward curvature near the islands. Late season tropical storms and hurricanes follow a somewhat different track, forming south of Hawaii and moving north toward the islands.

There are many recorded tropical storms or hurricanes which have approached the Hawaiian Islands during the past 35 years, and hurricane waves are generally selected as the design criteria for coastal projects. Most of these storms passed well south or west of the islands, or weakened in intensity as they reach Hawaii, but there have been notable exceptions. Hurricanes Hiki, Della, Nina and Fico passed within about 200 miles of the islands, Dot passed over Kauai, and Iwa passed with 30 miles of Kauai. Kauai.
The report Hurricanes in Hawaii (Haraguchi, 1984), prepared for the U.S. Army Corps of Engineers presents hypothetical model hurricanes for the Hawaiian Islands. The model Hawaiian Hurricane is defined as the probable hurricane that will strike the Hawaiian Islands in the future. The characteristics of the model hurricane are based on the characteristics of hurricanes Dot and Iwa. The predicted wave height and period for the model hurricane are calculated to be 31 feet and 12.0 seconds.

This is a worst case scenario; the actual likelihood of this occurring at one particular site is very low. It is more likely that the storm would pass at some distance, thus the wave height at a particular site would depend on the storm track and decay distance over which the waves travel.

TIDES

The tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e. two tidal cycles per day with the range of water levels being unequal). The average daily tidal range is approximately 2 feet, the maximum range is 2.8 feet.

COASTAL CURRENTS

Coastal currents in Hawaii are influenced by several factors: large scale oceanic currents, tidal currents, wind-driven currents, waves, and island topography. Hawaii is located in the region of the Pacific North Equatorial current, which generally flows to the west with north current speeds ranging from 0.1 to 1 knot. The current direction may vary from west southwest to north-northwest, and the average speed is estimated to be approximately 0.5 knots. Eddies may form in this current as it passes through the islands. Large scale eddies may also be caused by wind circulation patterns around the large mountains on the islands, and small scale eddies may be caused by local landforms.

In most nearshore locations in Hawaii, the tidal flow is the primary current component. Tidal currents are reversing and generally follow bathymetric contours. The maximum tidal current speed in most locations is 2 knots, with speeds of 0.3 to 1.0 knot being typical. Surface currents are modified by the prevailing winds. Past studies around Oahu have indicated that the top 5 to 15 feet of the water column is influenced during moderate trade wind conditions.

The circulation at any particular location is due to a combination of the above factors.

TSUNAMIS

Tsunami, or seismic sea waves, are primarily generated by submarine earthquakes and earth movement with magnitudes greater than about 6.5 on the Richter scale. Coastal and submarine landslides and volcanic eruptions can also generate tsunamis. The Hawaiian Islands are directly exposed to the major tsunami wave generating areas in the Pacific Ocean: the Kuril-Kamchatka-Aleutian region of the north and northwestern Pacific, the west coast of South America, and the seismically active southwest Pacific. Over 80 tsunamis have been observed in the Hawaiian Islands since 1813, and 22 of them resulted in significant damage. The most damaging occurred in 1946 when an earthquake in the East Aleutian Islands generated a tsunami which killed 173 people in Hawaii and caused $26 million in property damage in Hilo alone.

Tsunami wave periods vary from 5 minutes to over 1 hour. Tsunami wave heights in the deep ocean are only a foot or two and their passage is generally not noticeable. However, in coastal regions, the tsunami wave may be subject to extensive transformation by the shallow water processes of refraction and shoaling, and also resonance in bays and harbors, and it may result in a much amplified wave height at the shoreline. Procedures have been developed for the U.S. Army Corps of Engineers, Pacific Ocean Division to determine tsunami wave elevations along the coastlines of Hawaii for various frequencies of occurrence (Manual For Determining Tsunami Runup Profiles on Coastal Areas of Hawaii, 1978). Tsunami runup elevations computed for 50 and 100 year tsunamis in the landing site areas are presented in later sections of this report.

III. METHODOLOGY FOR MARINE BIOLOGICAL SURVEYS

GENERAL

The quantitative sampling of macrofauna of marine communities presents a number of problems; many of these are related to the scale on which one wishes to quantitatively enumerate organism abundance. Marine communities in the areas surveyed for this surveyed may be spatially defined in a range on the order of a few hundred square centimeters (such as the community residing in a Pocillopora meandrina coral head) to major biotopes covering many hectares. Recognizing this ecological. characteristic, the sampling program was designed to delineate all major communities in the limits of the study areas and to quantitatively describe these communities. Thus a number of methods were used.

To obtain an overall perspective on the extent of the major communities or "zones" occurring in the study area, divers were slowly towed behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. This exercise allowed the qualitative delineation of major biotopes based partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each of these, stations were established and quantitative studies were conducted, including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrats. Besides these quantitative measures, a qualitative reconnaissance was made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments were carried out using SCUBA.

Biotopes are defined by physical characteristics including water depth, relative exposure to wave and current action, and the major structural elements present in benthic communities. The latter include the amount of sand, hard substratum, and vertical relief present as well as the biological attributes of relative coral coverage, fish abundance, and dominant species of the coral community. Biotopes are named for the distinctive features of the zone. It should be noted that the boundaries of each zone are not sharp but rather grade from one to another; these are ecotones or zones of transition.

The locations of stations were subjectively chosen as being representative of a given biotope. Immediately following station selection, a visual census of fishes was undertaken to estimate their abundance. These censuses were conducted over a 4 x 25 meter corridor and all fishes within this area from the bottom to the water surface were counted. Data collected included the number of individuals of each species as well as an estimate of individual lengths of all fishes seen; the length data were later utilized in estimating the standing crop of fishes present at each station using linear regression techniques (Ricker 1975, Brock and Norris 1989). A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954). The 25m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels or puhis (family Muraenidae) and nocturnal species, e.g., squirrelfishes or ala'ihis (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus or rockfishes, family Scorpaenidae; the flat fishes or paki'is, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any com- parisons between surveys. In the present study, one individual carried out all of the visual censuses. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2cm in some dimension (without disturbing the substratum) were censused in a 4 x 25m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some sea urchins and sea cucumbers). Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae were quantitatively surveyed by use of quadrats and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points were assessed (once every 50cm). These data have been converted to percentages. Quadrat sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in six one-meter square frames placed at five-meter intervals along the transect line established for fish censusing (at 0, 5, 10, 15, 20 and 25m).

If macrothalloid algae were encountered in the 1 x 1m quadrats or under one of the 50 points, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats.

During the course of the fieldwork notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near to the study area. With green turtles, efforts were made to record the size (straight line capapace length) of the individuals seen as well as the presence of tags, tumors or any deformities. We also attempted to note the presence of appropriate resting and foraging areas for green turtles.

IV. MOKAPU BEACH, MAUI

ALTERNATIVES CONSIDERED

The coastal sector investigated for the Maui cable landing extended from the old Kihei Pier to Ulua Beach, a distance of approximately 6.0 miles. Much of the shoreline in the northern half of the sector is sandy beach, with interspersed rocky outcrops. Significant erosion has occurred along this coastline, and shore protection structures are common. The two mile length at the south end of the sector consists of crescent shaped sand beaches bounded by rocky headlands. The sector is shown in Figure IV-1.

In the Kihei area, the 60-foot depth contour is located approximately 9000 feet offshore. This distance decreases in the southern part of the sector, and the 60 foot depth contour is only is only 2000 feet offshore in the Wailea area.

Specific sites investigated during the initial reconnaissance included Kihei Memorial Park, The three Kamaole Beach Parks, Keawakapu Beach and Mokapu Beach. The sector initially extended only to Keawakapu Beach, but when a suitable site could not be found in the area, the sector was extended south to Ulua Beach.

Most of this coastline has similar bottom characteristics, with the variation between sites primarily due to the width of the various zones. Most sites typically have sand deposits extending from the shoreline out to a water depth of 30 to 70 feet. Seaward of the sand deposit, a very irregular rock and coral bottom typically drops off slowly to the 90 foot water depth. In general, there is extensive coral coverage in this zone. The coral band terminates at a near vertical ledge which drops to the 150 foot depth. This configuration was noted all along this coast, so the search for a suitable landing site concentrated on locating a sandy channel through the coral band, and avoiding the vertical ledge. In general, conditions for a cable landing were worst at the north end of the sector, and improved gradually with distance to the south.
Specific sites considered but not selected for a landing site are discussed below.

1. <u>Kihei Memorial Park</u>

This was an area of interest because the aerial photographs showed extensive offshore sand deposits. However, the sand extends out only to about the 45 to 50 foot depth. The sand then gives way to rock and coral bottom, with some of the coral mounds rising to within 30 feet of the surface. Vertical relief is on the order of 10 to 12 feet. The coral band is several thousand feet wide, with water depth slowly increasing with distance seaward. The offshore limit of the coral band is in approximately 90 feet of water, where a steep ledge drops to the 150 foot depth. Disadvantages of this site include the steep ledge, the wide band of coral that would have to be crossed, the distance to the 60 foot contour, and the extensive use of the old pier site as an anchorage for recreational and charter boats.

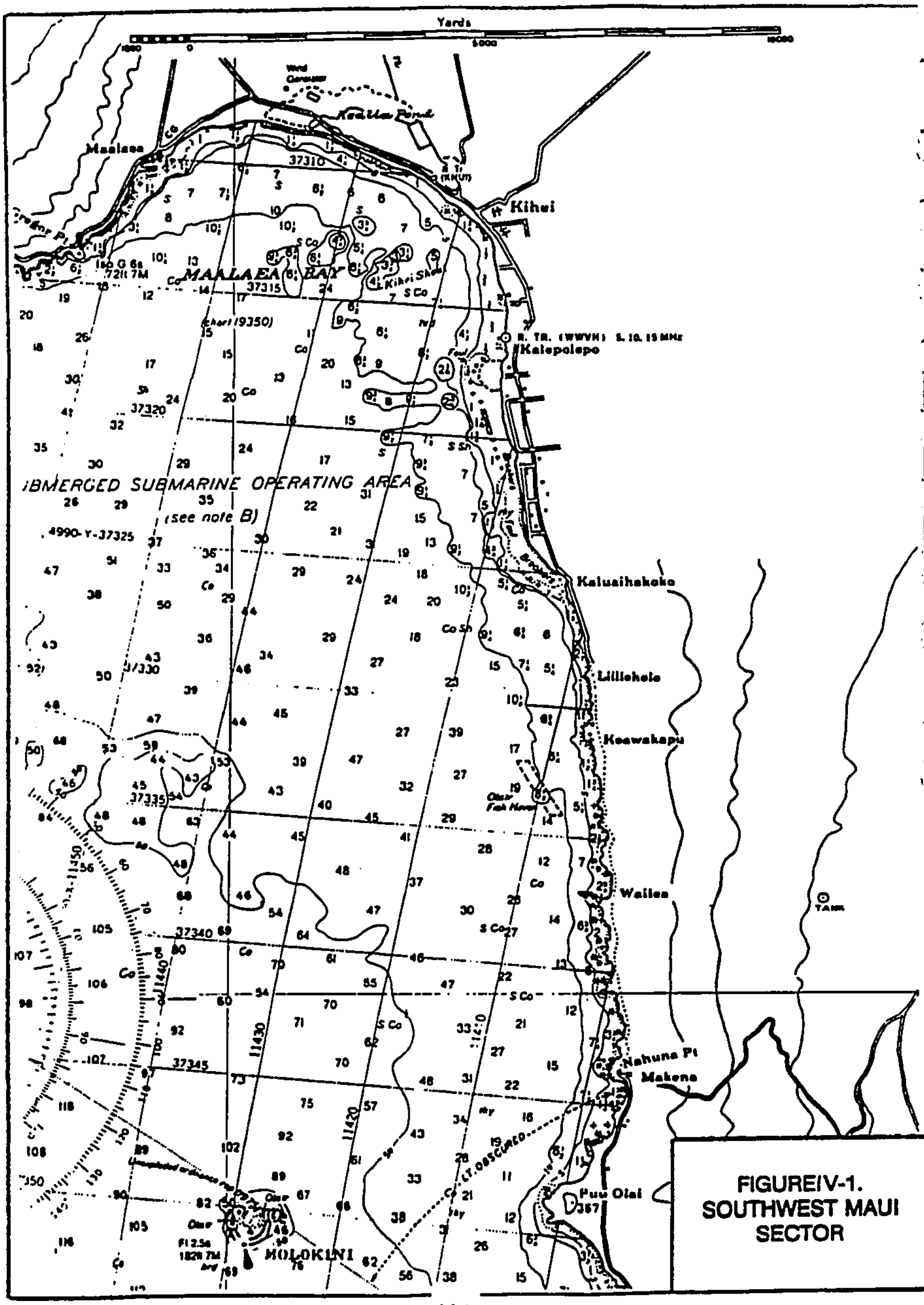

FIGURE IV-1.
SOUTHWEST MAUI
SECTOR

2. Kalama Beach Park

The shoreline at Kalama Beach Park has been subject to severe erosion, and is now protected by a massive rock revetment. Unlike the other areas along this sector, there is no inshore band of sand, and the revetment gives way to a rock and coral bottom. The top of the ledge (90 foot water depth, approximately 6500 feet from shore) defines the seaward boundary of the coral zone. Disadvantages of this site include the ledge, the wide band of coral, the lack of any significant inshore sand deposits and the onshore revetment.

3. Kamaole Beach Parks

The Kamaole Beach Parks are three small pocket beaches, separated by rock headlands. Kamaole I is 1800 feet long, Kamaole II is 1200 feet long, and Kamaole III is 900 feet long. The beaches are directly exposed to wave approach from the south, and are subject to severe erosion during Kona storms and hurricanes. At Kamaole II, there have been instances where all the sand was scoured from the beach by severe Kona storms. Kamaole III has extensive outcroppings of beachrock at the water's edge. The bottom off the beaches is sand to the 30 foot depth, with a 2000 to 3000 foot wide band of coral seaward of the sand. The coral coverage is extensive, with high vertical relief. The coral band terminates at a ledge at the 50 foot depth. The ledge drops almost vertically to the 90 foot depth. Disadvantages of this site include the ledge, the coral band, and the potential instability of the shoreline sand during Kona storms.

4. Keawakapu Beach

Off Keawakapu, the sand bottom extends from the shoreline to the 70 foot water depth. Seaward of the sand, a coral ridge rises to the 40 foot depth before giving way to a steep offshore slope. Private homes line most of the beach, and the most likely cable landing site would be at the east end, at Keawakapu Beach Park. There is a pronounced gully in this area, and it appears likely that the landing site would be subject to severe flooding and localized beach erosion during periods of heavy rainfall. Offshore, in water depths varying from 70 to 110 feet, there is an artificial fish haven. The haven consists of old car bodies and concrete blocks placed by the Department of Land and Natural Resources. The designated area as shown on nautical charts is approximately 3,300 feet long by 600 feet wide. The location of the fish haven can be seen on Figure V-1. Disadvantages of this area include the potentially unstable shoreline, the coral ridge, and the fish haven which lies across any cable route through this area.

5. Ulua Beach

Mokapu Beach, described below, was selected as the landing site due to favorable offshore conditions. Ulua Beach was investigated to determine how far to the south the favorable conditions extended, in order to have the widest range of landing options. The sand channel through the coral band is only 1100 feet wide off Mokapu Beach, and conditions off Ulua Beach are typical of the areas described above. A wide band of rock and coral lies seaward of the nearshore sand deposit, and terminates in a steep ledge at 90 feet. The rocky headland and associated reef between Mokapu Beach and Ulua Beach prevents the cable from being routed at an angle through the sand channel to make landfall on Ulua Beach.

DESCRIPTION OF THE SELECTED ROUTE

General Description

Mokapu Beach is a crescent-shaped, wide, calcareous sand beach bounded by rocky headlands. The beach is approximately 800 feet long, and 85 feet wide. The inshore bottom is sandy and gently sloping, with the sand extending to deeper water offshore. There is no fringing reef directly off the beach, but there are reefs extending seaward from both the headlands.

Shoreline History

Mokapu Beach has undergone net erosion over the past 42 years. This beach was included in a statewide aerial photographic analysis conducted by Makai Ocean Engineering and Sea Engineering, Inc.(1991). The study results indicate that between 1949 and 1988, the east end of the beach eroded 40 feet and the west end eroded 85 feet. This coastal sector is subject to extensive damage due to severe Kona storms and the passage of hurricanes to the south. For example, at Keawakapu Beach, located just east of Mokapu Beach, a 1959 Kona storm scoured all sand from the beach, leaving only exposed beachrock. Additional damage was caused by storms in the winter of 1962-1963, by a severe Kona storm in January 1980, and by Hurricane Iwa in 1982. The erosion at Mokapu Beach is not chronic, and apparently occurs only during the severe storms. The beach is currently undergoing the slow process of recovery, but as a very general approximation, the beach seems to rebuild more slowly than others in this sector.

Existing Usage

Mokapu Beach is a popular beach for swimming, snorkeling, SCUBA diving, bodysurfing and occasionally board surfing. At the east end, a landscaped minipark includes a paved parking lot and a public access to the shoreline. The Stouffer Wailea Beach Hotel is located directly behind the beach. Condominiums and resort hotels of the Wailea resort complex occupy much of the backshore area.

Physical Characteristics of the Selected Route

The proposed cable landing site is approximately in the middle of Mokapu Beach. On land, the cable will cross some private property before reaching the public park easement. Selection of the route was determined by two overriding factors:

1. Although the sandy beach is 800 feet long, basalt rock and/or fringing reef extend toward the center of the beach from each headland. As a result, there is only a 300 foot length in the center of the beach where the sand extends continuously seaward.

2. Similarly, there is only one gap in the almost continuous offshore coral reef that parallels the south Maui coastline. At its narrowest, in approximately 120 feet of water, this gap is 1100 feet wide.

Figure V-2 shows the location of these features and the proposed route. Orienting the route to avoid the two features described above results in the entire nearshore cable alignment being on a sandy bottom. The sand is medium to fine grained, with a noticeable increase in silt content closer to shore. The sand deposit appears to be thick; there are no protruding rock outcrops or coral formations in the deposit. There are patchy growths of Halimeda, a coralline algae, extending seaward from the 90 foot water depth. Although this growth presents a different biological environment, the underlying bottom is still sand. Fathometer runs along the route centerline indicates that the bottom is flat and probably sandy to at least the 180 foot depth.

The selected route has ideal physical conditions for a cable landing. In addition to the sand bottom, the 50 foot contour is only 1600 feet offshore, which will result in a short cable pull during the landing process. The only disadvantage is the proximity to a fish haven established by the State Department of Land and Natural Resources. The fish haven is located off Keawakapu Beach, in water depth of approximately 90 feet. The closest point of approach of the cable to the fish haven is 660 feet.

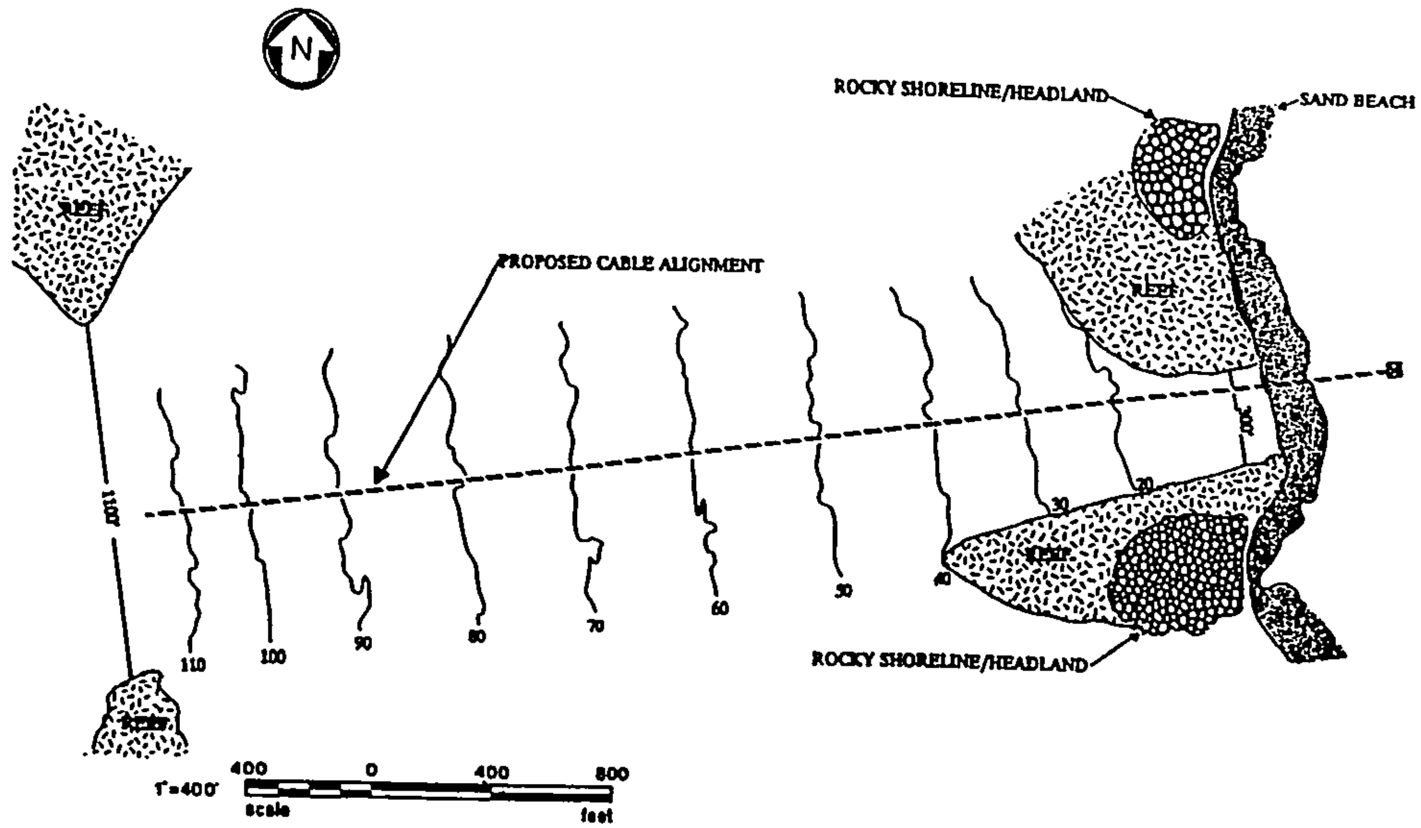

FIGURE IV-2. PHYSICAL CHARACTERISTICS OF SELECTED ROUTE

OCEANOGRAPHIC CONDITIONS

Mokapu Beach is sheltered from the tradewinds and tradewind generated waves. Nearshore, the prevailing winds are generally diurnal onshore-offshore sea breezes caused by the heating and cooling of the land. Offshore the tradewinds blow north to south after being funneled between Haleakala and the West Maui mountains. The project site is directly exposed to Kona winds blowing from the south or southwest.

Due to the orientation of the coastline, and the protection provided by the other islands and the rocky headlands, the beach is primarily vulnerable to south swell and Kona storm or hurricane waves. There is no fringing reef offshore so the beach is exposed to the full force of these waves. The beach is therefore dynamic and subject to episodes of severe storm erosion. Storms during the winter of 1962 - 1963, and in 1980 and 1982 caused severe erosion to beaches along this coast. Many beaches have not yet recovered from the erosion damage.

No current data exists for the nearshore area off Mokapu Beach, or the adjacent areas. A northerly setting current has been reported by the U.S. Coast Pilot (National Oceanic and Atmospheric Administration, 1977). It is presumed that the coastal currents along the southwest coast of Maui follow patterns similar to the currents further north in the vicinity of Lahaina, with the prevailing currents being semi-diurnal reversing tidal currents with a resultant weak net transport to the north.

Nearshore waters are rated Class "A" by the State Department of Health. Several past studies in the general area (off Kihei, Keawakapu, Kamaole and Wailea) by Aecos (1989), Environmental Consultants, Inc.(1977) and M & E Pacific (1979) have included limited, site specific water quality measurements. Typically the sampling programs have not collected sufficient data to allow calculation of a geometric mean, but most of the areas sampled would probably exceed the criteria for Total N and nitrite plus nitrate. These high levels are partially attributable to ground water seepage along the coast, but human activities and development (fertilizer application, cesspool seepage, etc.) can also augment the naturally high levels. The relatively high silt content of the nearshore bottom would lead to the conclusion that turbidity levels would be high during periods of high surf, when the finer bottom sediments would be resuspended.

The estimated 50 and 100 year tsunami elevations 200 feet inland along this coastline are 5.8 and 7.5 feet.

DESCRIPTION OF THE PROPOSED PROJECT

The cable landing process for Mokapu Beach should be relatively simple. Preparing the trench across the backshore portion of the beach will be the most significant preparatory task. Depending upon the depth of excavation, temporary sheetpiling may or not be used to stabilize the trench. It is anticipated that a sand "dam" will be left in place at the seaward end of the trench to prevent generation of turbidity in the nearshore waters. Preliminary construction work on the beach should not exceed a time period of two weeks.

The cable ship should be able to approach to within 2000 feet of shore for the actual cable pull. Positioning of the cable before cutting the floats is not critical as long as the reefs to the north and south of the shore landing site are avoided. There are no other obstacles along the route. After securing the cable to the onshore manhole and cutting the floats, the sand "dam" will either be excavated or the cable will be waterjetted down to the elevation of the beach toe (probably -3 to -5 feet). The sheetpile will then be removed and the beach restored to its natural condition. This should complete the marine work, as no offshore protection, anchoring or trenching should be required on the sand bottom.

MARINE BIOLOGICAL SETTING

The qualitative reconnaissance of Mokapu Beach was carried out on 26 June 1991 and the quantitative sampling of this site was done on 4 December 1991. The qualitative survey extended from shore to about the 90 foot isobath approximately 2,800 feet from shore. In this area three major zones or biotopes were defined. These biotopes are the biotope of sand and Halimeda beds, the biotope of sand and the biotope of basalt rock and corals which lies both to the east and west of the proposed cable alignment. In general, the biotopes approximately parallel shore but along the proposed cable alignment, the biotope of sand extends shoreward from the deeper offshore biotope of sand and Halimeda beds uninterrupted to the beach. Thus the biotope of sand bisects the nearshore biotope of basalt rock and corals. Figure V-3 shows the boundaries of the biotopes as well as the quantitative transect stations. The biotope of sand and Halimeda beds is at depths in excess of 80 feet (about 2,600 feet from shore) and continues seaward to well outside of the study area. To both the east and west of the proposed cable alignment are basalt rock headlands; between these is an 325 foot sand shoreline that is the central part of Mokapu Beach. Offshore and subtidally of these rock headlands is the biotope of basalt rock and coral; on the western side this biotope extends more than 400 feet offshore and on the eastern side in excess of 550 feet seaward.

The Biotope of Sand and Halimeda Beds

The biotope of sand and Halimeda beds is found at depths greater than 80 feet. This biotope may be characterized by a relatively flat sand substratum with a little rubble present. A dominant feature of this biotope is the presence of beds of the alga, Halimeda opuntia. These beds range in size from 6 to 25 feet in width, 3 to 30 feet in length and rise no more than 6 inches from the surrounding substratum. These Halimeda patches are spaced from 5 to over 50 feet apart. In the area examined, the sand has a large number of fragments of the bivalve, Pinna muricata suggesting that somewhere in the near vicinity is probably a large "bed" of this species. Pinna muricata is usually found forming large beds that may cover hundreds of square meters of sand bottom in deeper water (Kay 1979, Brock and Chamberlain 1968).

Station 1 was established at a depth of 87 feet approximately 2,700 feet offshore on the proposed cable alignment. The substratum at this station is as described above. Table V-1 presents the results of the quantitative sampling at Station 1. The quadrat survey noted the alga Halimeda opuntia with a mean coverage of 6.8 percent; two corals (Montipora verrucosa and Porites lobata) were found on rubble having a mean coverage of 0.07 percent. Another species in the transect area that appeared in the 50-point analysis is the bryozoan, Steginoporella magnilabris. The invertebrate census noted one helmet shell (Cassis cornuta), a large mantis shrimp (Lysiosquilla maculata) and one banded shrimp (Stenopus hispidus). The results of the fish census are presented in Appendix B; only five species (11 individuals) were encountered in the census area having an estimated biomass of $2g/m^2$. The most common fishes were the alo'ilo'i or whitespot damselfish (Dascyllus albisella) and the serranid (Anthias thompsoni). Other than a small piece of metal, there was very little local shelter for fishes at this station.

In the vicinity of Station 1 was seen the orange bryozoan (Schizoporella decorata), harp shell (Harpa harpa), augers (Terebra maculata, T. crenulata, T. inconstans), the 'ulae or lizard fish (Synodus binotatus), orangespot surgeonfish or na'ane'a (Acanthurus olivaceus), goatfish or malu (Parupeneus pleurostigma), smooth puffer or keke (Arothron hispidus) and deepwater puffer (Lagocephalus lagocephalus).

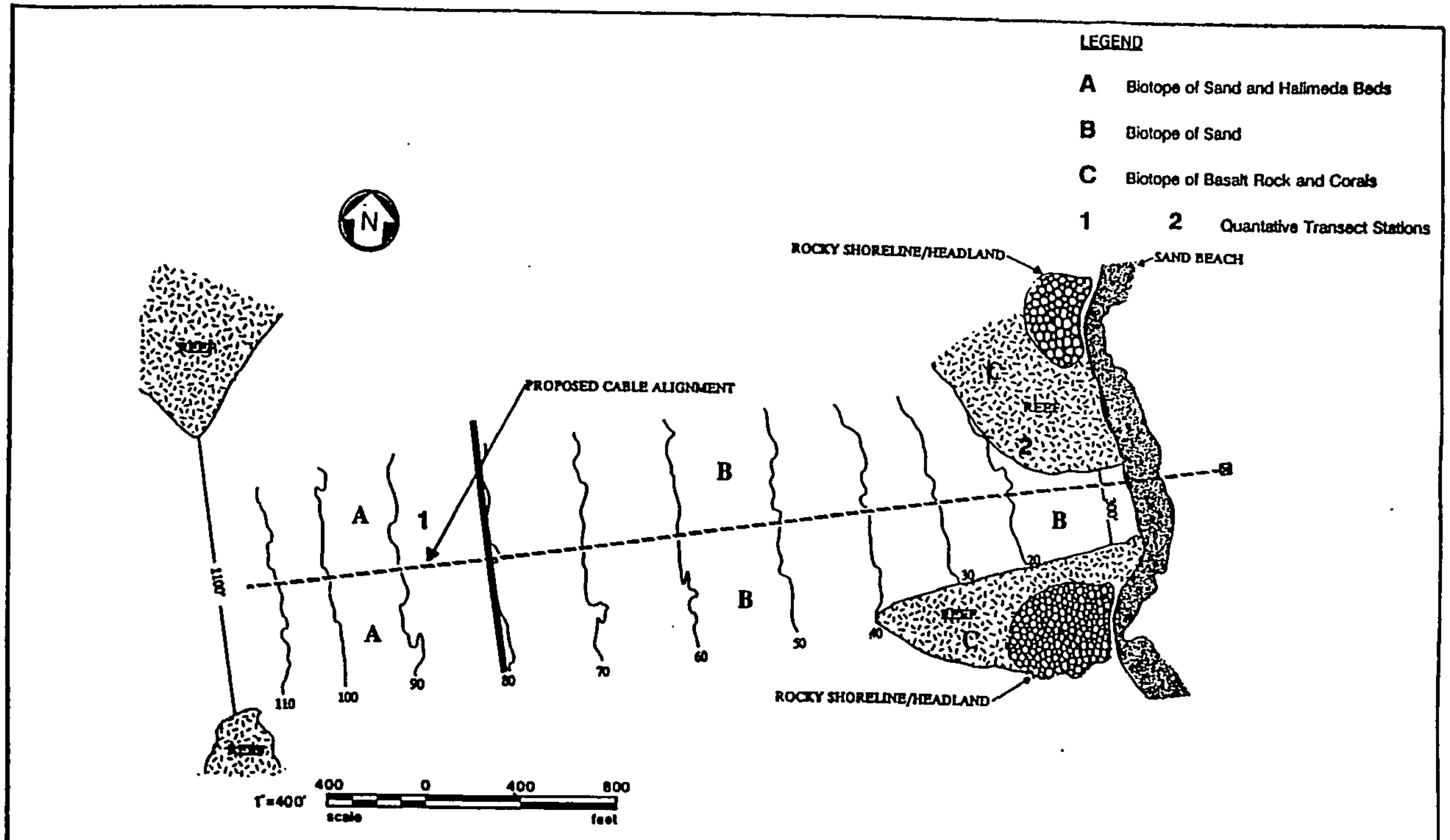

FIGURE IV-3. BIOTOPES ALONG SELECTED CABLE ALIGNMENT

TABLE IV-1.

Summary of the benthic survey conducted in the biotope of sand and Halimeda beds. Results of the 6m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth is 87 feet; mean coral coverage is 0.07 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Halimeda opuntia	1	9	17			14
Corals						
Montipora verrucosa	0.3					
Porites lobata					0.1	
Bryozoans						
Steginoporella magnilabris	0.7					2
Sand	98.7	90.3	83	100	99.9	84

B. 50-Point Analysis

Species	Percent of the Total
Algae	
Halimeda opuntia	2
Bryozoans	
Steginoporella magnilabris	2
Sand	96

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Cassis cornuta	1
Phylum Arthropoda	
Lysiosquilla maculata	1
Stenopus hispidus	1

D. Fish Census (4 x 25m)

5 Species
11 Individuals
Estimated Biomass = 2g/m^2

The Biotope of Sand

The biotope of sand lies shoreward of the biotope of sand and Halimeda beds and it extends uninterrupted to the beach in the area of the proposed cable alignment. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Thus many species in the sand biotope are cryptic and difficult to see; among those are many of the molluscs and crustaceans such as the kona crab (Ranina serrata). Hence, without considerable time spent searching in the sand, many species in the sand habitat will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant.

Because of the dispersed and cryptic nature of many of the species resident to the biotope of sand we did not quantitatively sample this biotope but rather carried out a qualitative reconnaissance of the habitat in waters from 30 to 80 feet in depth. Species noted in this overview of the biotope include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), opelu or mackeral scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), the lizard fish or 'ulae (Synodus binotatus), the flatfish or paki'i (Bothus mancus), uku or snapper (Aprion virescens), goatfish or malu (Parupeneus pleurostigma) and the weke or white goatfish (Mulloides flavolineatus). With greater effort many more fish species would be encountered in this biotope.

A short survey was made of the sand beach at the point of the proposed cable landing; no macrofauna was seen although one ghost crab hole (probably Ocypode ceratophthalmus) was present on the beach. A short visual appraisal was made of the rocky intertidal that lies to the east and west of the proposed alignment. The substratum of the rocky intertidal is primarily a pahoehoe (basalt) bench with scattered basalt boulders. On the emergent rocks were seen the grey littorine snail (Littorina pintado) and the prosobranch mollusc, Siphonaria normalis; slightly lower down on the rocks are the black snail or pipipi (Nerita picea). Algae seen include limu hulu'ilio (Giffordia breviarticulata) and the encrusting coralline alga (Porolithon onkodes). Also present are a number of unidentified microalgal species that form a fine "turf". We noted the black rock crab or ama'ama (Grapsus grapsus) on the basalt boulders and the small hermit crabs (Calcinus herbstii and C. elegans) in the shallows.

The Biotope of Basalt Rocks and Corals

The biotope of basalt rocks and corals is not in the path of the proposed cable alignment but at the closest point, lies within 80 feet of it. The substratum of this biotope is primarily basalt rock with corals on it. There is a small amount of sand present in this biotope and as the waves pass, the sand roils and must scour the substratum. Much of the basalt is in the form of boulders with a mean diameter of about 2 feet. Many of the corals are found on the boulders up away from the depressions with sand. Common species on the boulders include the coral Pocillopora meandrina, sea urchins, wrasses, surgeonfishes and damselfishes.

Station 2 was established about 300 feet offshore in the biotope of basalt rocks and corals which lies west of the proposed cable alignment. Water depth at this station ranges from 10 to 12 feet and the visibility at the time of sampling was no more than 10 feet probably due to passing waves "stirring up" fine material on the bottom. The substratum at Station 2 is as described above; Table V-2 presents the results of the quantitative survey carried out at Station 2. The quadrat survey noted a small amount of the alga, Desmia hornemanni) and eleven species of corals having a mean coverage of 16.9 percent. The corals present included Porites lobata, P. compressa, P. evermanni, P. (Synarea) convexa, Pocillopora meandrina, P. damicornis, Montipora verrucosa, M. patula, M. flabellata, M. verrilli and Pavona varians. Porites lobata was the dominant coral species. The invertebrate census noted five species including two polychaetes (Loimia medusa and Spirobranchus gigantea) and three sea urchin species. Both the black sea urchin (Tripneustes gratilla) and the slate pencil urchin (Heterocentrotus mammillatus) were very abundant. Sixteen species of fishes (71 individuals) were encountered in the fish census. The most abundant fishes were the banded goatfish or moano (Parupeneus multifasciatus), the damselfish (Chromis vanderbilti) and the saddleback wrasse or hinalea lauwili (Thalassoma duperrey). The standing crop of fishes was estimated to be $11 g/m^2$; the most important contributors to this biomass were the moano or banded goatfish (Parupeneus multifasciatus), the black damselfish (Stegastes fasciolatus) and the saddleback wrasse or hinalea lauwili (Thalassoma duperrey).

In the vicinity of Station 2 were seen the soft coral (Palythoa tuberculosa), corals (Leptastrea purpurea and Pocillopora eydouxi), blue goatfish or moano kea (Parupeneus cyclostomus), red hawkfish or piliko'a (Cirrhitops fasciatus), spotted wrasse (Macropharyngodon geoffroy), goatfish or malu (Parupeneus pleurostigma), whitebar surgeonfish or maikoiko (Acanthurus leucoparieus) abd the triggerfish or humuhumu (Rhinecanthus rectangulus).

TABLE IV-2.

Summary of the benthic survey conducted in the biotope of basalt rock and corals approximately 325 feet offshore of Mokapu Beach, Maui on 4 December 1991. Results of the 6m[2] quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Pact C. A short summary of the fish census is given in Part D. Water depth is 10 to 12 feet; mean coral coverage is 16.9 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Desmia hornemanni			0.1			
Corals						
Porites lobata	8	6	13	7	4	6
Porites evermanni			7			
Porites compressa					4	
Porites (Synarea)convexa					0.5	
Pocillopora damicornis			0.1		0.5	
Pocillopora meandrina		2.5	4.5	2.5	0.5	4
Montipora verrucosa			3	3	2	
Montipora patula					4	
Montipora flabellata					5	
Montipora verrilli	7	5				
Pavona varians			2.5			
Sand		9		6		
Basalt Rock	92	75.5	71.9	74.4	80	89.5

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	8
Porites evermannni	2
Porites compressa	2
Pocillopora meandrina	4
Montipora verrilli	2
Sand	8
Basalt Rock	74

TABLE IV-2.
Continued.

C. **Invertebrate Census (4 x 25m)**

Species	Number
Phylum Annelida	
Loimia medusa	2
Spirobranchus gigantea	7
Phylum Echinodermata	
Tripneustes gratilla	105
Heterocentrotus mammillatus	92
Echinometra mathaei	17

D. **Fish Census (4 x 25m)**

16 Species
71 Individuals
Estimated Biomass = $11 g/m^2$

No green sea turtles were seen during this survey of Mokapu Beach. There was little algae present that could serve as appropriate forage for green turtles although several sites were seen in the biotope of basalt rocks and corals that could serve as resting sites. We have found no information to suggest that nesting of sea turtles on Mokapu Beach has occurred in historical times.

The biological survey of the proposed cable alignment at Mokapu Beach did not find any rare or unusual species or communities. Another protected species, the humpback whale (Megapteranovaeangliae) was not seen offshore of the study area during the period of our field effort.

POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts with Construction

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment enters the shallows through the biotope of sand and Halimeda beds. We expect that the cable will have little negative impact to the communities in the biotope of sand and Halimeda beds because the majority of the substratum is sand. It is expected that a cable deployed over a Halimeda bed would probably sink into the substratum between the individual algal fronds and present little impact.

As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom. Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., most macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are; (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur in low abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will sink into the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

A major consideration in the selection of the route is the presence of sand because deployment through sand offers little chance of negative impact to benthic communities relative to the impact that could occur to benthic communities situated on hard substratum. The proposed cable alignment at Mokapu Beach is through a sand channel to the shoreline. We expect little impact to surrounding marine communities if this proposed route is utilized.

It is expected that a shallow trench will be dug in the beach sand where the cable comes ashore. The construction of this trench will generate some temporary turbidity which may impact surrounding communities. With any construction adjacent to benthic communities situated on hard substratum is the concern over possible impacts to corals because of their sessile nature and usual slow growth characteristics.

Another concern may be with disturbance to threatened or endangered species. If construction activities are restricted to the period between April through October, the endangered humpback whale (Megaptera novaeangliae) would not be impacted because it is only in Hawaiian waters on a seasonal basis (November through March).

Assuming that deployment of the cable occurs during the period of time that humpback whales are in island waters, it is anticipated that the impacts to whales would be minimal. The deployment of the cable from shallow water (i.e., the 60 foot isobath) to shore should not take longer than one day. In general, this deployment is done by bringing the cable laying ship into about the 60 foot isobath; from this point to shore the cable is buoyed up using floats and small craft are used to maneuver the cable into the appropriate alignment and into shore.

The probable source of local impact to whales would be the production of noise by the cable laying ship and smaller vessels used to bring it ashore. There are variable and conflicting reports as to the impact of vessel traffic on whales. Evidence from the northwest Atlantic and northeast Pacific suggest behavioral changes by whales in response to vessels, but they may show considerable fidelity to specific feeding areas despite vessel traffic (major shipping, trawler activity, etc.; Brodie 1981, Matkin and Matkin 1981, Hall 1982, Mayo 1982). In contrast Jurasz and Jurasz (1980) found a sharp decline in humpback whale numbers in Glacier Bay, Alaska with increases in vessel activity. In a short term study, Bauer (1986) found no correlation between vessel and whale numbers as well as no net movement offshore at Olowalu, Maui in 1983-84. However, a six year study suggested a major offshore movement of mother-calf pods off Maui with increased vessel traffic (Glockner-Ferrari and Ferrari 1985, 1987). This study along cannot be used to determine whether the observed reductions in sighting around Maui is correlated with vessel traffic; there is not consistent baseline information or comparative studies on humpback whale habitat utilization around Maui which may corroborate the trends reported by Glockner-Ferrari and Ferrari (Tinney 1988).

With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman 1986). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the cable deployment. However as noted above the impacts (here noise) are not expected to last for more than one day, and all activities will be concentrated in a very small area.

Sea turtles are permanent residents in inshore Hawaiian habitats thus the potential exists for problems during the construction phase if it entails dredging. The generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, green turtles moved from an offshore diurnal resting site about one kilometer offshore to a point about 200m from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Any construction activity that generates fine particulate material will lower light levels and in the extreme, bury benthic communities. Sedimentation has been implicated as a major environmental problem for coral reefs. Increases in turbidity may decrease light level resulting in a lowering of primary productivity. When light levels are sufficiently decreased, hermatypic corals (i.e., the majority of the corals found on coral reefs) will eject their symbiotic unicellular algae (zooxanthallae) on which they depend as source of nutrition. However, in nature corals will eject their zooxanthallae and survive (by later acquiring more zooxanthallae) if the stress is not a chronic (longterm) perturbation.

Perhaps a greater threat would be the simple burial of benthic communities that may occur with high sediment loading and concurrent low water movement. Many benthic species including corals are capable of removing sediment settling on them by ciliary action and the production of mucous, but there are threshold levels of deposition where cleaning mechanisms may be overwhelmed and the individual becomes buried. However, the impact of sedimentation on Hawaiian reefs may be overstated. Sedimentation from land derived sources (usually the most massive source) is a natural event usually associated with high rainfall events. Dollar and Grigg (1981) studied the fate of benthic communities at French

Frigate Shoals in the Northwest Hawaiian Islands following the accidental spill of 2200mt of kaolin clay. These authors found that after two weeks there was no damage to the reef corals and associated communities except where the organisms were actually buried by the clay deposits for a period of more than two weeks.

Fishery Considerations

Access to the shoreline at Mokapu Beach is excellent; the beach is heavily used by people interested in sunbathing, swimming, snorkeling and SCUBA diving. Apparently SCUBA dive tours use this beach for "shore dives". Also, fishing occurs in the waters fronting Mokapu Beach. Fishermen catch fish both from shore as well as offshore from small boats. In all probability, some commercial fishing occurs offshore of the proposed cable alignment. During our field survey we noted several boats fishing in the offshore waters using a drift-fishing, hook and line technique. We are unaware of any individuals that specifically and exclusively use Mokapu Beach for subsistence fisheries. Probably most of the fishing activity in and around Mokapu Beach from the shoreline is by recreational fishermen. With most Hawaiian recreational fisheries, species targeted include papio and ulua (family Carangidae), o'io or bonefish (Abula vulpes), moi (Polydactylus sexfilis), goatfishes (family Mullidae), snappers (family Lutjanidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and a host of smaller species such as the aholehole (Kuhlia sandvicensis), aweoweo (Priacanthus cruentatus) and menpachi (Myripristes amaenus). Fishing methods used include nets, spears, traps as well as hook and line.

The present study found a low abundance of fish species of interest to fishermen in the Mokapu Beach stations. The paucity of fishes may be related to fishing pressure as well as a lack of shelter space (particularly in the offshore sand bottom areas. The standing crop of fishes was estimated to be 2g/m^2 at Station 1 on a sand substratum and 11g/m^2 in the biotope of basalt rocks and corals. Standing crop estimates of fishes on coral reefs have been found to range from about 2 to 200g/m^2 (Brock 1954, Goldman and Talbot 1975, Brock et al. 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, the variation in standing crop appears to be related to the variation in local topographical complexity of the substratum. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fishes (i.e., 2 to 20g/m^2).

Water Quality Considerations

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This may occur through natural events such as storm surf resuspending fine material that had previously come into the area through natural events and settled or by human activities including the directing of storm water runoff into the ocean or by underwater construction activities. Underwater construction (principally dredging) will generate fine particulate material that could impact corals. The generation of fine sedimentary material could have a negative impact to corals and other benthic forms if it occurs in sufficient quantity over sufficient time. Studies (e.g., Dollar and Grigg 1981 noted above) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the construction activities that would be necessary to protect the cable in shallow water would probably produce little sediment. This statement is supported by the fact that trenching would probably confined to an area directly adjacent to the shoreline and through it and would be carried out in a sand substratum. The small scale and anticipated short duration of the project suggest a minimal impact.

High water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats thus assisting in the advection of this material out of these areas (less than 100m in depth) where corals are found.

Turbidity is a an optical property that is related to the scattering of light by the suspended particles in the water column. The finer the particles, the longer they may remain in suspension (Ekern 1976) and if fine materials are associated with much water motion (waves, currents) the actual deposition rates in these turbid waters may be quite low. However, if the amount of suspended particles (i.e., turbidity) is great enough to reduce light levels, some impact to corals may occur.

The deposition of sediment on coral reefs has been measured and correlated with the "condition" of the reef corals. Loya (1976) defined a "high" sedimentation rate as 15mg/cm^2/day and a "low" rate as 3mg/cm^2/day for Puerto Rican reefs. Low cover and species diversity were associated with reefs exposed to "high" sediment deposition rates. In contrast, "high" sediment deposit- ion rates on Guamian reefs was defined in the range of 160- 200mg/cm^2/day and this rate of deposition limited coral cover and diversity (here less than 10 species and 2% cover; Randall and Birkeland 1978). A "low" rate was defined as 32mg/cm^2/day and was associated with rich coral communities (more than 100 species and 12%+ coral cover). These comparisons demonstrate the relat- ive nature of sedimentation rates; the rate considered to be low in Guam is more than twice the high rate from Puerto Rico. Rea- sons for this disparity relate to differences in how rates are measured (i.e., lack of a standardized methodology) as well as difficulty in relating environmental factors such as water motion and sediment deposition in sediment traps. Water motion may mitigate or enhance the deleterious effects of sedimentation on the diversity and cover of corals in a given area. Hopley and Woesik (1988) note a chronic sedimentation rate of 129mg/cm^2/day (7 month mean) did not negatively impact an Australian coral reef with high cover and species diversity.

These data suggest that if needed as a means for protecting the proposed fiber optic cable in shallow water, the short term disturbance (probably less than two weeks) created by small-scale tenching will be a minor impact.

Mitigation Measures

As described in an earlier section (Description of the Proposed Project) of this chapter, no cable protection, anchoring or trenching is anticipated in the nearshore waters. However, a cable path will have to be trenched across the beach. As described earlier, this trench will "daylight" where the beach toe intersects the nearshore bottom (approxmiately at the 3 to 5 foot water depth).

Adverse effects due to turbidity can be minimized by leaving a barrier of sand in place at the water's edge until the day of the cable pull. Once the cable is pulled ashore, up and over the "dam" and into the trench, it can then be water jetted down to the design elevation. Turbidity is typically only generated on one or two days on a cable pull into a sandy beach.

APPENDIX A.

Results of the quantitative visual censuses conducted at three locations offshore of Sandy Beach, Oahu on 7 January 1992. Each entry in the body of the table represents the total number of individuals of each species seen; totals are presented at the foot of the table along with an estimate of the standing crop (g/m^2) of fishes present at each location.

FAMILY AND SPECIES	STATION NUMBER 1	2	3
MURAENIDAE			
Gymnothorax meleagris	1		
Gymnomuraena zebra		1	
HOLOCENTRIDAE			
Myripristes amaenus	8		
FISTULARIIDAE			
Fistularia commersoni			1
APOGONIDAE			
Apogon kallopterus	4		
MULLIDAE			
Parupeneus pleurostigma	17	1	1
P. multifasciatus	38	17	8
CHAETODONTIDAE			
Forcipiger flavissimus		2	
Chaetodon fremblii	1	2	
C. kleini	9		
C. ornatissimus	2	2	
C. multicinctus	1	2	
POMACANTHIDAE			
Centropyge potteri	13		
POMACENTRIDAE			
Dascyllus albisella	68		
Plectroglyphidodon imparipennis		4	15
P. johnstonianus	2	3	
Chromis vanderbilti	40	122	
C. hanui	28		
Stegastes fasciolatus			3
CIRRHITIDAE			
Paracirrhites arcatus	4	4	
Cirrhitops fasciatus	1	3	

APPENDIX A. Continued.

FAMILY AND SPECIES	STATION NUMBER 1	2	3
LABRIDAE			
Bodianus bilunulatus		1	
Cheilinus bimaculatus	5		
Pseudocheilinus octotaenia	1		
Thalassoma duperrey	7	38	15
T. ballieui		1	1
Coris venusta	1	1	1
C. gaimard		1	1
Pseudojuloides cerasinus	14		
Stethojulis balteata	3		6
Macropharyngodon geoffroy	12	2	
Anampses chrysocephalus			1
A. cuvier			1
SCARIDAE			
Scarus perspicillatus			4
S. sordidus		4	3
S. psittacus		3	4
PARAPERCIIDAE			
Parapercis schauslandi	3		
MALACANTHIDAE			
Malacanthus hoedtii	1		
BLENNIIDAE			
Plagiotremus ewaensis		1	
GOBIIDAE			
Ptereleotris heteropterus	2		
ACANTHURIDAE			
Acanthurus triostegus		1	32
A. achilles	3		
A. leucoparieus			1
A. nigrofuscus	8	26	27
A. nigroris	4	13	
A. olivaceus	3	4	
A. dussumieri		2	1
Ctenochaetus strigosus			3
ZANCLIDAE			
Zanclus cornutus		2	

APPENDIX A. Continued.

FAMILY AND SPECIES	STATION NUMBER 1	2	3
BALISTIDAE			
Rhinecanthus rectangulus		2	2
Melichthys vidua		1	
Sufflamen bursa	3	1	
MONACANTHIDAE			
Cantherhines dumerilii	1		
CANTHIGASTERIDAE			
Canthigaster coronata	2		
C. jactator	1		1
Total Number of Species	34	30	22
Total Number of Individuals	311	267	132
Estimated Standing Crop (g/m^2)	44	43	74

APPENDIX B.

Results of the quantitative visual censuses conducted at two locations offshore of Mokapu Beach, Maui on 4 December 1991. Each entry in the body of the table represents the total number of individuals of each species seen; totals are presented at the foot of the table along with an estimate of the standing crop (g/m^2) of fishes present at each location.

FAMILY AND SPECIES	STATION NUMBER 1	2
SERRANIDAE		
Anthias thompsoni	3	
APOGONIDAE		
Apogon kallopterus		1
MULLIDAE		
Parupeneus multifasciatus		15
CHAETODONTIDAE		
Chaetodon lunula		1
POMACENTRIDAE		
Dascyllus albisella	5	
Plectroglyphidodon imparipennis		1
P. johnstonianus		4
Chromis vanderbilti		12
Stegastes fasciolatus		7
CIRRHITIDAE		
Paracirrhites arcatus		
Cirrhitops fasciatus		
LABRIDAE		
Hemipteronotus baldwini	1	
Thalassoma duperrey		11
Coris venusta		2
Stethojulis balteata		4
BLENNIIDAE		
Cirripectes variolosus		1

APPENDIX B.
Continued.

FAMILY AND SPECIES	STATION NUMBER 1	2
ACANTHURIDAE		
Acanthurus triostegus		7
A. nigrofuscus		1
A. dussumieri		1
Naso unicornis	1	
OSTRACIONIDAE		
Ostracion meleagris		2
CANTHIGASTERIDAE		
Canthigaster coronata	1	
C. jactator		1
Total Number of Species	5	16
Total Number of Individuals	11	71
Estimated Standing Crop (g/m^2)	2	11

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APPENDIX E

Marine Environmental Analysis of Selected Landing Sites Spencer Beach Park, Hawaii

GTE Hawaiian Tel
Interisland Fiber Optic Cable System

MARINE ENVIRONMENTAL ANALYSIS OF SELECTED LANDING SITES

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March 1992

91-85

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I. INTRODUCTION

GENERAL

GTE Hawaiian Tel is planning the installation of an Interisland Fiber Optic Cable System linking the islands of Kauai, Oahu, Maui and Hawaii. The site selection and evaluation process has been underway since early 1991, and Sea Engineering, Inc. has been retained over that period by the R.M. Towill Corporation to evaluate the marine considerations for potential landing sites and to assist in the preparation of the Environmental Assessments for the recommended landing sites. Dr. Richard Brock of the Environmental Assessment Company, a subconsultant to Sea Engineering, Inc., was responsible for characterizing the nearshore marine biological conditions along the cable routes and also assisted with the impact evaluation.

This report describes the nearshore marine selection process, the alternatives considered, the physical and biological characteristics of the nearshore cable routes, and the anticipated marine environmental impacts.

Figure I-1 shows the interisland cable configuration and the recommended landing sites.

ROUTE SELECTION PROCESS

This report describes only the nearshore marine considerations of the selection process. Other considerations included land suitability, deep ocean conditions, public usage and terrestrial and marine impacts. A series of two Working Papers, prepared by the R.M. Towill Corporation (1991), describe in detail the overall selection process, the alternatives considered, and the rationale for the recommended routes.

The coastal sector boundaries for the potential cable landing sites were initially defined by two primary constraints:

1. The total cable length between central offices was limited to a maximum of 200 kilometers, and preferably to less than 185 km. Cable lengths over 200 km would require an expensive subsea repeater.

2. Proximity of the cable landing site to a central office was desirable, along with relatively easy access to the central office via available polelines, ductlines, or other GTE infrastructure.

Given these constraints, sectors of coastline were delineated which bounded the potential landing areas. An office evaluation of each coastal sector was then completed, utilizing existing literature, color aerial photographs, marine charts, coastal inventories prepared by state and Federal agencies, and personal knowledge of nearshore physical and biological

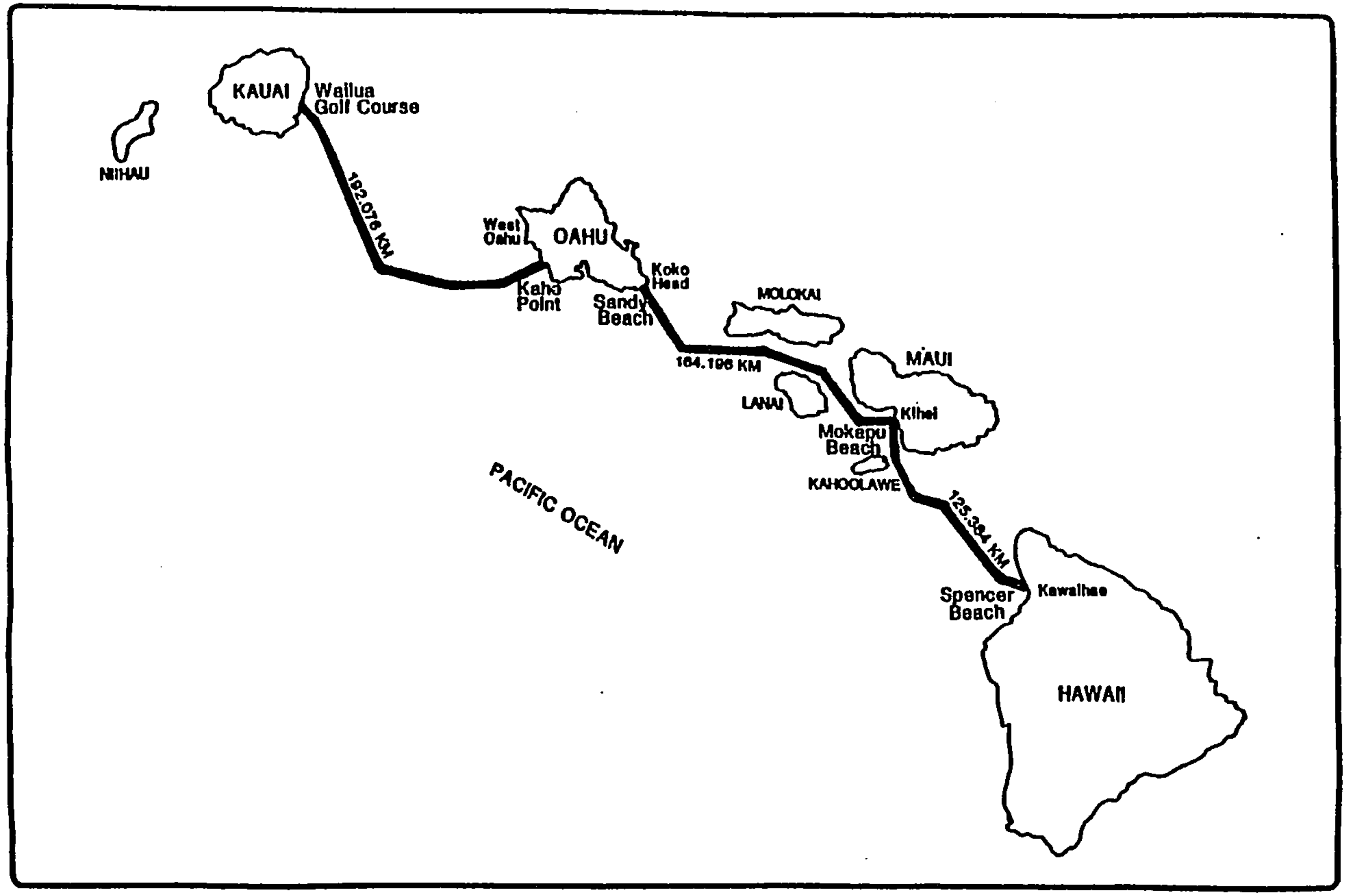

FIGURE I-1. SUMMARY OF RECOMMENDED GTE HAWAIIAN TEL FIBER OPTIC LANDING SITES – STATE OF HAWAII

characteristics and uses. A one day field reconnaissance was then conducted in each sector to select three potential landing sites in each sector. If no suitable sites were found within the sector limits, the sector was enlarged as required.

Following the consolidation of all planning considerations mentioned above (terristrial and marine) a more detailed field study was conducted at each site by an ocean engineer and marine biologist. The objective of this phase was to select the primary and secondary route alternatives.The marine biologist was incorporated into this phase of the study to conduct a preliminary assessment of the selected alternatives and to ensure that there were no overriding environmental constraints.

After initial approval by the client of the recommended route, a detailed bathymetric survey was conducted at each site. During this survey, while accurate positioning equipment was available, a diver was towed along the route centerline, and his visual observations were correlated with the track line and the water depth. This step provided valuable information about the precise conditions along the route, and also ensured that there were no unexpected conditions in the nearshore area.

One additional field trip was made to each site, for the express purpose of describing the physical and biological characteristics of the route and adjacent areas, and to evaluate the potential environmental impacts.

The limit of the diving surveys was the 100 foot depth contour. However, the diving support vessels were equipped with fathometers, and tracklines were were run to the 180 foot depth to ensure that no steep ledges were encountered beyond the limit of the visual survey.

MARINE SELECTION CRITERIA FOR NEARSHORE
CABLE ROUTE EVALUATION

Throughout the cable route selection and evaluation process the primary objective was to find a suitable, safe cable route which would also result in the minimum environmental impacts possible in that sector.

Specific selection criteria included the following:

1. Sandy bottoms and coastlines were preferred, both for integrity of the cable and to minimize environmental impacts. Experience at other cable landing sites on Oahu (Makua Beach, Makaha Beach and Nanakuli Beach) indicates that cables on sandy bottoms tend to sink into the sand. No cable cross section is exposed, and wave forces on the cables are therefore minimal. In most of these areas, the winter surf and shorebreak can be very large, yet the numerous cables making landfall there have remained stable.

   Hawaii beaches are usually in a dynamic balance with a large offshore sand deposit, and the two are frequently linked by a continuous sand channel, thus providing the ideal configuration for a cable route. In addition to the engineering advantages, the environmental effects of a placing a cable on a sandy bottonm are much less than placing one across a diverse coral community.

2. Minimizing the horizontal distance from the shoreline to the 60 foot depth was another important factor. This is the zone of maximum wave forces, and the assumption was made that some form of cable protection or anchoring would be required when crossing any hard bottom inshore of the 60 foot contour. This distance is also an important factor in the cable landing process. The cable ship can approach shore to approximately the 50 or 60 foot depth, where it is then held in place by tugs. As the cable is towed to shore by a small boat or tug, floats are attached to the cable as it is paid out, so that it floats on the surface until the shore connection is secured. During this time, the cable position must be maintained along the route centerline. Strong currents or long distances make this process more difficult. The goal was to select a route where the distance from shore to the 60 foot contour was less than 4000 feet.

3. There is a semi-continuous ledge which drops off from the 60 foot contour, and extends through many of the coastal sectors of Hawaii. This ledge was formed during an ancient stand of the sea, and typically has a vertical drop of 30 feet or more. This ledge was present in the Kauai sector, both Oahu sectors and the Maui sector. It was therefore important to find a route which either avoided the ledge or passed through a channel in the ledge. Fortunately, the sand channels connecting the beaches to the deeper offshore deposits often bisect the ledge.

4. Routes were selected to avoid, to the maximum extent possible, environmentally sensitive areas or areas frequented by rare or endangered species. A specific example was the avoidance of areas used by green sea turtles for resting or forage. The marine biological consultant was an early participant in the study, so that environmental input was received during the initial route evaluations.

II. GENERAL OCEANOGRAPHIC CHARACTERISTICS

WINDS

The predominant winds in the Hawaiian Islands are the northeast trades, which are present approximately 70 percent of the time with an average speed of 13 mph. The frequency of tradewinds varies greatly with the season. They occur 90-percent of the time during the months of April to October. The winter season (November to March) is defined by a weakening of the high pressure system generating the tradewinds, and the frequency of occurrence decreases to approximately 50-percent. During the winter season, low pressure systems periodically displace the tradewinds, resulting in south or southwest winds known as "Kona" winds. Kona winds, which occur rarely in summer and 17-percent of the time in the winter, range from light and variable to gale or hurricane force.

PREVAILING WAVE CLIMATE

The general Hawaiian wave climate can be described by four primary wave types; the northeast tradewind waves, south swell, North Pacific swell and kona storm waves. These wave types and their general approach direction are shown on Figure II-2.

Tradewind waves may be present in Hawaiian waters throughout the year, but are most frequent in the summer season, between April and September, when they usually dominate the Hawaiian wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Typical deepwater tradewind waves have periods of 5 to 8 seconds and heights of 4 to 10 feet. During gale conditions tradewind waves may reach heights in excess of 20 feet.

South swell is generated by southern hemisphere storms, and is most prevalent during the months of April through October. These long, low waves approach from the southeast through southwest, with typical periods of 12 to 20 seconds and deepwater heights of 1 to 4 feet. Although their deepwater height is relatively low, the long period results in considerable shoaling near shore with resultant large breaker heights. The surf along the exposed south shores of the islands occasionally reaches heights of 15 feet.

North Pacific swell is produced by winter storms in the North Pacific Ocean and by mid-latitude low pressure areas. North swell may arrive in the Hawaiian Islands throughout the year, but is largest and most frequent during the winter months of October through March. North Pacific swell typically has periods of 12 to 20 seconds and deepwater heights of 5 to 15 feet. The approach direction is typically from the west-northwest through north-northeast. North Pacific swell results in some of the largest waves in Hawaiian waters.For expample, breaking wave heights approaching 50 feet were observed in December 1969.

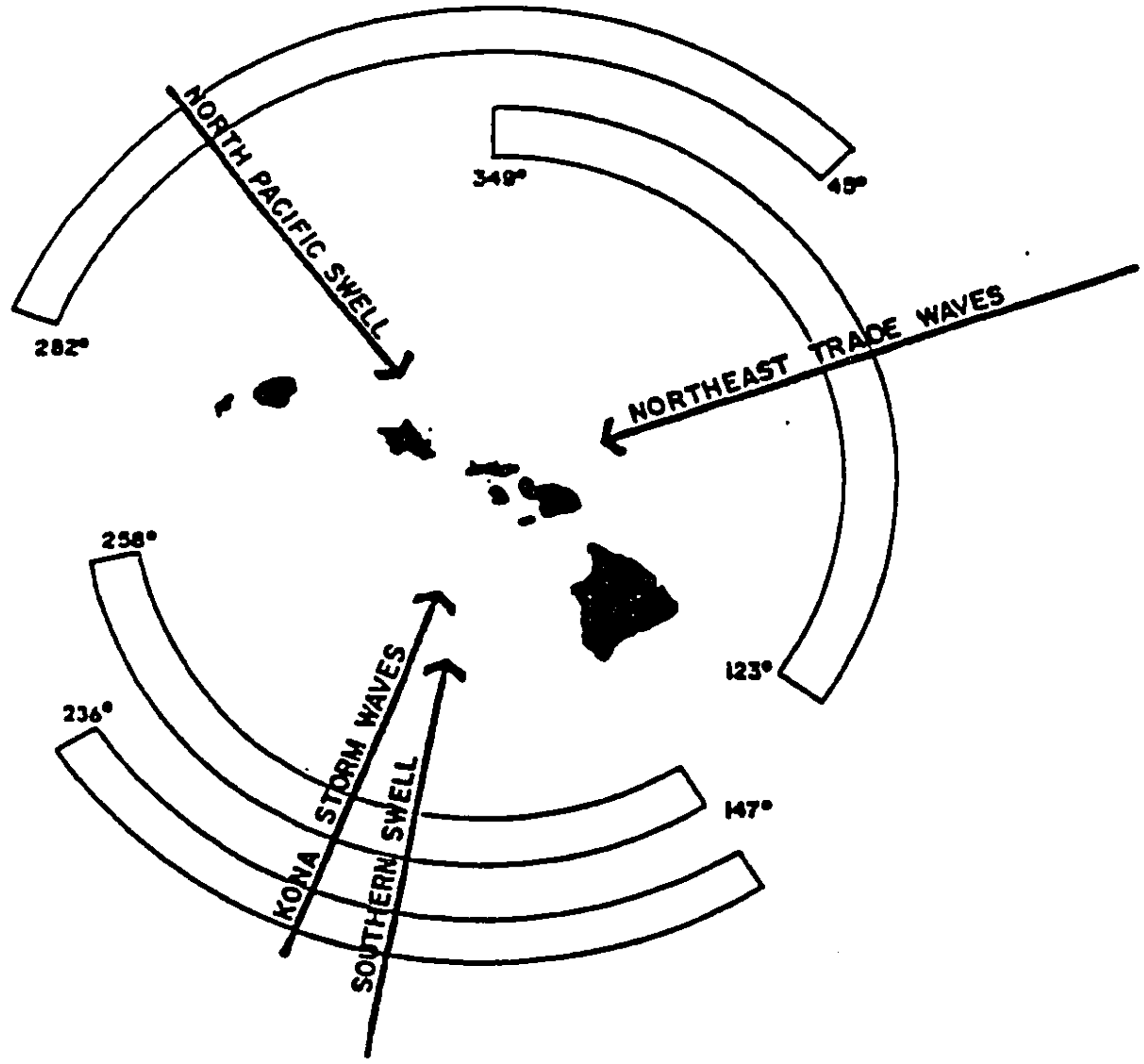

FIGURE II-1.
GENERALIZED WAVE TYPES
(Adapted From The Atlas of Hawaii)

Kona storm waves are generated by intense winds associated with local fronts or low pressure systems and typically have periods ranging from 6 to 10 seconds and typical heights up to 10 feet, but during severe storms heights can approach 20 feet. These waves are most common in late winter and early spring, approaching from the south to southwest.

Hurricane Storm Waves

Hurricanes form near the equator, and in the central North Pacific usually move toward the west or northwest. The primary hurricane season is July through September. These tropical storms or hurricanes usually pass south of the Hawaiian Islands, with a northward curvature near the islands. Late season tropical storms and hurricanes follow a somewhat different track, forming south of Hawaii and moving north toward the islands.

There are many recorded tropical storms or hurricanes which have approached the Hawaiian Islands during the past 35 years, and hurricane waves are generally selected as the design criteria for coastal projects. Most of these storms passed well south or west of the islands, or weakened in intensity as they reach Hawaii, but there have been notable exceptions. Hurricanes Hiki, Della, Nina and Fico passed within about 200 miles of the islands, Dot passed over Kauai, and Iwa passed with 30 miles of Kauai. Kauai.
The report Hurricanes in Hawaii (Haraguchi, 1984), prepared for the U.S. Army Corps of Engineers presents hypothetical model hurricanes for the Hawaiian Islands. The model Hawaiian Hurricane is defined as the probable hurricane that will strike the Hawaiian Islands in the future. The characteristics of the model hurricane are based on the characteristics of hurricanes Dot and Iwa. The predicted wave height and period for the model hurricane are calculated to be 31 feet and 12.0 seconds.

This is a worst case scenario; the actual likelihood of this occurring at one particular site is very low. It is more likely that the storm would pass at some distance, thus the wave height at a particular site would depend on the storm track and decay distance over which the waves travel.

TIDES

The tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e. two tidal cycles per day with the range of water levels being unequal). The average daily tidal range is approximately 2 feet, the maximum range is 2.8 feet.

COASTAL CURRENTS

Coastal currents in Hawaii are influenced by several factors: large scale oceanic currents, tidal currents, wind-driven currents, waves, and island topography. Hawaii is located in the region of the Pacific North Equatorial current, which generally flows to the west with north current speeds ranging from 0.1 to 1 knot. The current direction may vary from west southwest to north-northwest, and the average speed is estimated to be approximately 0.5 knots. Eddies may form in this current as it passes through the islands. Large scale eddies may also be caused by wind circulation patterns around the large mountains on the islands, and small scale eddies may be caused by local landforms.

In most nearshore locations in Hawaii, the tidal flow is the primary current component. Tidal currents are reversing and generally follow bathymetric contours. The maximum tidal current speed in most locations is 2 knots, with speeds of 0.3 to 1.0 knot being typical. Surface currents are modified by the prevailing winds. Past studies around Oahu have indicated that the top 5 to 15 feet of the water column is influenced during moderate trade wind conditions.

The circulation at any particular location is due to a combination of the above factors.

TSUNAMIS

Tsunami, or seismic sea waves, are primarily generated by submarine earthquakes and earth movement with magnitudes greater than about 6.5 on the Richter scale. Coastal and submarine landslides and volcanic eruptions can also generate tsunamis. The Hawaiian Islands are directly exposed to the major tsunami wave generating areas in the Pacific Ocean: the Kuril-Kamchatka-Aleutian region of the north and northwestern Pacific, the west coast of South America, and the seismically active southwest Pacific. Over 80 tsunamis have been observed in the Hawaiian Islands since 1813, and 22 of them resulted in significant damage. The most damaging occurred in 1946 when an earthquake in the East Aleutian Islands generated a tsunami which killed 173 people in Hawaii and caused $26 million in property damage in Hilo alone.

Tsunami wave periods vary from 5 minutes to over 1 hour. Tsunami wave heights in the deep ocean are only a foot or two and their passage is generally not noticeable. However, in coastal regions, the tsunami wave may be subject to extensive transformation by the shallow water processes of refraction and shoaling, and also resonance in bays and harbors, and it may result in a much amplified wave height at the shoreline. Procedures have been developed for the U.S. Army Corps of Engineers, Pacific Ocean Division to determine tsunami wave elevations along the coastlines of Hawaii for various frequencies of occurrence (Manual For Determining Tsunami Runup Profiles on Coastal Areas of Hawaii, 1978). Tsunami runup elevations computed for 50 and 100 year tsunamis in the landing site areas are presented in later sections of this report.

III. METHODOLOGY FOR MARINE BIOLOGICAL SURVEYS

GENERAL

The quantitative sampling of macrofauna of marine communities presents a number of problems; many of these are related to the scale on which one wishes to quantitatively enumerate organism abundance. Marine communities in the areas surveyed for this surveyed may be spatially defined in a range on the order of a few hundred square centimeters (such as the community residing in a Pocillopora meandrina coral head) to major biotopes covering many hectares. Recognizing this ecological characteristic, the sampling program was designed to delineate all major communities in the limits of the study areas and to quantitatively describe these communities. Thus a number of methods were used.

To obtain an overall perspective on the extent of the major communities or "zones" occurring in the study area, divers were slowly towed behind a skiff over most of the study site from shore seaward to at least the 80 foot contour. This exercise allowed the qualitative delineation of major biotopes based partially on the presence of large structural elements (e.g., amount of sand, hard substratum, fish abundance, coral coverage or dominant coral species). Within each of these, stations were established and quantitative studies were conducted, including a visual enumeration of fish, counts along benthic transect lines and cover estimates in benthic quadrats. Besides these quantitative measures, a qualitative reconnaissance was made in the vicinity of each station by swimming and noting the presence of species not encountered in the transects. All assessments were carried out using SCUBA.

Biotopes are defined by physical characteristics including water depth, relative exposure to wave and current action, and the major structural elements present in benthic communities. The latter include the amount of sand, hard substratum, and vertical relief present as well as the biological attributes of relative coral coverage, fish abundance, and dominant species of the coral community. Biotopes are named for the distinctive features of the zone. It should be noted that the boundaries of each zone are not sharp but rather grade from one to another; these are ecotones or zones of transition.

The locations of stations were subjectively chosen as being representative of a given biotope. Immediately following station selection, a visual census of fishes was undertaken to estimate their abundance. These censuses were conducted over a 4 x 25 meter corridor and all fishes within this area from the bottom to the water surface were counted. Data collected included the number of individuals of each species as well as an estimate of individual lengths of all fishes seen; the length data were later utilized in estimating the standing crop of fishes present at each station using linear regression techniques (Ricker 1975, Brock and Norris 1989). A single diver equipped with SCUBA, transect line, slate and pencil would enter the water, count and note all fishes in the prescribed area (method modified from Brock 1954).

The 25m transect line was paid out as the census progressed, thereby avoiding any previous underwater activity in the area which could frighten wary fishes.

Fish abundance and diversity is often related to small-scale topographical relief over short linear distances. A long transect may bisect a number of topographical features (e.g., coral mounds, sand flats and algal beds), thus sampling more than one community and obscuring distinctive features of individual communities. To alleviate this problem, a short transect (25m in length) has proven adequate in sampling many Hawaiian benthic communities (Brock and Norris 1989).

Besides frightening wary fishes, other problems with the visual census technique include the underestimation of cryptic species such as moray eels or puhis (family Muraenidae) and nocturnal species, e.g., squirrelfishes or ala'ihis (family Holocentridae), aweoweos or bigeyes (family Priacanthidae), etc. This problem is compounded in areas of high relief and coral coverage affording numerous shelter sites. Species lists and abundance estimates are more accurate for areas of low relief, although some fishes with cryptic habits or protective coloration (e.g., the nohus or rockfishes, family Scorpaenidae; the flat fishes or paki'is, family Bothidae) might still be missed. Obviously, the effectiveness of the visual census technique is reduced in turbid water and species of fishes which move quickly and/or are very numerous may be difficult to count and to estimate sizes. Additionally, bias related to the experience of the diver conducting counts should be considered in making any com- parisons between surveys. In the present study, one individual carried out all of the visual censuses. In spite of these drawbacks, the visual census technique probably provides the most accurate nondestructive method available for the assessment of diurnally active fishes (Brock 1982).

After the assessment of fishes, an enumeration of epibenthic invertebrates (excluding corals) was undertaken using the same transect line as established for fishes. Exposed invertebrates usually greater than 2cm in some dimension (without disturbing the substratum) were censused in a 4 x 25m area. As with the fish census technique, this sampling methodology is quantitative for only a few invertebrate groups, e.g., some of the echinoderms (some sea urchins and sea cucumbers). Most coral reef invertebrates (other than corals) are cryptic or nocturnal in their habits making accurate assessment of them in areas of topographical complexity very difficult. This, coupled with the fact that the majority of these cryptic invertebrates are small, necessitates the use of methodologies that are beyond the scope of this survey (see Brock and Brock 1977). Recognizing constraints on time and the scope of this survey, the invertebrate censusing technique used here attempted only to assess those few macroinvertebrate species that are diurnally exposed.

Exposed sessile benthic forms such as corals and macrothalloid algae were quantitatively surveyed by use of quadrats and the point-intersect method. The point-intersect technique only notes the species of organism or substratum type directly under a point. Along the previously set fish transect line, 50 such points were assessed (once every 50cm). These data have been converted to percentages. Quadrat sampling consisted of recording benthic organisms, algae and substratum type present as a percent cover in six one-meter square frames placed at five-meter intervals along the transect line established for fish censusing (at 0, 5, 10, 15, 20 and 25m).

If macrothalloid algae were encountered in the 1 x 1m quadrats or under one of the 50 points, they were quantitatively recorded as percent cover. Emphasis was placed on those species that are visually dominant and no attempt was made to quantitatively assess the multitude of microalgal species that constitute the "algal turf" so characteristic of many coral reef habitats.

During the course of the fieldwork notes were taken on the number, size and location of any green sea turtles and other threatened or endangered species seen within or near to the study area. With green turtles, efforts were made to record the size (straight line capapace length) of the individuals seen as well as the presence of tags, tumors or any deformities. We also attempted to note the presence of appropriate resting and foraging areas for green turtles.

IV. SPENCER BEACH PARK, HAWAII

ALTERNATIVES CONSIDERED

Areas initially considered for the cable landing included the old Kona airport and the coastline of Kawaihae Bay. The Kona site was eliminated during the preliminary office study due to both marine and terrestrial concerns. The primary negative factor from the marine viewpoint was the nearshore rocky bottom, which would have necessitated at least 1000 feet of cable protection or anchoring, and the heavy recreational use of the area.

The Kawaihae coastal sector is shown in Figure IV-1. There are several pocket beaches within this sector. The rest of the coast is rocky, with low cliff formations along the waterline. As in the other sectors, the search for a suitable landing site concentrated on finding sand channels to avoid crossing extensive lengths of rocky bottom. Specific areas investigated in detail are discussed below.

1. Hapuna Beach: At this site, a cable route could be selected which would provide a sand bottom out to the 50 or 60 foot depth. However, from that point to approximately the 80 foot depth, a distance of 1500 to 2000 feet, the route would cross several areas of prolific coral growth. The bottom in this zone consists of large beds of coral bounded by relatively small, by comparison, sand channels. The coral mounds rise 8 to 10 feet above the bottom, with a high degree of vertical relief on the actual mounds as well. In this area, approximately one-half to three-quarters of the route would be located on the coral beds. Seaward of the 80 foot depth, the bottom consists of limestone rock and coral rubble, with relatively low vertical relief.

2. Mauna Kea Beach: Bottom conditions at this site were almost identical to those at Hapuna, except that the inshore boundary of the coral beds is located at approximately the 45 foot depth. The zonation was similar, with the coral mounds giving way to the relatively flat limestone bottom at a depth of 75 feet.

The rest of the Kawaihae Bay shoreline, from Puako to Kawaihae Harbor, was also investigated during the first field visit, but no other candidate sites were found. Consideration was given to routing the cable up onto the Kawaihae Harbor breakwater, but this alternative was discarded because it would require crossing a shallow reef. The cable would also then be subject to damage by the commercial and industrial activities at the harbor, and by future improvements.

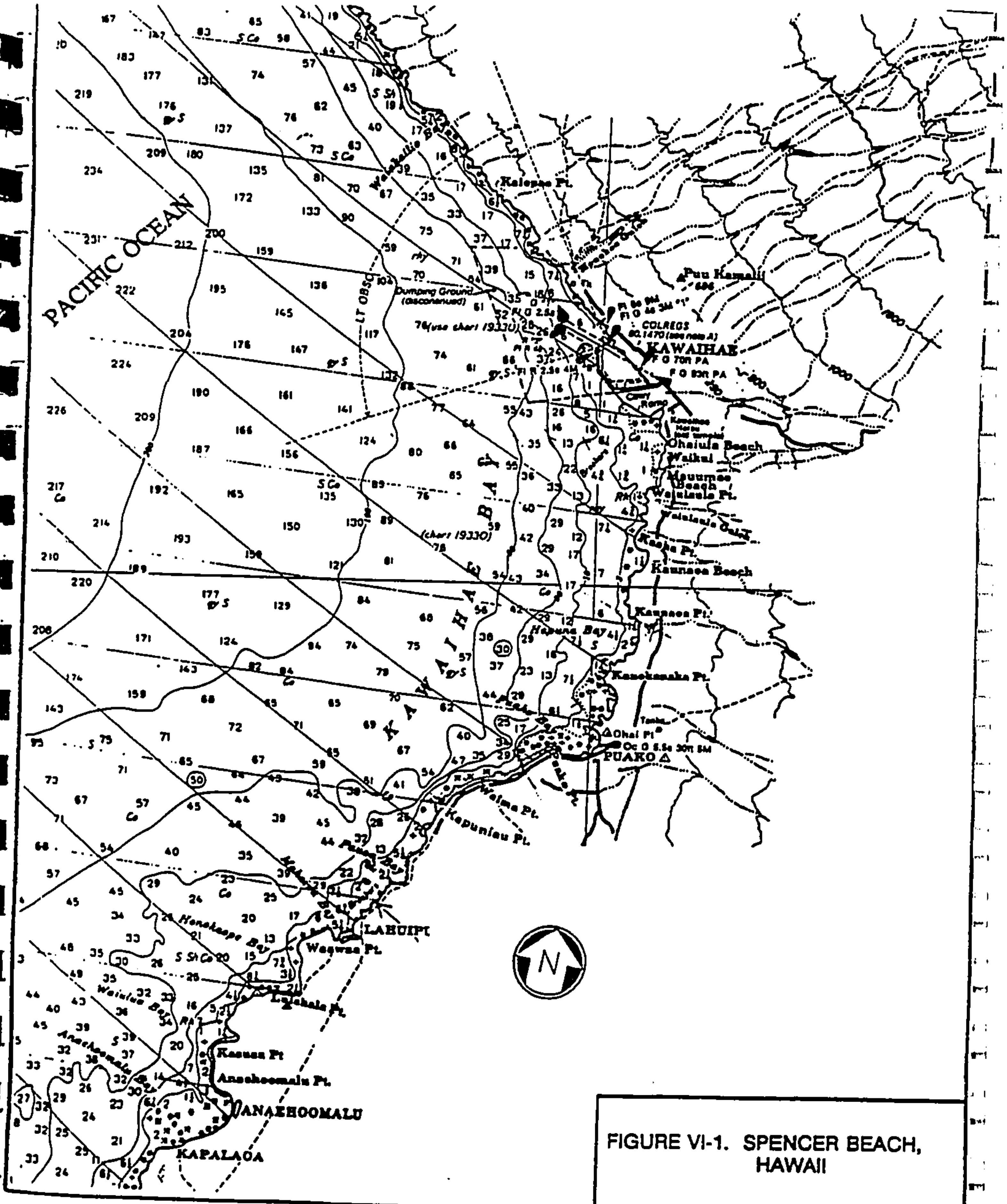

FIGURE VI-1. SPENCER BEACH, HAWAII

DESCRIPTION OF THE SELECTED ROUTE

General Description

Spencer Beach Park was selected as the recommended cable landing site. The park is located immediately south of the Kawaihae Deep Draft Harbor. Spencer Beach Park encompasses one of the typical small pocket beaches along this coast. The beach within the park is Ohaiula Beach, and is approximately 400 feet long. A shallow, fringing reef extends offshore, and shelters the shoreline from waves. A narrow sand channel extends through the reef at the northern end of the beach. Facilities at the beach park include restrooms, picnic tables, showers, tennis courts, a pavilion, a parking lot, a camping area and a lifeguard tower.

Shoreline History

Ohaiula Beach at Spencer Beach Park has been stable over the past 30 years. The vegetation line has experienced little erosion or accretion.

Existing Usage

Spencer Beach Park is a popular park used for tennis, camping, picnicking, swimming, and snorkeling. Facilities at the park include restrooms, picnic tables, showers, tennis courts, a pavilion, a parking lot, a camping area and a lifeguard tower.

Kawaihae Harbor, which lies just to the north, is the second largest harbor on the island. In was constructed in 1958 by blasting and dredging a coral reef platform. The extensive reef off Spencer Beach Park is a continuation of the reef off the harbor. The material removed from the reef for the harbor basin was used for landfill around the perimeter of the basin. An 850 foot long breakwater extends southeast from the main harbor and was constructed in anticipation of a future small boat harbor. The entrance channel and basin for the future harbor were blasted through the reef in 1969 and 1970. At present, the U.S. Army Corps of Engineers plans to begin construction of the harbor in January 1992. Plans are for a 90-boat facility.

A Hawaiian temple, the Puukohola Heiau, is located on the coast at the souteast corner of the harbor perimeter, at the mouth of the intermittently flowing Makeahua Stream. The heiau lies offshore of the beach and is buried under silt. It is listed in the Federal Register of Historic Places. The heiau is located approximately 1200 feet north of the proposed cable route.

Physical Characteristics of the Selected Route

Figure IV-2 shows the proposed cable route, and the characteristics of the surrounding area. The dominant feature of the nearshore area is the fringing reef, which extends 2500 feet out from the shore. As shown in the figure, the reef is cut by a sand channel, which connects the beach to a large offshore sand deposit. The water depth at the seaward limit of the reef is approximately 20 feet. The water depth in the sand channel is typically 10 to 15 feet, and much of the reef is within a few feet of the surface. There are many large coral formations within the channel, also shown on the figure. The channel boundaries and the coral formations within the channel were carefully digitized from a 1 inch = 200 foot aerial photograph, and then corrected for scale errors. The coral formations rise vertically up from the channel bottom to within a few feet of the surface.

Seaward of the fringing reef the bottom is entirely sand, out to at least the 100 foot depth, the limit of the visual survey. The R.M. Towill bathymetric survey shows a large reef formation south of the cable route, in water depths of 35 to 110 feet. The route was selected to avoid this formation, and the closest point of approach is 100 feet. The sand, both in the inner channel and the offshore deposit, is relatively fine and has a high silt content.

This cable route is the only location along this coast where large expanses of offshore coral formations do not have to be crossed. Disadvantages are the coral outcrops in the sand channel and a 50 foot wide basalt shelf at the toe of the beach.

The problem of the coral outcrops can be overcome by carefully selecting the initial route and then adjusting the cable prior to cutting the floats so as to avoid the coral. As shown in Figure IV-2, the selected route avoids most of the formations in the channel.

There is a 50 foot wide basalt shelf at the toe of the beach, extending out to approximately the 3 foot water depth.

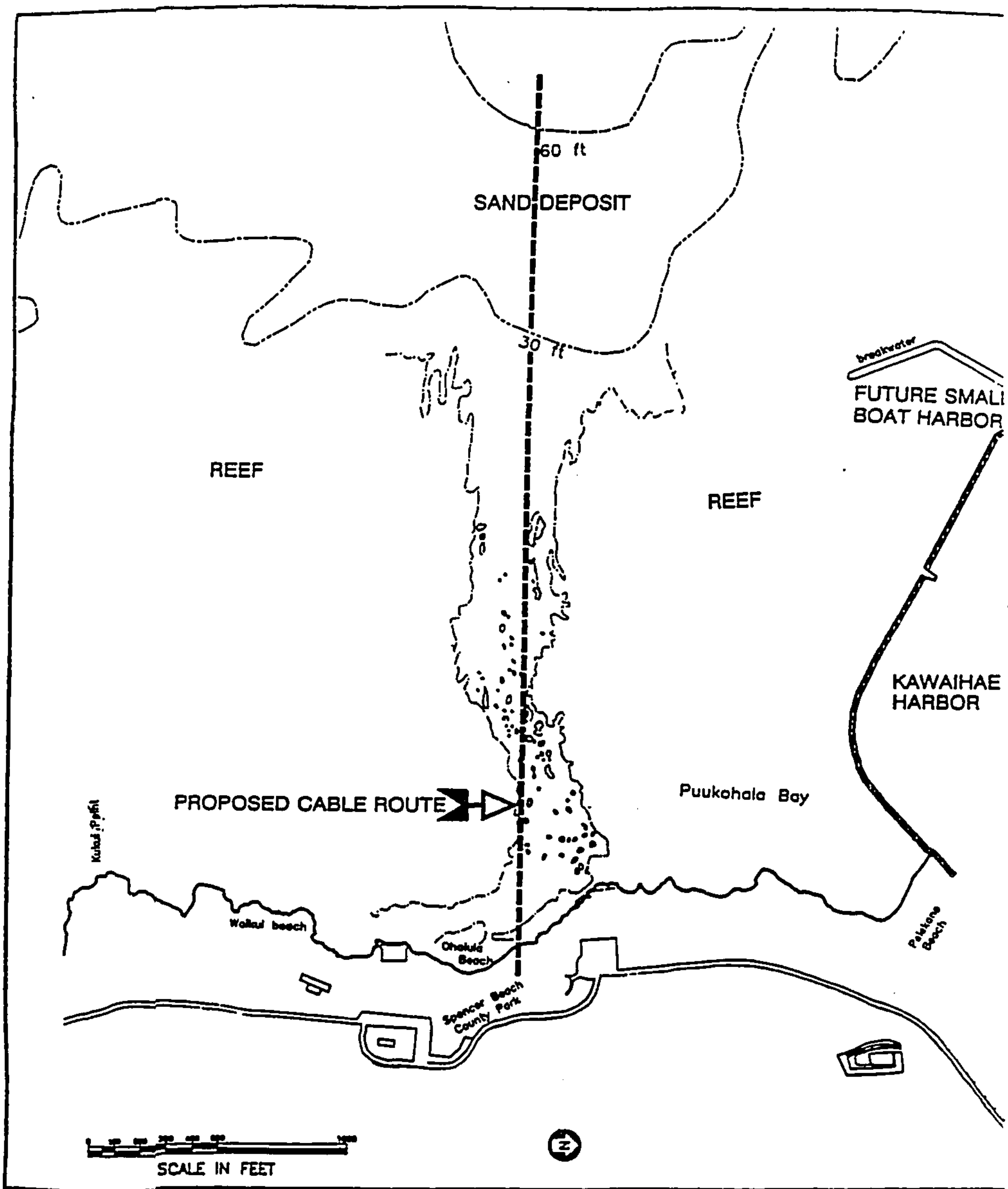

FIGURE VI-2. PHYSICAL CHARACTERISTICS OF SELECTED ROUTE

OCEANOGRAPHIC CONDITIONS

The coast in this area is sheltered from the northeast tradewind waves, but is exposed to wave approach from the northwest, west and southwest. North Pacific swell diffracts and refracts around the islands, and the portion of the energy reaching this site depends upon the approach direction. Kona storm waves and south swell, however, directly approach the coast. Kona wave periods range from 6 to 10 seconds, and wave heights may be as great as 10 feet. South swell periods range from 12 to 20 seconds, and deepwater heights range from 1 to 4 feet.

Wave data measured in Kaunaoa Bay and Mauna Lani are summarized in Table IV-1 (Sea Engineering, 1989). The data indicate that over 75 percent of the wave periods concentrate in the period band from 10 to 16 seconds, with the most frequent period around 13 seconds. Over 90 % of the waves recorded are less than 3 feet high. The design waves will be generated by a hurricane passing to the south and west of the island.

The inshore waters are frequently turbid, due to resuspension of silt and fine sediments by wind and waves (ORCA, Ltd, 1984). Infrequent storm water runoff from usually dry streambeds in the area initially carries silt and debris into Kawaihae Bay. Wind borne coral dust from the dredging stockpiles at Kawaihae Harbor also adds to the sediment load.

Nearshore currents are relatively weak. Six months of current measurements off the Mauna Lani Hotel, approximately six miles south of the landing site, indicated that the nearshore currents (inside the 40 foot contour) had an average speed of less than 0.1 knot. (Sea Engineering, 1989). The resultant flow was a weak net transport to the southwest.

The estimated 50 and 100 year tsunami elevations for this coastline are 5.9 and 8 feet, respectively.

DESCRIPTION OF THE PROPOSED PROJECT

The cable landing process for this site will be similar to that for other sites, except that the 2000 feet of cable closest to shore will require more careful placement than normal. The cable ship will be held in place approximately 4000 offshore during the cable pull. Once the shore end of the cable is secured, it is anticipated that the cable will be attached to a temporary anchor at the seaward head of the sand channel. The floats will then be cut from that point seaward, and the ship can move offshore and proceed with the deep water cable laying. The cable section through the sand channel will still be floating, and several small boats will be used to pull the cable into place prior to cutting the floats. This process can be completed incrementally, adjusting and then sinking one section of cable before moving on the the next. As can be seen from Figure IV-2, there are not too many adjustments that have to be made, and all bends will be well within the allowable bending radius of the cable.

Wave conditions inside the sand channel are mild, even during large surf on the outer reef. Most or all of the energy is dissipated during the initial breaking process. The cable should sink into the sand bottom and remain stable. Depending upon the cable vendor, some split pipe casing may or may not be used as insurance against abrasion.

Some type of protection will likely be required where the cable crosses the 50 foot wide basalt shelf. Casing the cable and then anchoring the split pipe is one possibility, but it is more likely that the cable will be trenched through the rock. This will be a small scale manual operation, removing only enough material to place the cable in a small trench. The trench will then be backfilled with tremie concrete to match the surrounding grade and material.

TABLE VI-1.
WAVE DATA MEASUREMENTS

PERCENT FREQUENCY HISTOGRAM OF WAVE HEIGHT AND PERIOD

(1/13/89 - 4/12/89)

HEIGHT (FEET)	WAVE PERIOD (SEC.) 0.0- 2.0	2.0- 4.0	4.0- 6.0	6.0- 8.0	8.0-10.0	10.0-12.0	12.0-14.0	14.0-16.0	16.0-18.0	18.0-20.0	TOTAL
0.0- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.0- 1.5	0.0	5.6	0.7	0.4	3.4	9.0	10.9	7.1	0.7	0.0	37.8
1.5- 2.0	0.0	0.4	0.0	0.4	0.7	9.0	11.6	4.9	1.5	0.4	28.8
2.0- 2.5	0.0	0.7	1.1	0.7	0.4	3.4	7.5	2.2	0.4	0.0	16.5
2.5- 3.0	0.0	0.0	1.5	0.0	0.7	1.5	2.6	2.6	0.4	0.0	9.4
3.0- 3.5	0.0	0.0	0.0	0.4	0.7	0.4	0.4	0.7	0.7	0.0	3.4
3.5- 4.0	0.0	0.0	0.0	0.0	1.1	0.0	1.1	0.4	0.0	0.0	2.6
4.0- 4.5	0.0	0.0	0.0	0.0	0.7	0.4	0.4	0.0	0.0	0.0	1.5
TOTAL	0.0	6.7	3.4	1.9	7.9	23.6	34.5	18.0	3.7	0.4	100.0

THE TOTAL NUMBER OF DATA = 267
THE RANGE OF WAVE HEIGHTS (FEET) : 1.0 - 4.3
THE RANGE OF WAVE PERIODS (SEC.) : 2.0 - 19.7

PERCENT FREQUENCY HISTOGRAM OF WAVE HEIGHT AND PERIOD

PERCENT FREQUENCY (%)
(4/12/89 - 7/25/89)

HEIGHT (FEET)	WAVE PERIOD (SEC.) 0.0- 2.0	2.0- 4.0	4.0- 6.0	6.0- 8.0	8.0-10.0	10.0-12.0	12.0-14.0	14.0-16.0	16.0-18.0	18.0-20.0	TOTAL
0.0- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.6	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	1.0
1.0- 1.5	0.0	10.0	1.6	2.6	2.3	3.2	20.9	23.2	4.8	0.0	68.5
1.5- 2.0	0.0	1.0	2.9	1.3	0.6	1.0	7.7	9.3	0.6	0.3	24.8
2.0- 2.5	0.0	0.0	0.6	0.0	0.0	0.0	1.6	1.9	1.0	0.0	5.1
2.5- 3.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
3.0- 3.5	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
TOTAL	0.0	11.6	5.8	3.9	2.9	4.2	30.5	34.4	6.4	0.3	100.0

THE TOTAL NUMBER OF DATA = 311
THE RANGE OF WAVE HEIGHTS (FEET) : 1.0 - 3.1
THE RANGE OF WAVE PERIODS (SEC.) : 2.0 - 19.7

PERCENT FREQUENCY HISTOGRAM OF WAVE HEIGHT AND PERIOD

PERCENT FREQUENCY (%)
(1/13/89 - 7/25/89)

HEIGHT (FEET)	WAVE PERIOD (SEC.) 0.0- 2.0	2.0- 4.0	4.0- 6.0	6.0- 8.0	8.0-10.0	10.0-12.0	12.0-14.0	14.0-16.0	16.0-18.0	18.0-20.0	TOTAL
0.0- 0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.5- 1.0	0.0	0.3	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.5
1.0- 1.5	0.0	8.0	1.2	1.6	2.8	5.9	16.3	15.7	2.9	0.0	54.3
1.5- 2.0	0.0	0.7	1.6	0.9	0.7	4.7	9.5	7.3	1.0	0.3	26.6
2.0- 2.5	0.0	0.3	0.9	0.3	0.2	1.6	4.3	2.1	0.7	0.0	10.4
2.5- 3.0	0.0	0.0	0.9	0.0	0.3	0.7	1.2	1.2	0.2	0.0	4.5
3.0- 3.5	0.0	0.0	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.0	1.7
3.5- 4.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.2	0.0	0.0	1.2
4.0- 4.5	0.0	0.0	0.0	0.0	0.3	0.2	0.2	0.0	0.0	0.0	0.7
TOTAL	0.0	9.3	4.7	2.9	5.2	13.1	32.4	26.8	5.2	0.3	100.0

THE TOTAL NUMBER OF DATA = 578
THE RANGE OF WAVE HEIGHTS (FEET) : 1.0 - 4.3
THE RANGE OF WAVE PERIODS (SEC.) : 2.0 - 19.7

THE WAVE HEIGHT IS THE SPECTRALLY BASED SIGNIFICANT WAVE HEIGHT.
THE WAVE PERIOD IS THE PERIOD ASSOCIATED WITH THE [illegible]

MARINE BIOLOGICAL SETTING

The qualitative reconnaissance of Spencer Beach Park was carried out on 17 July 1991 and the quantitative sampling of this site was done on 16 January 1992. The qualitative survey extended from shore to about the 90 foot isobath approximately 3,900 feet from shore. In this area three major zones or biotopes were defined. In general, the biotopes parallel the shore but in the proposed cable alignment, the most seaward biotope (the biotope of sand) extends into shallow water towards the beach. The presence of sand was an important factor in the selection of the proposed route. The biotopes recognized in the vicinity of the proposed cable alignment at Spencer Beach Park are the biotope of sand, the biotope of emergent hard substratum and corals and the biotope of scattered corals. The biotope of emergent hard substratum and corals lies to the north and south of the proposed cable alignment. The boundaries of these biotopes are given in Figure VI-3. The biotope of sand is situated primarily seaward of the project area but encroaches as a 160 to 325 foot wide channel well into the study site to within 1400 feet of shore. Shoreward of the biotope of sand is the elongate biotope of scattered corals which is restricted to a sand channel that is oriented perpendicular to shore and cuts through the biotope of emergent hard substratum and corals. Inshore of the biotope of scattered corals on the proposed cable alignment is an area of sand that extends to the shoreline with a small area of scoured emergent hard substratum just seaward of the beach.

The Biotope of Sand

The biotope of sand lies principally seaward of the project site. It occurs as a "pie-shaped wedge" towards the shoreline in the area proposed for the cable alignment. As the name implies, the substratum in the biotope of sand is dominated by sand. Because of its shifting nature, the benthic species found in sand habitats are generally adapted for life on an unstable and frequently abrading environment. Many species that are found in this habitat will bury into the sand to avoid predators and the abrasion that occurs with storm waves. Thus many species in the sand biotope are cryptic and difficult to see; among those are many of the molluscs and crustaceans such as the kona crab (Ranina serrata). Hence, without considerable time spent searching in the sand many species in the sand habitat will not be seen. The biotope of sand is best developed at greater depths; where it enters the shallow water, many of the characteristic species become less abundant. Therefore, the inshore boundary of this biotope is arbitrarily shown well offshore in Figure VI-3 despite the presence of considerable sand shoreward of this point.

Because of constraints with bottom time at the depth of which the biotope of sand is found as well as very poor water clarity on 16 January 1992, we did not quantitatively sample this biotope but rather utilized the data gathered in our qualitative reconnaissance of the habitat on 17 July 1991 in waters from 80 to 90 feet in depth. Species frequently seen in the biotope of sand include a number of molluscs: the helmet shell (Cassis cornuta), augers (Terebra crenulata, T. maculata and T. inconstans), the leopard cone (Conus leopardus) and flea cone (Conus pulicarius) as well as the sea hare (Brissus

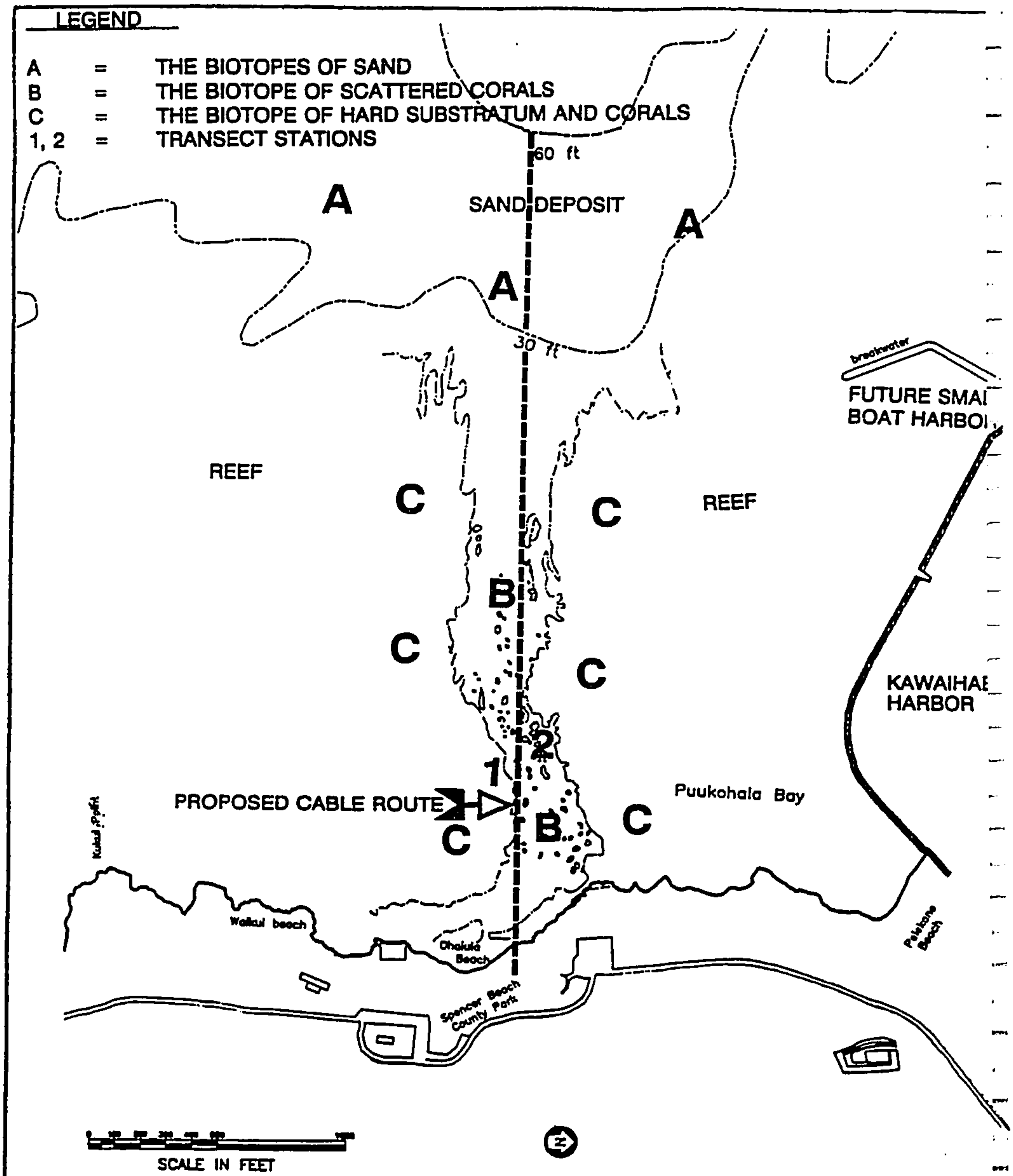

FIGURE VI-3. BIOTOPES ALONGS SELECTED CABLE ALIGNMENT sp.), starfish (Mithrodia bradleyi), brown sea cucumber (Bohadschia vitiensis), opelu or mackeral scad (Decapterus macarellus), nabeta (Hemipteronotus umbrilatus), the goby-like fish (Parapercis schauslandi), uku or snapper (Aprion virescens), hihimanu or sting ray (Dasyatis hawaiiensis) and the weke or white goatfish (Mulloides flavolineatus). Undoubtedly, with greater searching, many more fish species would be encountered in this biotope.

The Biotope of Emergent Hard Substratum and Corals

Both to the north and south of the channel alignment is the biotope of emergent hard substratum and corals. This biotope may characterized as a hard substratum reef flat that is quite shallow, ranging from about 3 to 8 feet in depth. The biotope extends for a considerable distance both north and south of the study area. Although the proposed cable alignment does not cross this biotope, we sampled the biotope because of its proximity to the proposed alignment.

The substratum in the biotope of emergent hard substratum and corals is comprised of both basalt rock (pahoehoe) and limestone as well as corals. There are scattered depressions and small channels on this substratum; the depressions are from 3x3 feet to about 12x30 feet in dimensions and are up to 2 feet in depth. These depressions are spaced from 8 to 30 feet apart and between them are small channels no more than 4 feet in width, up to 15 feet in length and to about 1 foot in depth. The small channels have a general orientation approximately perpendicular to shore. The channels, depressions and corals provide ample cover for fishes and invertebrates, yet as noted below, few organisms were seen in the quantitative survey.

Station 1 was established approximately 650 feet offshore about 30 feet south of the proposed cable alignment at a point where the proposed alignment occurs directly adjacent to the hard substratum of the biotope of hard substratum and corals in water ranging from 3 to 7 feet in depth. The substratum at this station is as described above for the biotope. The results of the quantitative survey are presented in Table IV-1. Two algal species (Porolithon gardineri and Galaxaura acuminata) occurred at a mean coverage of 5.3 percent. Four coral species (Porites lobata, P. (Synaraea) convexa, P. compressa and Pocillopora damicornis) were present in the quadrat survey with a mean estimated coverage of 10.4 percent. Three macroinvertebrate species were encountered in the 4 x 25m census area; these species were the ubiquitous green sea urchin (Echinometra mathaei), the slate pencil urchin (Heterocentrotus mammillatus) and the pearl oyster (Pinctado marginifera). The results of the fish census made at Station 1 are presented in Appendix C. In total eleven fish species (36 individuals) were censused and the standing crop was estimated to be $8 g/m^2$. The most abundant fish species at Station 1 include the saddleback wrasse or hinalea lauwili (Thalassoma duperrey) and the small eleotrid (Asterropteryx semipunctatus). The saddleback wrasse contributed most to the estimated biomass.

In the vicinity of Station 1 were seen the corals (Pavona duerdeni, Montipora flabellata, M. verrucosa, Fungia suctaria) the black sea urchin (Tripneustes gratilla), the moa or boxfish (Ostracion meleagris) and the sharpback puffer (Canthigaster jactator).

TABLE IV-2.

Summary of the benthic survey conducted in the biotope of hard substratum and corals approximately 650 feet offshore of Spencer Beach Park, Hawaii on 16 January 1992. Results of the $6m^2$ quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Pact C. A short summary of the fish census is given in Part D. Water depth is 3 to 7 feet; mean coral coverage is 10.4 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m	20m	25m
Algae						
Galaxaura acuminata						5
Porolithon gardineri	4	5	4	6	4	4
Corals						
Porites lobata	3.5		37	1.2	4	
Porites (Synaraea) convexa						13
Porites compressa	3					0.2
Pocillopora damicornis	0.2					
Sand			9			
Rubble		40	3			
Hard Substratum	89.5	54.8	47	92.8	92	77.8

B. 50-Point Analysis

Species	Percent of the Total
Algae	
Porolithon gardineri	12
Corals	
Porites lobata	4
Porites compressa	2
Cyphastrea ocellina	2
Sand	12
Rubble	12
Hard Substratum	56

TABLE IV-2.
Continued

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Pinctado marginifera	1
Phylum Echinodermata	
Echinometra mathaei	154
Heterocentrotus mammillatus	1

D. Fish Census (4 x 25m)
11 Species
36 Individuals
Estimated Biomass = $8g/m^2$

The Biotope of Scattered Corals

The proposed cable alignment passes through the biotope of scattered corals. This biotope may be described as occurring in a sand channel that has an orientation perpendicular to shore. The dominant substratum in this biotope is sand; spaced from 2 to 75 feet apart are areas of corals. These coral "mounds" range in size from about 3x3 feet to 20x50 feet and are up to 8 feet in height. Common coral species seen in this biotope include Porites lobata, Porites compressa and Montipora verrucosa. Few macroinvertebrates are seen on the sand substratum but there are a number of burrows or holes created by a number of species including the commensal goby-shrimp, unidentified crustaceans, echinoderms, etc.

Station 2 was established approximately 40 feet north of the proposed alignment in water about 15 feet in depth. The transect at this station sampled both the hard substratum with corals as well as the open sand substratum. The sand at this station had a surface layer of very fine sedimentary material over it; below this 0.25 inch layer was the usual coarser beach sand. Water visibility at the time of censusing was about 6 feet.

Table IV-2 presents the results of the quantitative survey carried out at Station 2. The quadrat survey noted three coral species (Porites lobata, Porites compressa and Montipora verrucosa) having a mean coverage of 17.9 percent. Only one macroinvertebrate species was noted at this station; this was the Hawaiian rock oyster (Spondylus tenebrosus). However on the sand were seen the burrows of the commensal gobies and shrimps occurring in a density of about $3/m^2$ but no shrimps (Alpheus sp.) were seen. Other smaller unidentified burrows occurred in at a density of about $8/m^2$. The fish census noted four species (44 individuals) in the 4 x 25m census area (Supplemental Table IV-2A). The most common fishes were the alo'ilo'i or whitespot damselfish (Dascyllus albisella) and the small eleotrid (Asterropteryx semipunctatus). The standing crop of fishes at this station was estimated at $4g/m^2$.

In the vicinity of Station 2 were seen the algae or limu (Desmia hornemannii and Cladymenia pacifica), corals (Porites evermanni, Leptastrea purpurea and Pocillopora meandrina), the christmas-tree worm (Spirobranchus gigantea), oak cone (Conus quin), the butterfly fish or kikakapu (Chaetodon auriga), lizard fish or 'ulae (Synodus binotatus), the brown surgeonfish or ma'i'i'i (Acanthurus nigrofuscus) and goldring surgeonfish or kole (Ctenochaetus strigosus).

TABLE IV-3.

Summary of the benthic survey conducted in the biotope of scattered corals approximately 850 feet offshore of Spencer Beach Park, Hawaii on 16 January 1992. Results of the 6m^2 quadrat sampling of the benthic community (expressed in percent cover) are given in Part A; a 50-point analysis is presented in Part B and counts of invertebrates in Part C. A short summary of the fish census is given in Part D. Water depth is 15 feet; mean coral coverage is 17.9 percent (quadrat method).

A. Quadrat Survey

	Quadrat Number					
Species	0m	5m	10m	15m2	0m	25m
Corals						
Porites lobata	53	1				
Porites compressa	9	43				
Montipora verrucosa	1.4					
Sand/mud	36.6	50	96	95	100	100
Rubble			4			
Hard Substratum		6		5		

B. 50-Point Analysis

Species	Percent of the Total
Corals	
Porites lobata	10
Porites compressa	8
Montipora patula	2
Pocillopora damicornis	2
Sand	68
Rubble	4
Hard Substratum	6

C. Invertebrate Census (4 x 25m)

Species	Number
Phylum Mollusca	
Spondylus tenebrosus	1
Unidentified Burrows in Sand	
Psilogobius-Alpheus burrows	3/m^2 in sand
Unidentified small burrows	8/m^2 in sand

TABLE IV-3
Continued.

D. Fish Census (4 x 25m)

4 Species
44 Individuals
Estimated Biomass = $4g/m^2$

Inshore of the biotope of scattered corals (commencing 325 feet offshore) is an area of sand that extends from that point to within 80 feet of the shoreline. Inspection of this area on the 16 January 1992 survey noted no macrofauna present. Undoubtedly, with enough search time one would note fishes crossing this sand area such as juvenile jacks or papio (family Carangidae) as well as other species. Between the sand area and the shore in the vicinity of the proposed cable alignment is a small "finger" of emergent basalt (pahoehoe). This hard bottom commences about 15 feet offshore of the sand beach (about 3 feet deep) and continues seaward to a maximum extent of about 80 feet offshore in 8 feet of water. Most of this hard substratum was partially covered with a veneer of sand at the time of sampling and appeared to be quite scoured with no obvious macrobiota present in the area of the proposed alignment. However about 50 feet to the north the hard substratum rises further from the sand (i.e., is shallower) and has a veneer of microalgal species. In a short inspection of this area, the alga (Microdictyon setchellianum) was seen as well as the green sea urchin (Echinometra mathaei), the boring urchin (Echinostrephus aciculatum), the long spined urchin or wana (Echinothrix diadema), green wrasse or 'omaka (Stethojulis balteata) and the saddleback wrasse or hinalea lauwili (Thalassoma duperrey). Also noted were broken live loose fragments of the corals Porites lobata and Pocillopora meandrina.

The intertidal region at this proposed cable landing site is a sand beach. We did not encounter any fauna or flora on this beach.

One small green sea turtle (Chelonia mydas) was seen in the biotope of scattered corals about 900 feet from shore in about 15 feet of water during the 16 January 1992 survey. This turtle was estimated to be about 55cm in straight line carapace length. We were unable to determine if this turtle bore any unusual features (i.e., tumors, tags or deformities). Offshore of Spencer Beach Park appears to have appropriate shelter for green turtles (i.e., undercuts, ledges and caves) at a size and scale appropriate for green turtle resting areas. However we noted little macroalgae present in the area that could be utilized as forage (Balazs, 1980, Balazs et al. 1987). We saw no other turtles in the vicinity of the proposed cable landing site but one individual (Mr. Patrick Cunningham) familiar with the area noted that about one-quarter mile to the south small green turtles are frequently seen in the nearshore waters. We have found no information to suggest that nesting of sea turtles at Spencer Beach Park has occurred in historical times.

The biological survey of the proposed cable alignment at Spencer Beach Park did not find any rare or unusual species or communities other than the single threatened green sea turtle noted above. Another protected species, the humpback whale (Megaptera novaeangliae), was not seen offshore of the study area during the period of our field effort. As noted by

Herman (1979), humpback whales tend to be found in regions remote from human activities and the proposed Spencer Beach Park cable alignment is in relatively close proximity to Kawaihae Harbor which has been the major commercial port serving West Hawaii for many years.

POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Impacts with Construction

The potential for impact to the shallow marine communities will probably be greatest with the construction phase of this proposed project. From the sea, the proposed cable alignment enters the shallows through the biotope of sand. As a substrate to support marine communities, sand is inappropriate for many coral reef forms because many species require a stable bottom (e.g.,corals and many of the associated invertebrates). Thus the species usually encountered in sand areas are usually those that are adapted to exist in an ever-changing, moving substratum. Similarly, much of the benthic production on coral reefs occurs on hard substratum, (i.e., macroalgae require a solid substratum for attachment). Because sand substrates are subject to movement, they may abrade and scour organisms on this substratum. Thus the characteristics of most species encountered in Hawaiian sand communities are (1) that they typically burrow into the substrate to avoid scouring, (2) that they frequently occur in low abundance which may be related to food resources, and (3) that they are mobile because of the shifting nature of the substratum and potential for burial. Since these forms are motile, deployment of the cable across such a substratum presents little chance of negative impact to resident species because they would probably "just move out of the way as the cable was deployed". Additionally since the substratum shifts, it is probable that the deployed cable will "sink into" the substrate. Personal observations made on other deployed cables shows them to often be partially buried by the natural movement of the sand.

As the cable enters the shallows offshore of Spencer Beach Park, there are areas where the scattered coral mounds will lie in the direct path of the cable. Cutting or trenching through these mounds, which are up to 8-feet above the surrounding bottom, would be difficult and would result in loss of the benthic community in the alignment path. Other impacts would be those associated with the generation of turbidity during the trenching process.

Spencer Beach Park was selected as the cable landing site based upon the assumption that the fiber optic cable would be routed as necessary to avoid the scattered coral mounds. The anticipated placement method was discussed in an earlier section of this chapter. At most, it is anticipated that trenching will only have to be undertaken in shallow water across approximately 50 feet of scoured pahoehoe adjacent to the beach. Since this scoured substratum supports few, if any, benthic organisms in the proposed path, there should be little or no impact to marine organisms.

Other construction methods to protect the cable in shallow water range from just laying the cable directly on the basalt shelf without any specific attachment, to placing it inside of a protective pipe that is bolted to the shelf. This strategy has been used at the Natural Energy

Laboratory of Hawaii facility at Keahole Point, Hawaii to secure pipes coming ashore through a subtidal region that is frequently subjected to extreme high energy conditions. Bolting a pipe to the substratum significantly reduces the impact to surrounding benthic communities over the alternative of trenching and backfilling. This alternative may provide low impact to marine communities but it will have an obvious visual impact to any underwater observer. If the trenching and back- filling strategy is used, the tremie concrete cap will probably be colonized by corals, algae and other benthic forms. Studies on substrate selection in Hawaiian coral larvae have shown concrete to be second only to limestone/coral as an appropriate substratum for settlement (Fitzhardinge and Bailey-Brock 1989). Laying the cable directly on the basalt without attachment may result in cable abrasion, and is not an acceptable alternative.

Our 16 January 1992 survey noted considerable turbidity in the region of the proposed cable alignment. Offshore in the biotope of sand, visibility was less than 1 foot at the 80 foot depth. Inshore in the biotope of scattered corals, visibility was about 6 feet. For two days preceding the survey, considerable rainfall had occurred on the West Hawaii coast (Mr. Patrick Cunningham, personal communication). Our inspection of the mouth of Waimea Stream (which is intermittent in its lower reaches) revealed a large amount of water had reached the sea bringing a considerable amount of terrigeneous material with it. Waimea Stream is south of the project site but it is surmised that the stream was the source of much of the turbid water encountered in the study area because of the brown (possibly terrigeneous) color. The second source of turbidity was from surf on the reef. During the month of January 1992 there was a near-continuous westerly swell impacting this coastline. The high surf resuspends fine sediments making the water turbid. These occasional natural inputs of turbidity serve to reduce light levels and potentially impact benthic communities. The communities present in the vicinity of the proposed alignment have evolved under this occasional impact. Construction activities related to the cable landing probably would not begin to match the level of turbidity both in terms of scale or intensity that we encountered on our 16 January 1992 field effort.

We expect that there would be no direct impacts to the threatened green sea turtle or to endangered humpback whales (Megaptera novaeangliae). As far as the impact to humpback whales is concerned, if construction activities are restricted to the period between April through October, there would be no impacts because the whales are seasonal and are only in island waters from November through March. Even assuming that the cable deployment occurs when the whales are present in Hawaiian waters, it is anticipated that the impacts would be minimal. The cable laying ship should not be on site more than one or two days.

The most probable source of local impact to whales would be noise generation by the cable laying ship, the support tugs and the small boats. There are variable and conflicting reports as to the impact of vessel traffic on whales (Brodie, 1981; Matkin and Matkin, 1981; Hall, 1982; and Mayo, 1982). With respect to the response of individual humpback whales, there is sufficient information to demonstrate that boating and other human activities do have an impact on behavior (Bauer and Herman, 1985). Thus it is probably valid to assume that impact to whales could occur if individuals are within several kilometers of the deployment site. However, as noted above, these impacts are of short duration, and all activity will be concentrated in a small area. The potential impacts also need to be evaluated in light of the proximity of the site to Kawaihae Deep Draft Harbor, the second largest harbor on the island.

Sea turtles are permanent residents in inshore Hawaiian habitats. Although the potential exists for problems during the construction phase if it entails dredging, the generation of fine particulate material from dredging appears not to hinder the green turtle in Hawaiian waters; at West Beach, Oahu, green turtles moved from an offshore diurnal resting site about one 3,300 feet offshore to a point about 600 feet from the construction site within days of the commencement of dredging and the generation of turbid water. The turtles appeared to establish new resting areas in the turbid water directly offshore of the construction site (Brock 1990a). The reason(s) for this shift in resting areas is unknown but may be related to the turtles seeking water of poor clarity to possibly lower predation by sharks (a major predator on green sea turtles).

Fishery Considerations

Access to the shoreline at Spencer Beach Park is excellent and has probably been so since prehistoric times; the Kawaihae area was an important center in the Hawaiian culture. The beach at Spencer is heavily used by people interested in beach going and probably fishing. Fishermen catch fish both from shore as well as offshore from small boats. In all probability, some commercial fishing occurs offshore of the proposed cable alignment. We are unaware of any individuals that specifically and exclusively use Spencer Beach Park area for subsistence fisheries. Probably most of the fishing activity in and around Spencer Beach Park is by recreational fishermen. With most Hawaiian recreational fisheries, species targeted include papio and ulua (family Carangidae), o'io or bonefish (Abula vulpes), moi (Polydactylus sexfilis), goatfishes (family Mullidae), snappers (family Lutjanidae), surgeonfishes (family Acanthuridae), parrotfishes (family Scaridae), and a host of smaller species such as the aholehole (Kuhlia sandvicensis), aweoweo (Priacanthus cruentatus) and mempachi (Myripristes amaenus). Fishing methods used include nets, spears, traps as well as hook and line.

This survey noted a paucity of fishes or invertebrates. One reason for this may be related to the high turbidity present at the time of sampling. Turbidity may temporarily cause motile species to leave; when conditions improve, they may return. Some comparative information for the Spencer Beach area is available from a study carried out by Brock (1991) where three stations were established seaward of Kawaihae Small Boat Harbor in May 1991. The closest station to the proposed cable alignment is approximately 1000 feet to the north in water 8 to 12 feet deep. A fish census at this station resulted in 26 species and 231 individuals encountered. The census methods were identical to those used here.

The standing crop of fishes on coral reefs is usually in the range of 2 to 200g/m^2 (Brock 1954, Goldman and Talbot 1975, Brock et al. 1979). Eliminating the direct impact of man due to fishing pressure and/or pollution, the variation in standing crop appears to be related to the variation in local topographical complexity of the substratum. Thus habitats with high structural complexity affording considerable shelter space usually harbor a greater estimated standing crop of coral reef fish; conversely, transects conducted in structurally simple habitats (e.g., sand flats) usually result in a lower estimated standing crop of fish (2 to 20g/m^2). Goldman and Talbot (1975) note that the upper limit to fish biomass on coral reefs is about 200g/m^2. The present study found extremely low estimated standing crops at both stations especially when viewed with respect to the availability of shelter space. It is probable that both fishing pressure as well as high turbidity have played a role in the low estimated biomass at these stations.

Water Quality Considerations

With any disturbance to the seafloor, sediment will be generated which will manifest itself as turbidity. This may occur through natural events such as storm surf resuspending fine material that had previously come into the area through natural events and settled, or by human activities including the directing of storm water runoff into the ocean or by underwater construction activities. Underwater construction may generate fine particulate material that could impact corals. The generation of fine sedimentary material could have a negative impact to corals and other benthic forms if it occurs in sufficient quantity over sufficient time. Studies (e.g., Dollar and Grigg 1981 noted above) have found that the impact must be at a high level and chronic to affect adult corals.

The small scale of the trenching activities that would be necessary to protect the cable in shallow water (if used) would probably produce little sediment. This statement is supported by the fact that only 50 lineal feet of hard substratum would be disturbed. The small scale and anticipated short duration of the project suggest a minimal impact. High water motion will keep fine particulate and sedimentary material suspended in the water column, reducing the settlement on benthic organisms in shallow water habitats thus assisting in the advection of this material out of these areas (less than 100m in depth) where corals are found.

The turbidity generated by the construction activity will be short in duration and relatively small in quantity. Numerous studies have provided observations showing the relationship between increased suspended or deposited sediment with reduced coral growth rates, cover and species diversity (Roy and Smith 1971, Maragos 1972, Loya 1976, Bak 1978, Randall and Birkeland 1978, Cortes and Risk 1985, Grigg 1985, Hubbard and Scaturo 1985, Kuhlman 1985, Muzik 1985, Hubbard 1987). In contrast, Glynn and Stewart (1973) found no correlation between these parameters on reefs off the Pacific side of Panama.

Turbidity is a an optical property that is related to the scattering of light by the suspended particles in the water column. The finer the particles, the longer they may remain in suspension (Ekern 1976) and if fine materials are associated with much water motion (waves, currents) the actual deposition rates in these turbid waters may be quite low. However, if the suspended particles (i.e., turbidity) is great enough to reduce light levels, impacts to corals may be low.

The deposition of sediment on coral reefs has been measured and correlated with the "condition" of the reef corals. Loya (1976) defined a "high" sedimentation rate as 15mg/cm^2/day and a "low" rate as 3mg/cm^2/day for Puerto Rican reefs. Low cover and species diversity were associated with reefs exposed to "high" sediment deposition rates. In contrast, "high" sediment deposit- ion rates on Guamian reefs was defined in the range of 160- 200mg/cm^2/day and this rate of deposition limited coral cover and diversity (here less than 10 species and 2% cover; Randall and Birkeland 1978). A "low" rate was defined as 32mg/cm^2/day and was associated with rich coral communities (more than 100 species and 12%+ coral cover). These comparisons demonstrate the relative nature of sedimentation rates; the rate considered to be low in Guam is more than twice the high rate from Puerto Rico. Reasons for this disparity relate to differences in how rates are measured (i.e., lack of a standardized methodology) as well as difficulty in relating environmental factors such as water motion and sediment deposition in sediment traps. Water motion may mitigate or enhance the deleterious effects of sedimentation on the diversity and cover of corals in a given area. Hopley and Woesik (1988) note a chronic sedimentation rate of 129mg/cm^2/day (7 month mean) did not negatively impact an Australian coral reef with high cover and species diversity.

These data suggest that if needed as a means for protecting the proposed fiber optic cable in shallow water, the short term disturbance (probably less than two weeks) created by small-scale trenching will be a minor impact.

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SUPPLEMENTAL TABLE IV-2A

Results of the quantitative visual censuses conducted at two locations offshore of Spencer Beach Park, Hawaii on 16 January 1992. Each entry in the body of the table represents the total number of individuals of each species seen; totals are presented at the foot of the table along with an estimate of the standing crop (g/m^2) of fishes present at each location.

FAMILY AND SPECIES	STATION NUMBER 1	2
MULLIDAE		
Mulloides flavolineatus		8
POMACENTRIDAE		
Dascyllus albisella		16
Abudefduf abdominalis	2	
Stegastes fasciolatus	3	
LABRIDAE		
Thalassoma duperrey	9	
Stethojulis balteata	4	
SCARIDAE		
Scarus sordidus	1	
BLENNIIDAE		
Cirripectus variolosus	1	
ELEOTRIDAE		
Asterropteryx semipunctatus	8	13
GOBIIDAE		
Psilogobius mainlandii		7
ACANTHURIDAE		
Acanthurus triostegus	2	
A. dussumieri	1	
Ctenochaetus strigosus	4	
ZANCLIDAE		
Zanclus cornutus	1	
Total Number of Species	11	4
Total Number of Individuals	36	44
Estimated Biomass (g/m^2)	8	4

APPENDIX F

Archaeological Assessment of the Proposed Fiber Optic Cable Landing Wailua Golf Course, Kauai

ARCHAEOLOGICAL ASSESSMENT OF THE PROPOSED FIBER OPTIC CABLE LANDING FOR WAILUA, KAUA'I

by

William H. Folk, B.A.
and Hallett H. Hammatt, Ph.D.

for

R.M. Towill Corporation

Cultural Surveys Hawaii
March 13, 1992

ABSTRACT

Cultural Surveys Hawaii conducted an archaeological surface survey of a corridor of land on the island of Kaua'i extending from the ocean to Kuhio Highway through the Wailua Golf Course (TMK 3-9- portions plat 02 and 05) for the proposed fiber-optic transmission cable. No surface archaeological sites were found. The locations of two isolated human burials are known to be in the vicinity of the proposed cable corridor and others are known farther north near Lydgate Park and near the Wailua River. Single, random human interments are expected to be unearthed during trenching in the proposed corridor.

Groups of burials - *i.e.*, cemeteries or conscribed graveyards - within the proposed corridor are not expected and subsurface testing strictly confined to the actual corridor of about 20 feet in width is recommended to confirm this, after the exact corridor is surveyed and staked in the field.

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INTRODUCTION

Cultural Surveys Hawaii conducted archaeological assessments for four proposed fiber optic cable landing sites on three of the Hawaiian islands. The proposed sites are located on O'ahu at Sandy Beach Park and Kahe Point Beach Park, on Hawai'i at Spencer Beach Park, and on Kaua'i at the Wailua Golf Course (Fig. 1-4).

This report treats the Wailua Golf Course cable landing site on Kaua'i.

The assessments, requested by R.M. Towill Corp., include background research and on-site inspections to determine the potential for encountering archaeological resources at the four proposed cable landing sites. Sub-surface testing was carried out at the Spencer and Sandy Beach Park Sites to gather additional information on stratigraphy.

Individual reports treat each of the proposed cable landing sites. Contained in each report are a site specific scope of work, field methods, a review of previous research pertinent to the individual landing site, research results, and recommendations for mitigation of existing cultural-archaeological resources.

Scope of Work

The scope of work at the cable landing site at the Wailua Golf Course on Kaua'i consisted of the following:

A. A field check of the cable landing and a corridor - up to a few hundred feet wide - to Kuhio Highway, including a stratigraphic profile visible in the wave cut bank along the shoreline.

B. Interviews with two individuals familiar with events and discoveries of Hawaiian remains in the area during the period from 1946 to the present.

C. Field check of two burial sites discovered in the vicinity of the fiber optic cable corridor.

D. Limited historical research on Wailua *ahupua'a.*

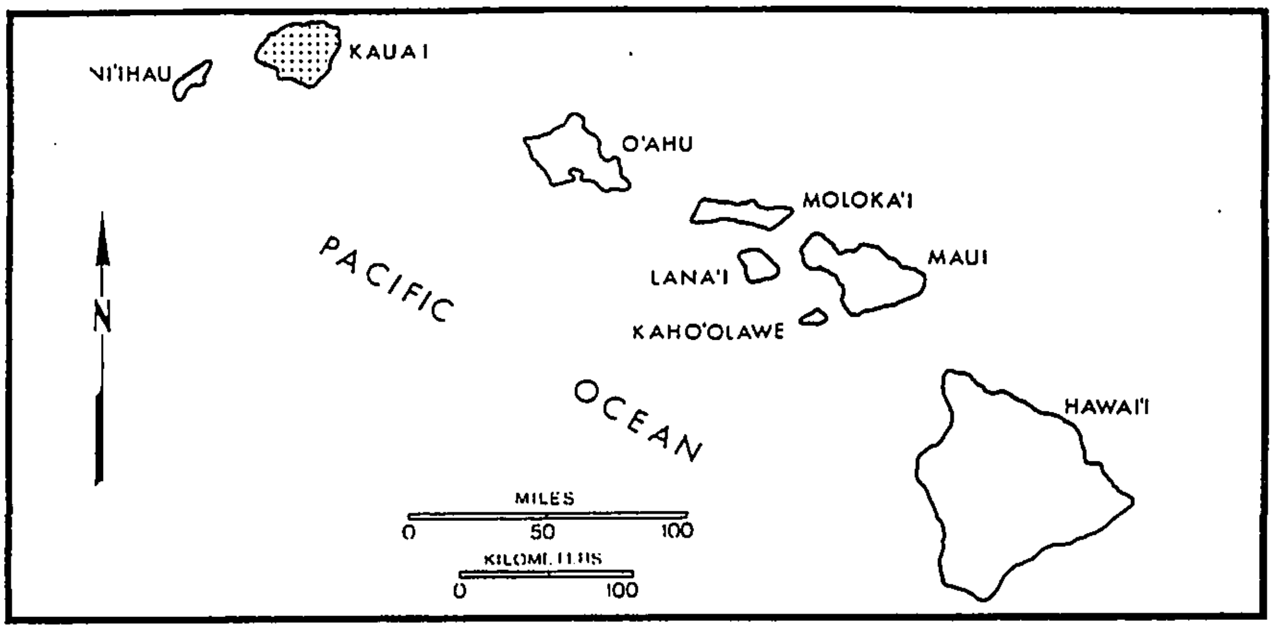

FIGURE 1
State of Hawai'i

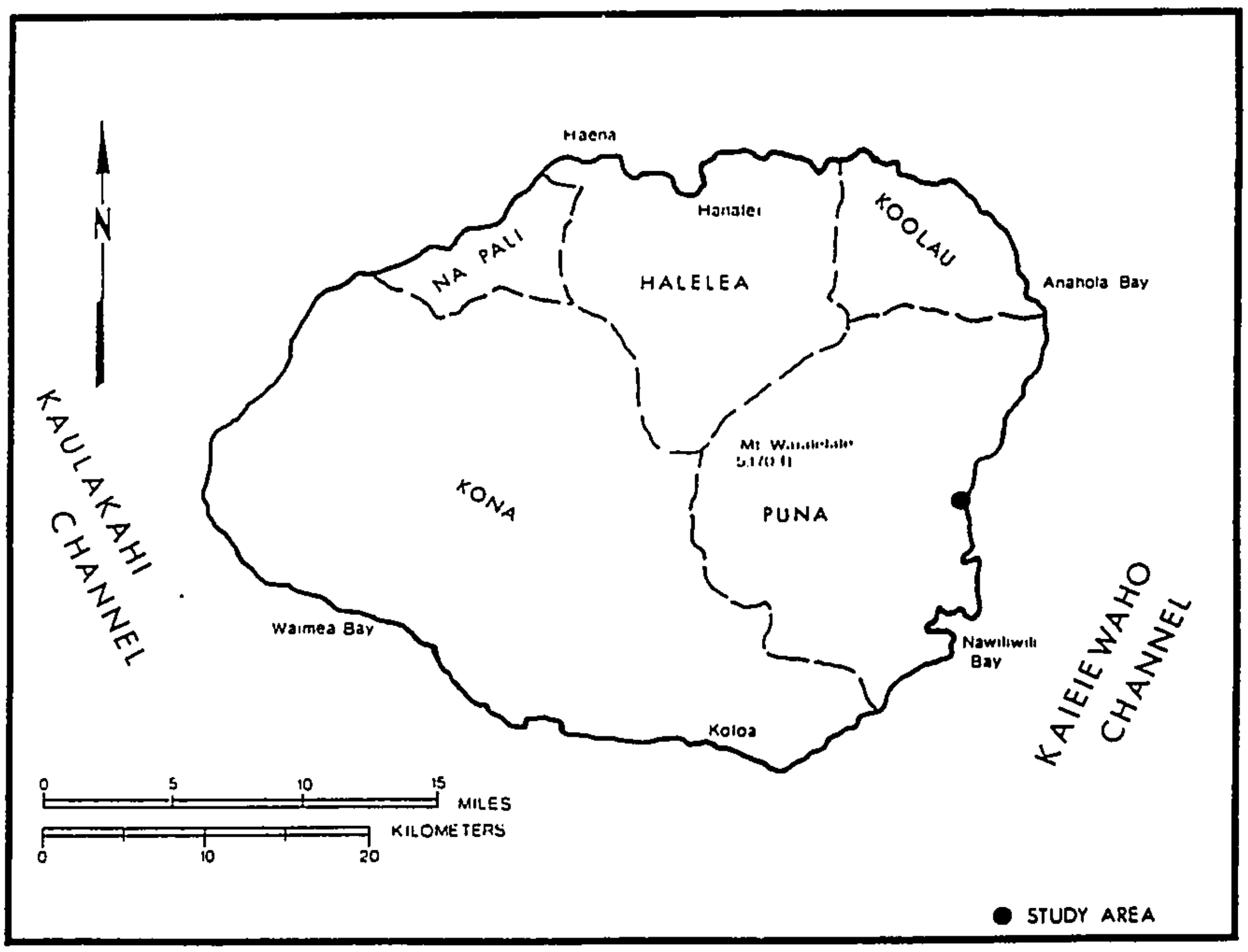

FIGURE 2
General Location Map, Kaua'i Island

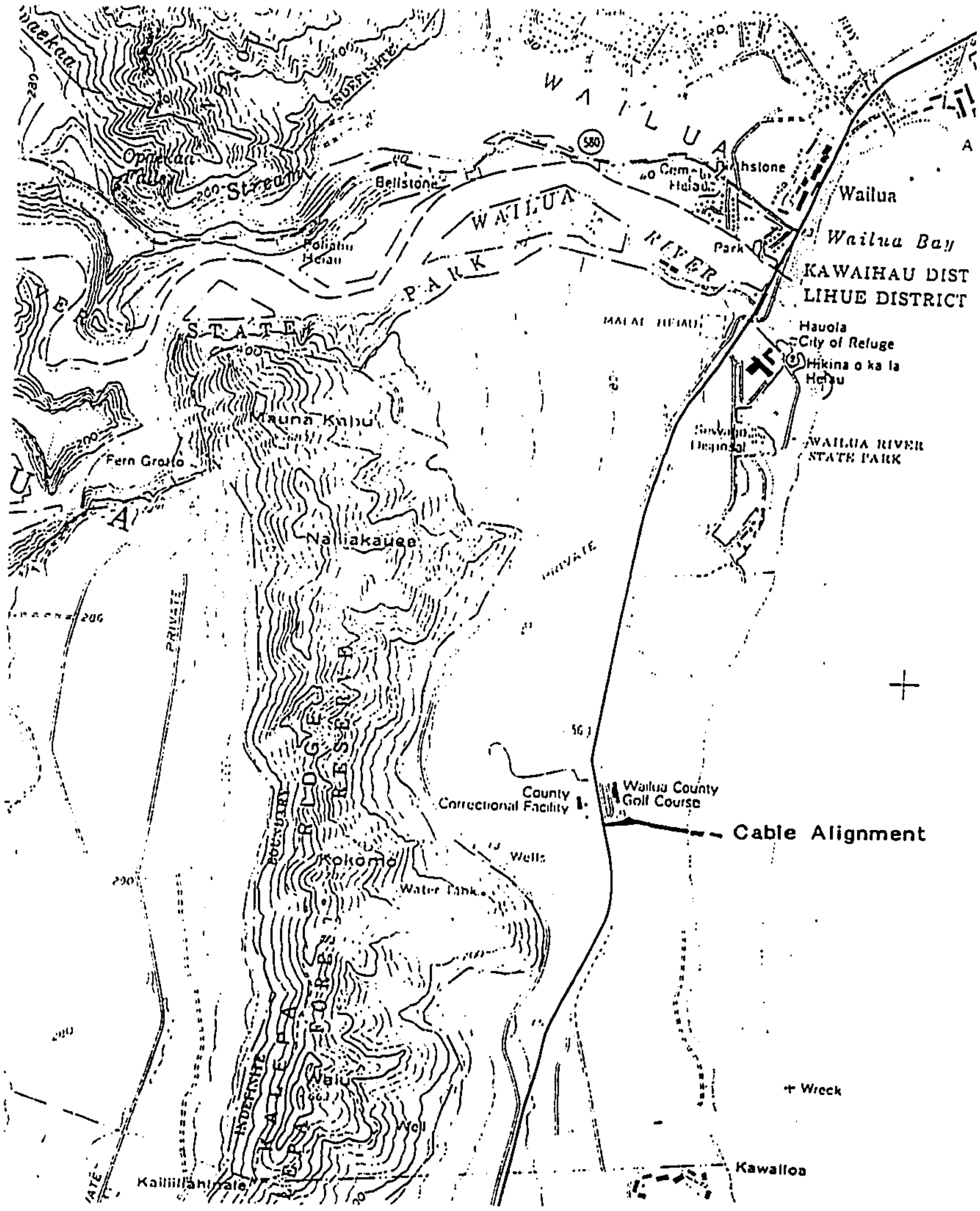

Figure 3 Portion of USGS 7.5 Minute Series Topographical Map, Kapa'a Quadrangle Showing Cable Landing and Corridor

Figure 4 Portion of Aerial Photo Showing Cable Corridor Alignment

BACKGROUND

Natural History

Wailua *ahupua'a*, located on the eastern side of the island of Kaua'i, is exposed to the prevailing northeast tradewinds and thus experiences 40 to 50 inches of rainfall annually at the seashore. This increases to 75 to 100 inches in more inland (western) localities. The Wailua River, largest in the state, and its tributaries comprise the major drainage system for the central area of the Līhu'e basin. The Līhu'e basin is bounded by the Haupu mountains to the south, Waialeale to the west and the Makaleha mountains to the north. Sea level changes in recent geologic time on this side of Kaua'i have submerged the eastern edge of the Līhu'e basin, resulting in the deposition of alluvium, beach and dune sand, and lagoonal clays and marls along the seaward (eastern) side of the Kalepa-Nonou Ridge through which the Wailua River flows. The present study area at the Wailua Golf Course is located along the seaward side of the Kalepa Ridge south of the Wailua River where beach and dune sand deposits predominate.

Cultural History

Events and activities in pre-contact Wailua *ahupua'a*, as summarized by Gerald "Kamalu" Ida (Folk and Ida 1981), are centered almost exclusively at Wailuanuiho'ānu - "great, sacred Wailua" (Dickey 1916) - situated on either side of the Wailua River between the confluence of the north and south forks, and the sea. This was a place where the *ali'i* resided and their offspring were raised and trained.

The *ahupua'a* (traditional land unit) of Wailua was retained as Crown Lands in the Mahele of 1848 and recipients of Land Commission Awards (*kuleana*) in the *ahupua'a* include high status individuals. These *kuleana* are concentrated in the areas closest to the Wailua river, predominantly on the north bank where the best agricultural land is located.

There are no known references to habitation, agriculture or *kuleana* in the immediate area of the project area, where the active sand dune environment is generally not suitable for agriculture, although annual rainfall today measures 40 to 50 inches. The presence of burials here, reported in personal communications with Toyo Shirai (retired golf course supervisor) and Abraham Koga (the current course supervisor), is certainly in line with traditional land use patterns. This type of use of the study area lands may have precluded other uses such as habitation and agriculture.

Archaeology

Archaeology in Wailua *ahupua'a* began to be addressed in the early 20th century by: L.A. Dickey (1917) and J.M. Lydgate (1916) with the Hawaiian Historical Society; Sloggett (1934) with the Kauai Historical Society; Thomas Thrum (1907) in the Hawaiian *Almanac and Annual*; M. Salisbury (1936) in the Honolulu Star Bulletin; and Wendell C. Bennett (1931) who conducted the first comprehensive survey of Kaua'i island archaeological sites. Other early traditional and non-traditional data on the Wailua area are recorded on maps constructed in part from data collected during 19th century surveys of the Boundary Commission and later, during the early 20th century, Territory of Hawaii and U.S. Geological Survey topographical surveys. Ethnohistorical data focusing on agriculture and the Hawaiian as an agriculturalist was collected in some detail in this century by Elizabeth and E.S. Craighill Handy (1940; 1972).

Recent archaeological studies are primarily the result of modern development in

Wailua. The bulk of this work documents cultural remains that include objects or structures, buried stratigraphic layers, and human burials. As might be expected, based on legendary history, the physical remains of Hawaiian society in Wailua are also focused on the Wailua River. No archaeological sites or buried cultural remains except for human burials are known to exist within or in close proximity to the present study area.

SURVEY RESULTS

Fieldwork, conducted on February 19,1992, consisted of walking over the proposed cable corridor from the shoreline to Kuhio Highway, and interviewing present and past superintendents of the Wailua Golf Course to gather information on the construction of the golf course. Subsurface testing of the cable corridor was not done at this time because of the disturbance testing would have caused to current use of the golf course. Also, the present approximated cable corridor covers a much wider area (100 feet or more) than will be utilized by the actual corridor (only 20 feet in width), and would require testing of a larger area than necessary. Thus testing before the precise corridor is selected would unnecessarily disturb any burials outside that specific area. Data on the stratigraphic layers present in the study area was recorded at a wave-cut face about eight feet in height. At the foot of the cliff face is active beach sand that is awash during maximum high tides and storm surf conditions. At the top of the cliff face is the rough of the first fairway of the golf course, along the north side of which runs the cable corridor. Further, on the north side of the cable corridor, is the practice driving range (Fig. 5 through Fig. 8).

The strata exposed in the wave cut face consists of a natural, wind deposited layer of very fine, well sorted coralline sand extending from sea level or below to about eight feet above sea level. A layer of imported alluvium was deposited upon the sand layer as top soil or leveling fill during the golf course construction, but *mauka* (inland) of the wave cut face this alluvium is not present and the golf course grasses are growing directly upon the natural sand layer.

Information from interviews with Mr. Abraham Koga, golf course superintendent,

Figure 5 Fiber Optic Cable Landing Corridor from the Shoreline to the Wave Cut Bank

Figure 6 Fiber Optic Cable Corridor from the Wave Cut Bank to *Mauka* (West)

Figure 7 Fiber Optic Cable Corridor Continuing to *Mauka* (West). Note Clubhouse and Other Facilities in Background.

Figure 8 View to Southeast (*Makai*) Across Driving Range with Project Corridor at Far Right. Known Burials Present Beneath Dead Tree at Left and in Center of Driving Range

and Mr. Toyo Shirai, superintendent from 1946 to 1978, included the locations of three burials found previously. One burial was uncovered at the north end of the course near Lydgate Park which is a considerable distance from the proposed cable corridor, but is an area of similar environs. Another was found in the area of the practice driving range during its construction. The third burial was found when Hurricane Iwa - in November of 1982 - uprooted a large kiawe tree along the north side of the driving range. Each of the three finds was reburied at the place of their discovery. The latter two burials are within about 1000 feet of the proposed cable corridor.

These finds are consonant with archaeological evidence from other areas around Wailua, sites around Kaua'i and sites on other islands of the Hawaiian group which have been used to predict the location of burials in sand beach and dune deposits along or near the shoreline. Information from the interviews with Mr. Koga and Mr. Shirai also revealed that little or no grading was done to construct most of the golf course. Thus there has been little, or in some areas, no disturbance of the sand beach and dune deposits in the project area. More extensive grading appears to have been necessary for the practice golf driving range where the previously noted single burial was found.

RECOMMENDATIONS

The established presence of human burials in the beach and dune sand deposits along the coast of Wailua *makai* of Kalepa-Nonou Ridge indicates a strong probability that burials will be encountered during excavation of the trench through the golf course for the proposed fiber-optic cable. Although only individual isolated burials have been reported near the cable corridor we believe that archaeological subsurface testing of the precise trench line should be conducted once the exact line is surveyed and staked in the field. This testing is necessary to ensure that such burials as may be encountered are not grouped or concentrated in the manner of a cemetery or family graveyard.

Continuous on-site monitoring by archaeologists is recommended during all excavation work in undisturbed beach and dune sand deposits between the wave cut bank at the shoreline and Kuhio Highway. This recommendation is based on the probability of undisturbed sand beach and dune deposits in the cable corridor, and our knowledge of apparently individual and isolated human burials within the bounds of the Wailua Golf Course.

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APPENDIX G

Archaeological Assessment of the Proposed Fiber Optic Cable Landing Kahe Point Beach Park, Oahu

Archaeological Assessment of the Proposed Fiber Optic Cable Landing for West O'ahu

Kahe Point, Honouliuli, O'ahu

by

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Douglas F. Borthwick, B.A.
Mike Pfeffer, B.A.

Prepared for

R.M. Towill Corp.

Cultural Surveys Hawaii
February 1992

Abstract

At the request of R.M. Towill Corp., Cultural Surveys Hawaii conducted an archaeological assessment for a proposed Fiber Optic Cable Landing at Kahe Point Beach Park, Ewa, Oahu. The assessment included surface survey of the proposed landing site and underground duct line, and review of pertinent literature.

Surface sites observed included a sea cave and associated trash and basalt boulder filled crevices, and a portion of the Oahu Railway and Land Co. railroad tracks. No sites were observed along the proposed duct line which is to be within Farrington Hwy right-of-way (r.o.w.).

Background literature review suggests that the proposed cable landing site is within area not intensively utilized for habitation or agricultural during pre-historic times (i.e. pre 1778). The landing site itself (shoreline to highway) contains two areas of interest, the partially filled crevices at the shoreline and the O. R. & L tracks. The crevices can basically be avoided, however, the rail right-of-way parallels the coast and is between the coast and Farrington Hwy. Mitigation to avoid adverse impacts to the rail line should be worked out with the Historic Sites Division of the Department of Land and Natural Resources.

Recommendations include: (1) further investigations of the sea cave and crevices if the proposed landing corridor cannot avoid them; (2) a mitigation plan to avoid undue disturbance to the O.R. & L. right-of-way; and (3) survey of a staked center line of the proposed underground duct line if it is to be located (in whole or part) outside of the highway r.o.w.

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A. Project Area Description

Cultural Surveys Hawaii conducted archaeological assessments for four proposed fiber-optic cable landing sites on three of the Hawaiian islands. The proposed sites are located on O'ahu at Sandy Beach Park and Kahe Point Beach Park, on Hawai'i at Spencer Beach Park, and on Kaua'i at the Wailua golf course.

The assessments were requested by R.M. Towill Corp. and included background research and on-site inspections to determine the potential for encountering archaeological resources at the four proposed cable landing sites. Sub-surface testing was carried out at the Spencer and Sandy Beach Park Sites to gather additional information on stratigraphy.

Individual reports treat each of the proposed cable landing sites. Contained in each report are site-specific scopes of work, field methods, a review of previous research pertinent to the individual landing site, research results, and recommendations for mitigation of existing cultural-archaeological resources.

The proposed Kahe Point Beach Park Fiber Optic Cable Landing Site (Figs. 1-4) is a narrow (20-foot) corridor within the northern section of the park with a proposed duct line extending southward within Farrington Hwy. right-of-way to Ko'olina Resort.

The Kahe Point Beach Park is located within the district of Ewa on the dry leeward coast of Oahu. Average annual rainfall is less than 20 inches per year.

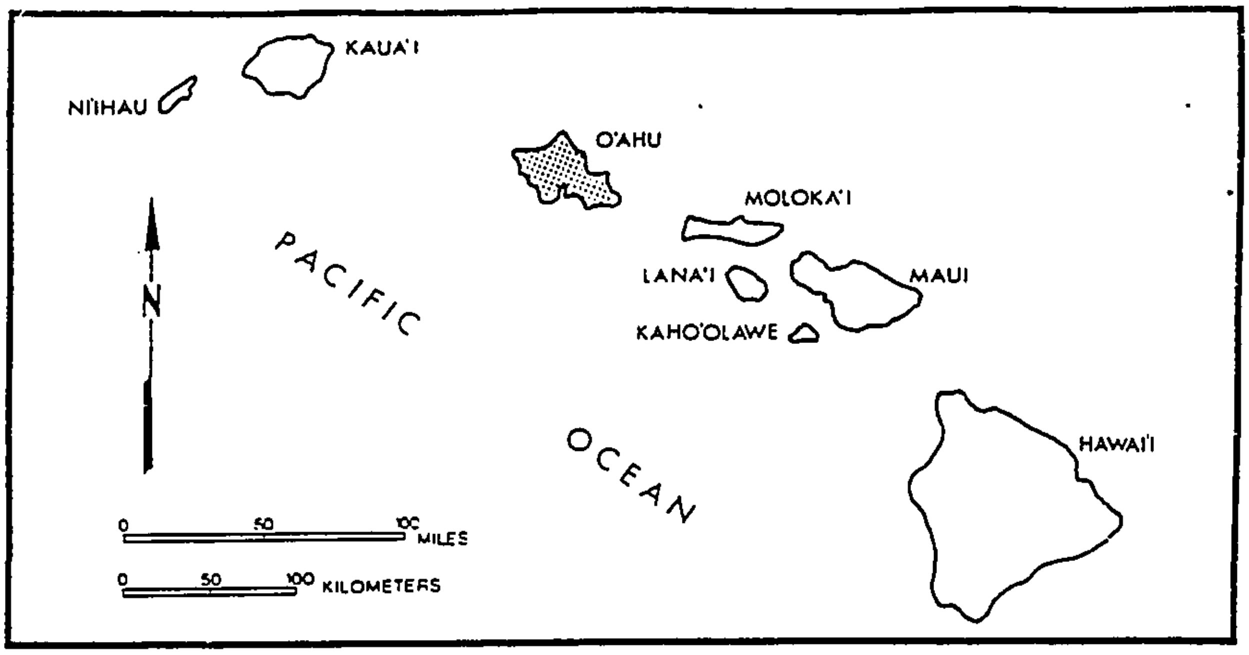

Fig. 1 State of Hawai'i

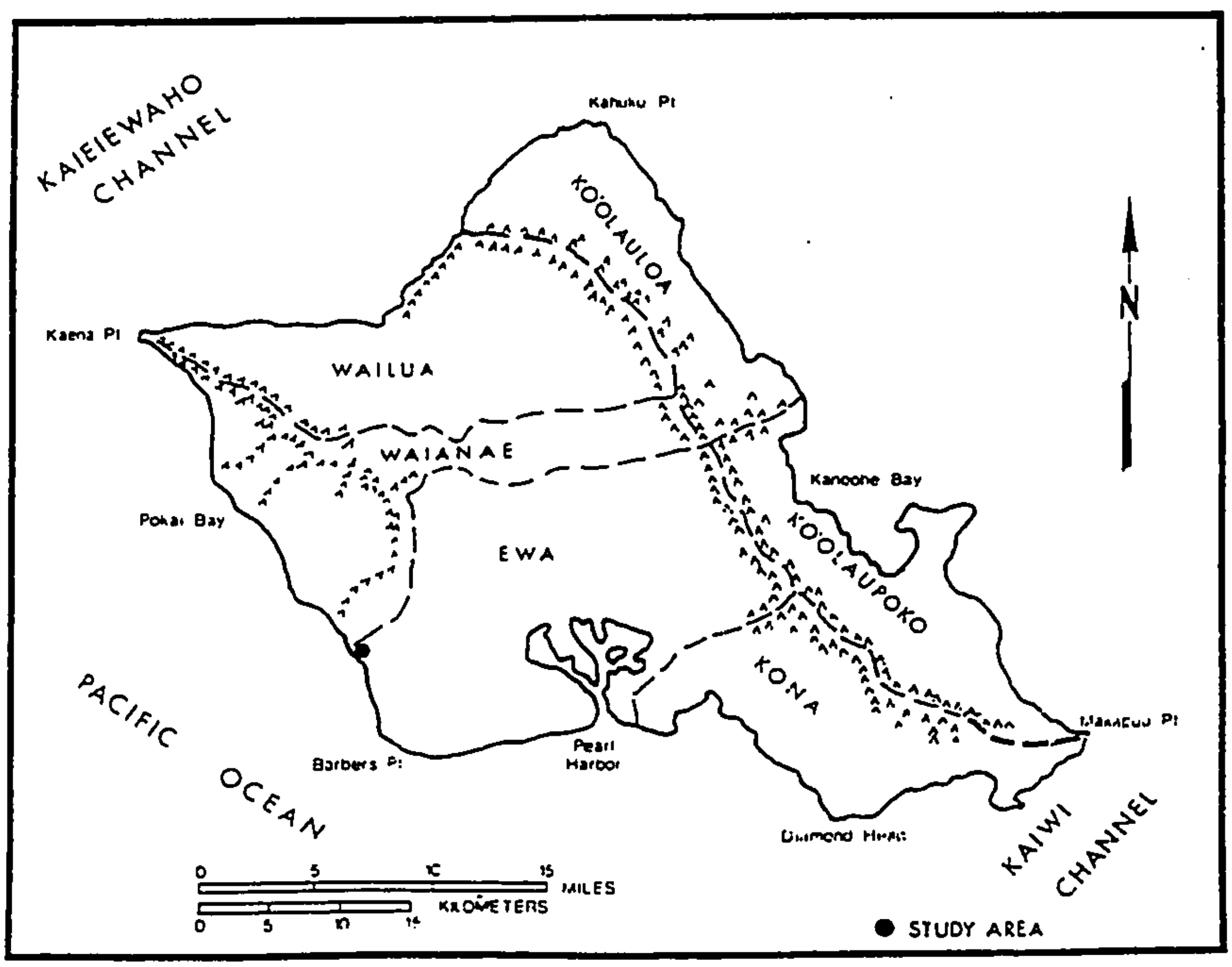

Fig. 2 O'ahu Island Location Map

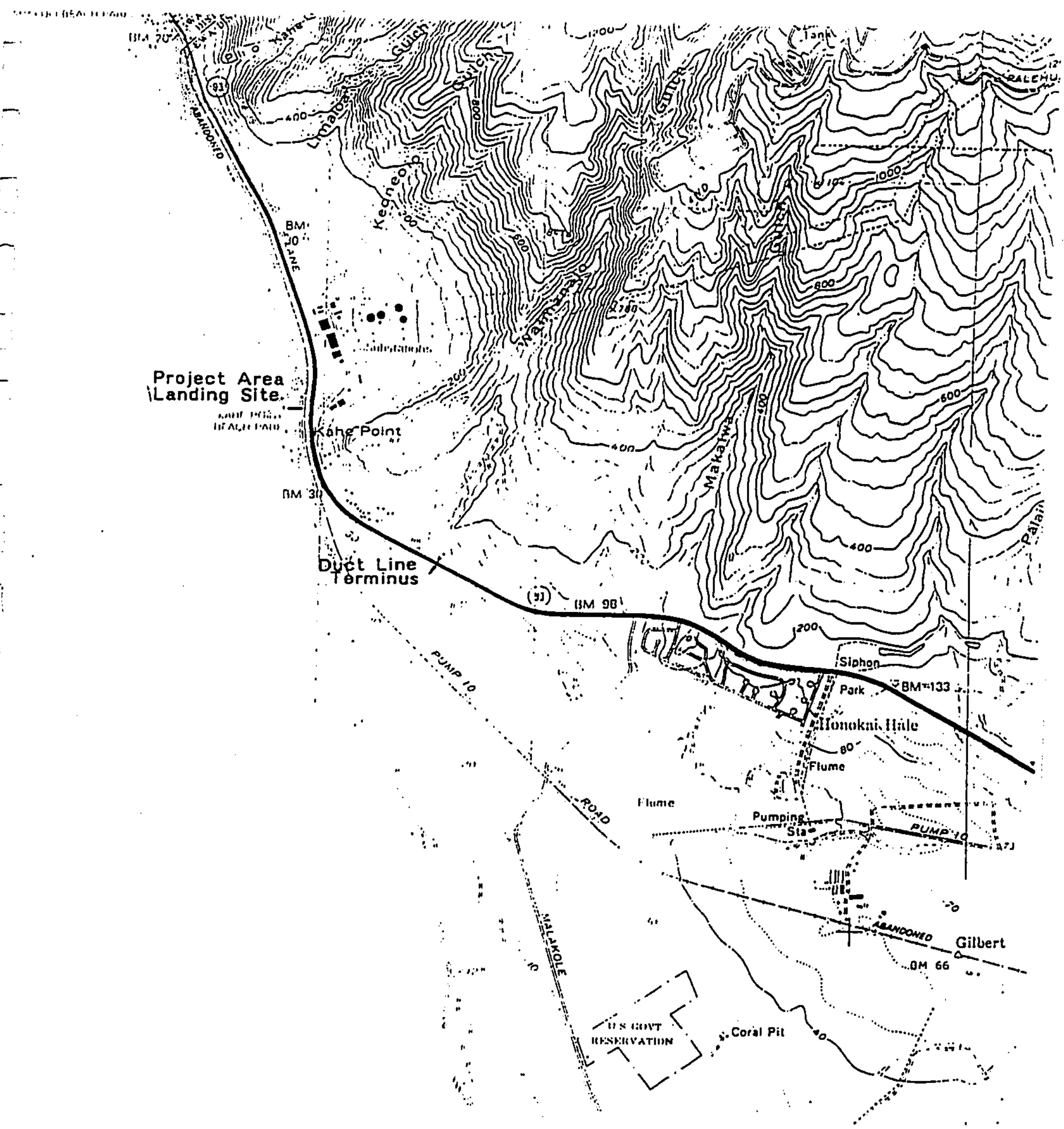

Fig. 3 USGS 'Ewa Quad Showing Project Location

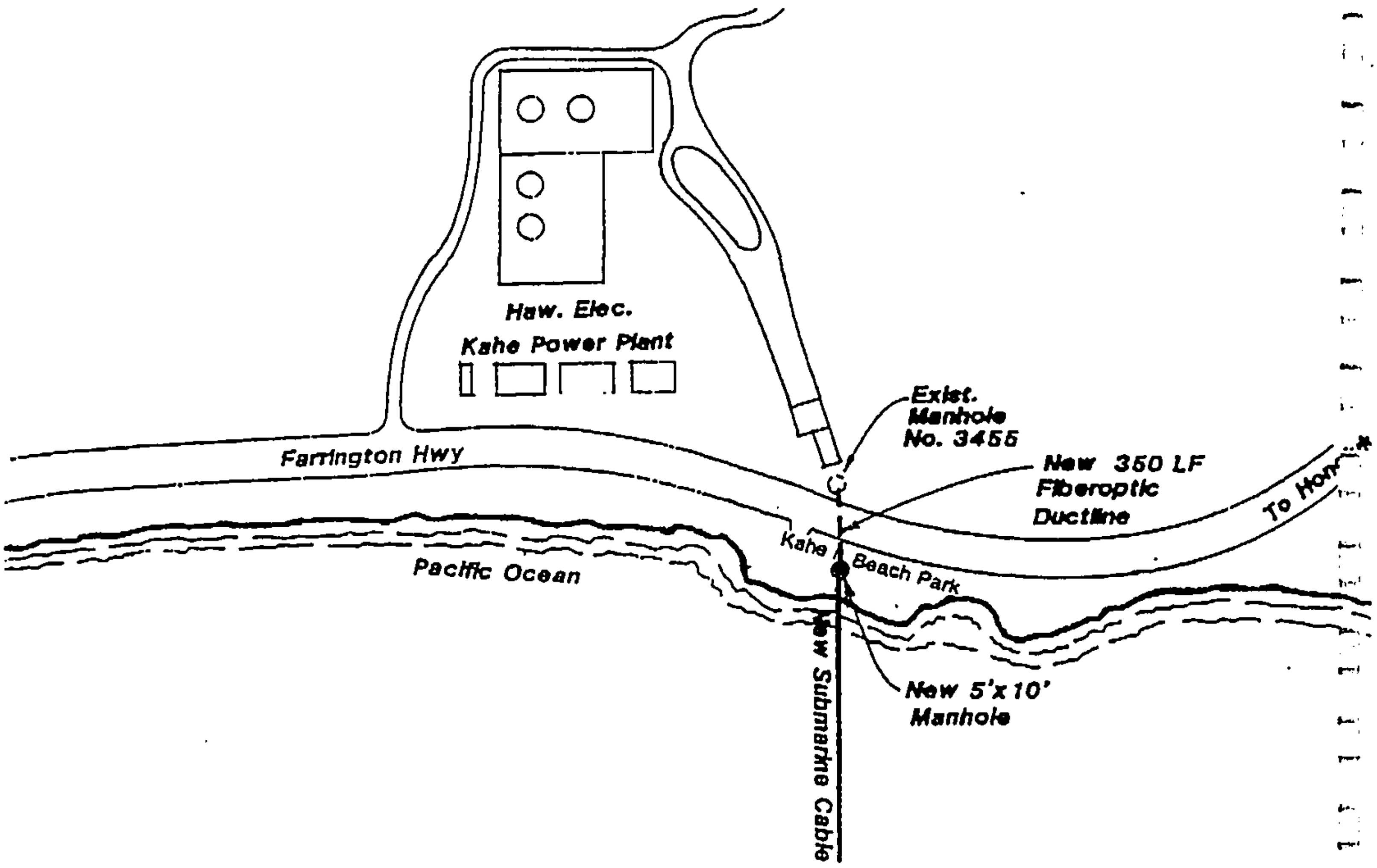

Fig. 4 Project Area Map From R. M. Towill Corp.

Topography within the Beach Park is raised reef limestone ("cr." Foot et.al. 1972) and soils along Farrington Hwy are part of the Lualualei series ("LPE," ibid). The only vegetation near the corridor are a few kiawe trees (*prosopis paladium*) and a single Indian Coral tree.

B. Scope of Work and Methods

Specific to the Kahe Point Beach Park assessment, the scope of work included inspection of the proposed landing site (Kahe Pt.) and the proposed duct line along Farrington Hwy. The fiber optic cable would then connect to existing underground utility lines at the Ko'olina Resort.

The landing and duct line corridor were inspected for any surface sites. Two areas of interest were noted within the Beach Park portion but none along the proposed duct line. The two areas within the Beach Park include a sea cave and associated crevices, and an extant section of fairly well preserved Oahu Railway and Land Co. (O.R. & L.) tracks.

No subsurface testing was undertaken in association with this assessment. This was due to a number of facts which include: (1) The sea cave and crevices in the park can easily be avoided; (2) The O.R. & L. right-of-way is listed as a national registered site (50-80-12-9714) and a mitigation plan to get by it must be approved by the Historic Sites Division of the Department of Land and Natural Resources; (3) Sub-surface testing along the approximately 2,500 ft. long duct line within Farrington Hwy is not only beyond the scope of this assessment, but based on the observed degree of land alteration associated with the highway's construction (massive cut and fill), it would appear that no archaeological resources of significance remain within the actual right-of-way itself.

Previous Archaeological Research

McAllister in his *Archaeology of Oahu* (1933) records no sites within two miles of Kahe Point. Sterling and Summers (1978) similarly record no sites and oddly not even a single reference to the Kahe Point area *per se*. The nearest places for which there is any traditional lore are Pilio Kahe about a mile north at the Wai'anae/'Ewa boundary and to Ko'olina in Waimānalo ('Ewa) about a mile to the south.

In July of 1984 Cultural Surveys Hawaii performed an archaeological reconnaissance of a parcel of land at the Hawaiian Electric Kahe Point Power Plant and determined that "the entire property [surveyed in 1984] has been graded and filled with quarried rock with a loose soil cover" (letter from Dr. Hammatt to Dames and Moore; August 6, 1984:1). While no archaeological remains were observed, it was noted that "if any archaeological remains existed here [the 1984 project area] they would have been destroyed by the activities described above" (Hammatt, 1984:1).

We are aware of a burial discovered in the sandy beach deposits in the vicinity of the Kahe Power Plant outfall pipe. On 28 December 1989, children found a burial 300 ft. north of Kahe Beach Park. A forensic report summarizes the police report and this burial has been designated State Site #80-12-4061. This appears to be a prehistoric burial (Bath, 1989: Site File on file for State Site 80-12-4061).

In 1989 Cultural Surveys Hawai'i conducted a reconnaissance survey of the six-acre HECO Kahe Training Facility, within a portion of the Kahe Substation, *mauka* of Farrington Hwy. One agricultural terrace wall was located during this survey. The report indicates that "within the whole Kahe Power Plant area this is the only site known extant.

In 1990, Cultural Surveys Hawai'i conducted an archaeological inventory survey of 1,900 acres for the proposed Makaīwa Hills Development project.. The Makaīwa survey was conducted on the southern facing slope of the Wai'anae Mountains *mauka* of Farrington Hwy. There was a total of 34 sites or site complexes located during this survey. One of these sites, 50-80-12-2893, located adjacent to Farrington Hwy contains habitation features as well as associated petroglyphs. Preservation and protection measures have already been implemented for this site complex, however any work near its location (i.e. adjacent to Farrington Hwy/Ko'olina Resort exit) should take into account the preservation status of this site.

The same report (Hammatt, Robins, Stride, McDermott, 1991) contains a review of archaeological research and an overall settlement pattern for the large *ahupua'a* of Honouliuli in which Kahe Point is situated. The reader is referred to that report for a detailed discussion of these topics.

Land Use

The following is a brief overview of traditional and historic land use, based on the references just mentioned, concerning the Kahe Point area of Honouliuli.

The apparent total absence of traditional references to the Kahe Point area suggests that there was little if any permanent habitation in the immediate area. The presence of a fishing shrine or *koa*, Site 1433, along the coast south of Kahe Beach Park is a testimony however to the prehistoric utilization of a particularly good fishing locality. Temporary fishing camps with possibly a few scattered permanent habitations right along the coast would probably have been the extent of traditional Hawaiian occupation in the area.

In recent years, Hawaiian occupation sites at the Ko Olino development to the south and Hawaiian Homes lands at Nanakuli to the north have been foci of archaeological research. The low rainfall within the present project area (20"/year) would have offered little inducement for numbers of Hawaiians to have created permanent habitations with the necessary agricultural resources.

However, based on a chronology developed at the Ko'olina project (Davis and Haun, 1987) the shoreline areas of Honouliuli were probably utilized as early as A.D. 420-620. Site -2893, just *mauka* of Farrington Hwy, was dated to A.D. 1400-1665. These dates suggest that the shoreline area of Honouliuli contained one of the earliest sites on the Leeward coast and that the inland portions of the *ahupua'a* were utilized by A.D. 1400.

Most of the accounts of the traditional history of Honouliuli (ex. Kelly, 1979) make no reference to the vicinity of Kahe Point. The history of western Honouliuli is dominated by the establishment of the 41,000 acre Honouliuli (Campbell) Ranch in 1877. The ranch encompassed most of the *ahupua'a*. Whether the Campbell Ranch ranged cattle as far north as Kahe Point is unclear. The O.R.& L. tracks were extended past Kahe Point circa 1895.

The Kahe Point Hawaiian Electric Power Plant property was acquired in 1960 from Campbell Estate. Construction of the first unit began in 1962 and power generation began in 1963.

Kahe Point Beach Park was acquired in 1954 and consists of 4.7 acres of land on the *makai* side of Farrington Hwy. Improvements include a comfort station and pavilion which were built in 1962. The present parking lot was completed in 1968. Beach park use is heavy including temporary shelter for homeless families.

Results of Fieldwork

On March 9, 1992 David Shideler and Michael Pfeffer conducted an on-site field inspection of the proposed cable landing site and duct line. The landing site is within Kahe Point Beach Park while the duct line will be within Farrington Hwy right-of-way. The survey was conducted with the aim of identifying and locating all known sites and potential sites that might be impacted by the cable route. No archaeological sites were observed within the landing corridor or along Farrington Hwy. The corridor (20 feet wide) for the cable landing would be through the existing limestone bench, which Kahe Point Park is built on. The area has been entirely graded and improved for the beach park.

Similarly, the proposed duct line is within a previously heavily impacted area (bulldozed, graded, fill, etc.) of the corridor of Farrington Hwy. The duct line is proposed to extend from Kahe Point to the Ko'olina turnoff where it will attach to an existing underground duct.

Three areas of interest were located during the survey: 1) A fishing shrine (*koa*); 2) an extant portion of the old Oahu Rail and Land Company, complete with ties, rails, and a rail crossing sign; and 3) a sea cave with several rock filled crevasses that may contain burials or other cultural matter.

The first area of interest is the fishing shrine, or *koa*, which is located outside of the proposed cable route. The shrine is thought to be one of the only *koa* that still exists on the island of O'ahu and is listed as a State Site (50-80-12-1433). The shrine is located approximately 1,000 feet (300 meters) to the south of the proposed cable route and no impact is foreseen on the site.

The second area of interest is a portion of the old Oahu Rail and Land Company right-of-way (50-80-12-9714) which is in an excellent state of preservation. The line runs along parallel to the coast and cuts across the proposed cable route. The line itself which is listed on the National Register, runs continuously from the intersection of Lualualei Road with Farrington Hwy in Nānākuli to 200 ft. east of where it intersects with Fort Weaver Road in Honouliuli. Just north of the proposed cable route (10 meters) is a railroad crossing sign that is still in excellent condition. It is recommended that care be taken to preserve the railroad line and associated features (the sign) if possible during construction of the cable route.

The third area of interest is a small sea cave and several associated fissures, or deep cracks, in an exposed portion of ancient reef/limestone shelf. At the point where the proposed cable is to exit the Pacific Ocean there is a sea cave located approximately 5 meters below the ground level. The cave floor is covered with a small boulders, part of a built-up beach that is constantly washed by the prevailing swell and there are no cultural deposits in the cave. There are also several large fissures located on the western edge of the sea cave that may contain cultural material. The fissures angle up from the sea cave and are located 2 to 4 meters below the ground level. The fissures are filled with a deposit of modern trash, however beneath the modern trash there is a loose layer of water worn boulders that may be cultural in origin. While the rocks probably have been washed into the cracks during large storms, there is a possibility that they have been artificially placed into the cracks. This may indicate the presence of burials in the fissures. If the cable route is to impact the cave and/or fissures an archaeological inventory survey (i.e. testing) of the trash-filled cracks should take place prior to construction. If the cable is routed to the south of the cave, then no impact would be foreseen to the cave or fissures.

Summary and Recommendations

The area to be impacted by the proposed fiber optic cable route was examined and surveyed by Cultural Surveys Hawai'i to determine the extent of any cultural deposits and/or sites in the area. Three areas of interest were noted and described above. Of the three, only two would be impacted by the proposed route, the rail line and the sea cave and fissures. If the cable is routed to the south of the sea cave then no impact is foreseen for the cave and fissures. However, if the proposed cable route will impact the cave and fissures then an archaeological survey, including sub-surface examination, should be conducted prior to construction. The rail line is in an excellent state of preservation and is listed on the National Register (50-8-12-9714). It is recommended that the cable route have little or no impact on the extant portion of the rail line and the state must be consulted to determine if any impact can be made on this section of rail line. If impact is allowed on the rail line an archaeologist should be present during excavation.

The proposed underground duct line within Farrington Hwy (right-of-way) from Kahe Point to Ko'olina Resort, appears to contain no significant archaeological resources. However, once the actual route with a surveyed and staked centerline is chosen, it is recommended that if portions of the duct line are outside of the highway right-of-way, a survey be conducted to properly assess the staked route.

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Photo Appendix

Fig. 5 Proposed Corridor Route. View to West

Fig. 6 Proposed Corridor Route. View to Northeast.

Fig. 7 Sea Cave. View to Northeast.

Fig. 8 Sea Cave With Reference Point (Indian Coral Tree). View to Northeast.

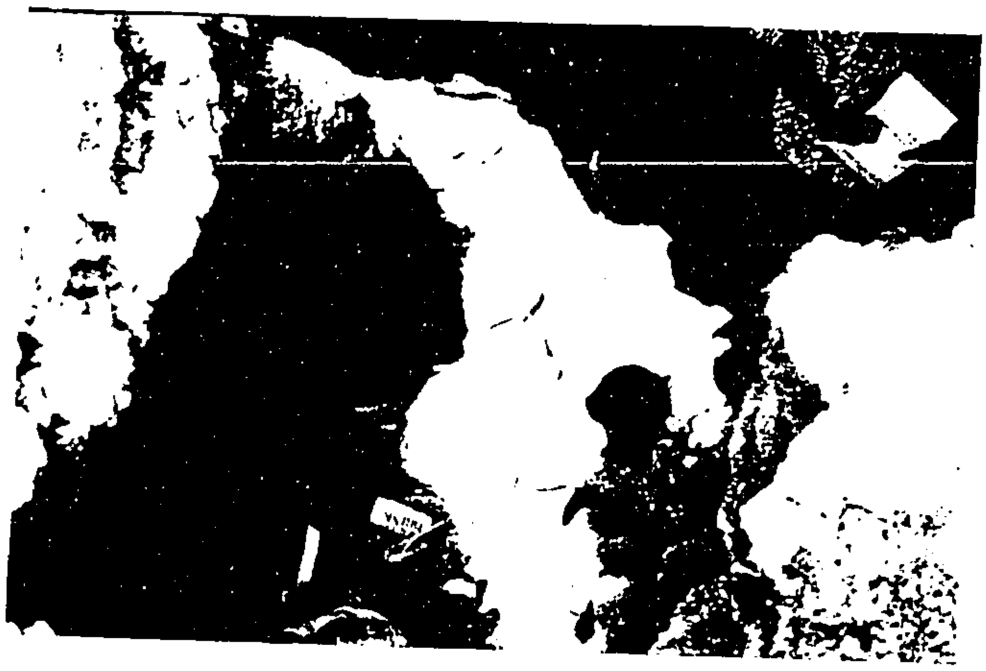

Fig. 9 Crevice With Modern Fill and Possible Modification. View to Northeast.

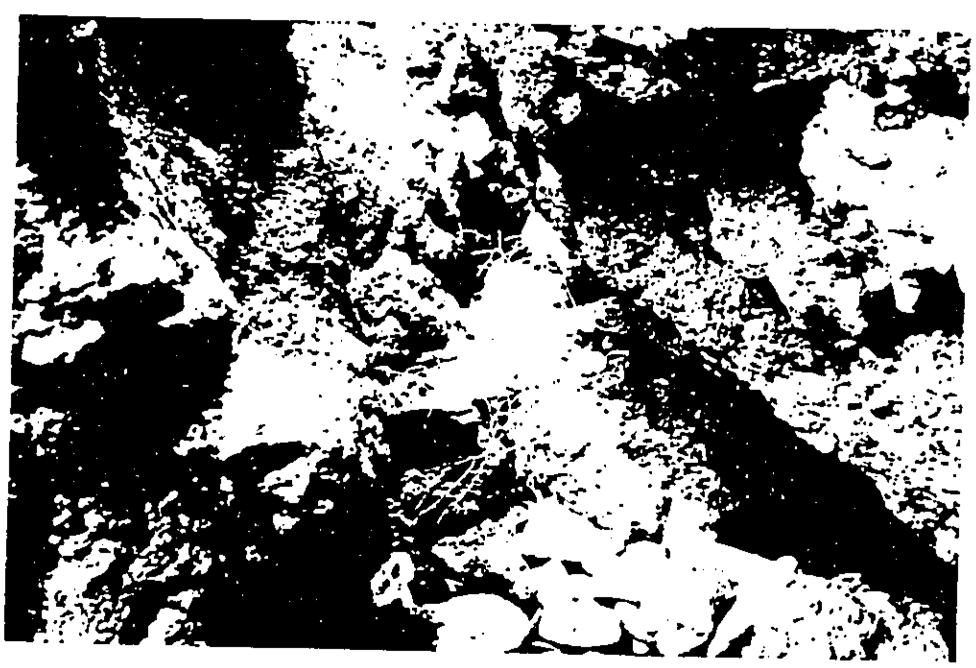

Fig. 10 Second Crevice With Modern Fill and Possible Modification. View to Northwest.

Fig. 11 View of Extant Oahu Railway and Land Company Track. View to Northwest.

Fig. 12 Oahu Railway and Land Company Track With Extant Railroad Crossing Sign in Foreground. View to Southeast.

APPENDIX H

Archaeological Assessment of the Proposed Fiber Optic Cable Landing East Oahu, Sandy Beach Park

Archaeological Assessment of the Proposed Fiber Optic Cable Landing for East O'ahu, Sandy Beach Park Maunalua, District of Honolulu, O'ahu

(TMK 3-9-12:02)

by

Douglas F. Borthwick, B.A.
Hallett H. Hammatt, Ph.D.

Prepared for

R.M. Towill Corp.

Cultural Surveys Hawaii
January 1992

Abstract

At the request of R.M. Towill Corp., Cultural Surveys Hawaii conducted an archaeological assessment for a proposed Fiber Optic Cable Landing at Sandy Beach Park, Honolulu, O'ahu. The assessment included surface survey, sub-surface testing, and review of pertinent literature.

The proposed corridor is situated, in part, within the active beach zone till connecting to the existing beach park roadway.

No surface sites exist within the proposed corridor. The sub-surface testing indicated that no significant intact, undisturbed (or non-mixed) cultural layer(s) exist within the cable corridor.

Background literature review suggests an absence of pre-existing permanent coastal habitation within Sandy Beach Park.

The beach park and its facilities have altered the landscape to a considerable degree which is evident within the portions of the beach that were tested. Based on the shallow beach deposits and observed absence of undisturbed beach strata no further archaeological investigations appear warranted. However, it is recommended that a qualified professional archaeological firm be contracted to be available for onsite inspections in the unlikely event significant cultural material is unearthed during construction.

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Introduction

A. Project Description

Cultural Surveys Hawai'i conducted archaeological assessments for four proposed fiber-optic cable landing sites on three of the Hawaiian islands. The proposed sites are located on O'ahu at Sandy Beach Park and Kahe Point Beach Park, on Hawai'i at Spencer Beach Park, and on Kaua'i at the Wailua Golf course.

The assessments were requested by R.M. Towill Corp. and included background research and on-site inspections to determine the potential for encountering archaeological resources at the four proposed cable landing sites. Sub-surface testing was carried out at the Spencer and Sandy Beach Park Sites to gather additional information on stratigraphy.

Individual reports treat each of the proposed cable landing sites. Contained in each report are site-specific scopes of work, field methods, a review of previous research pertinent to the individual landing site, research results, and recommendations for mitigation of existing cultural-archaeological resources.

The proposed Sandy Beach Park Fiber Optic Cable Landing Site (Figs. 1-4) is a narrow (20-foot) corridor within the eastern section of the beach park. The corridor includes a short section (approximately 100 feet) within the active beach zone, and then parallels existing roadways of the beach park and Kalanianaole Hwy.

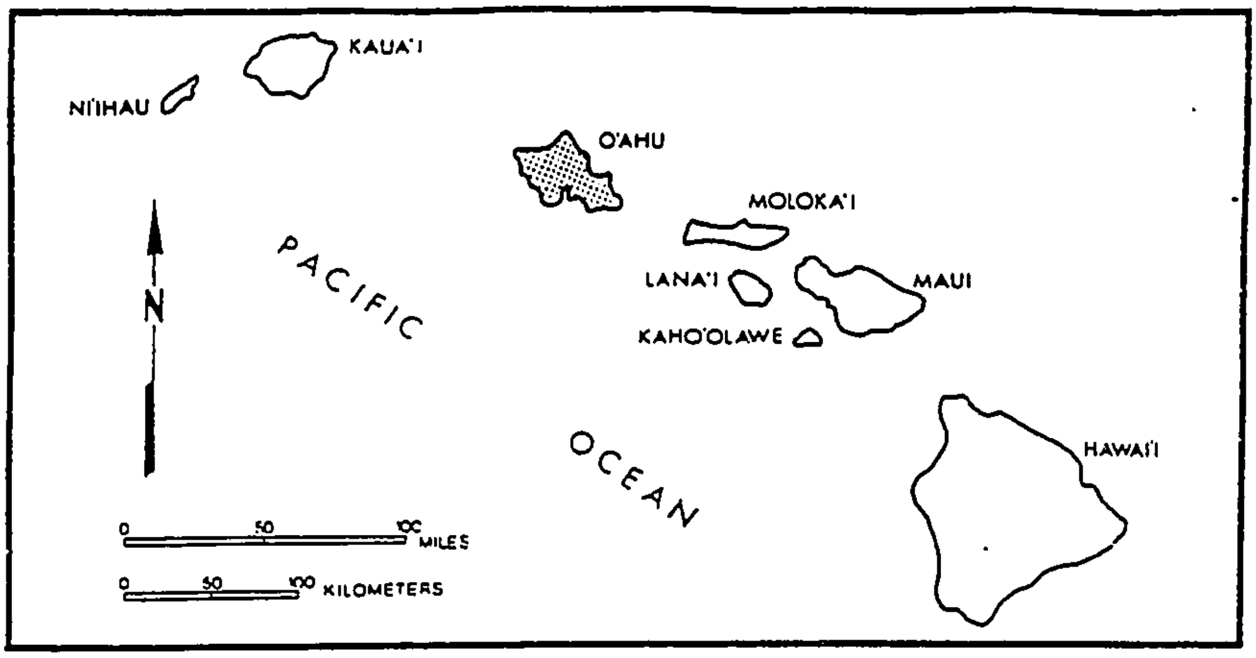

Fig. 1 State of Hawai'i

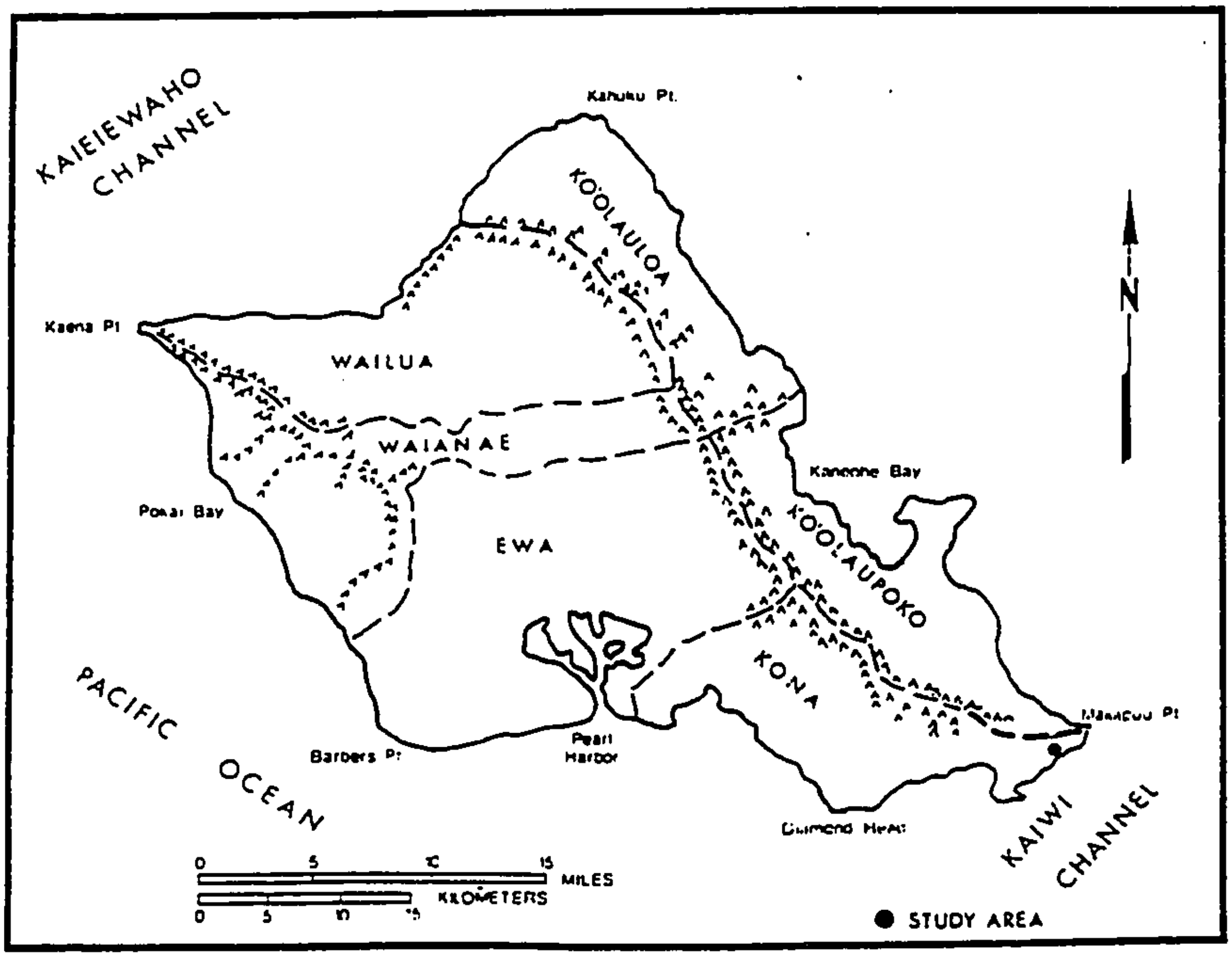

Fig. 2 O'ahu Island Location Map

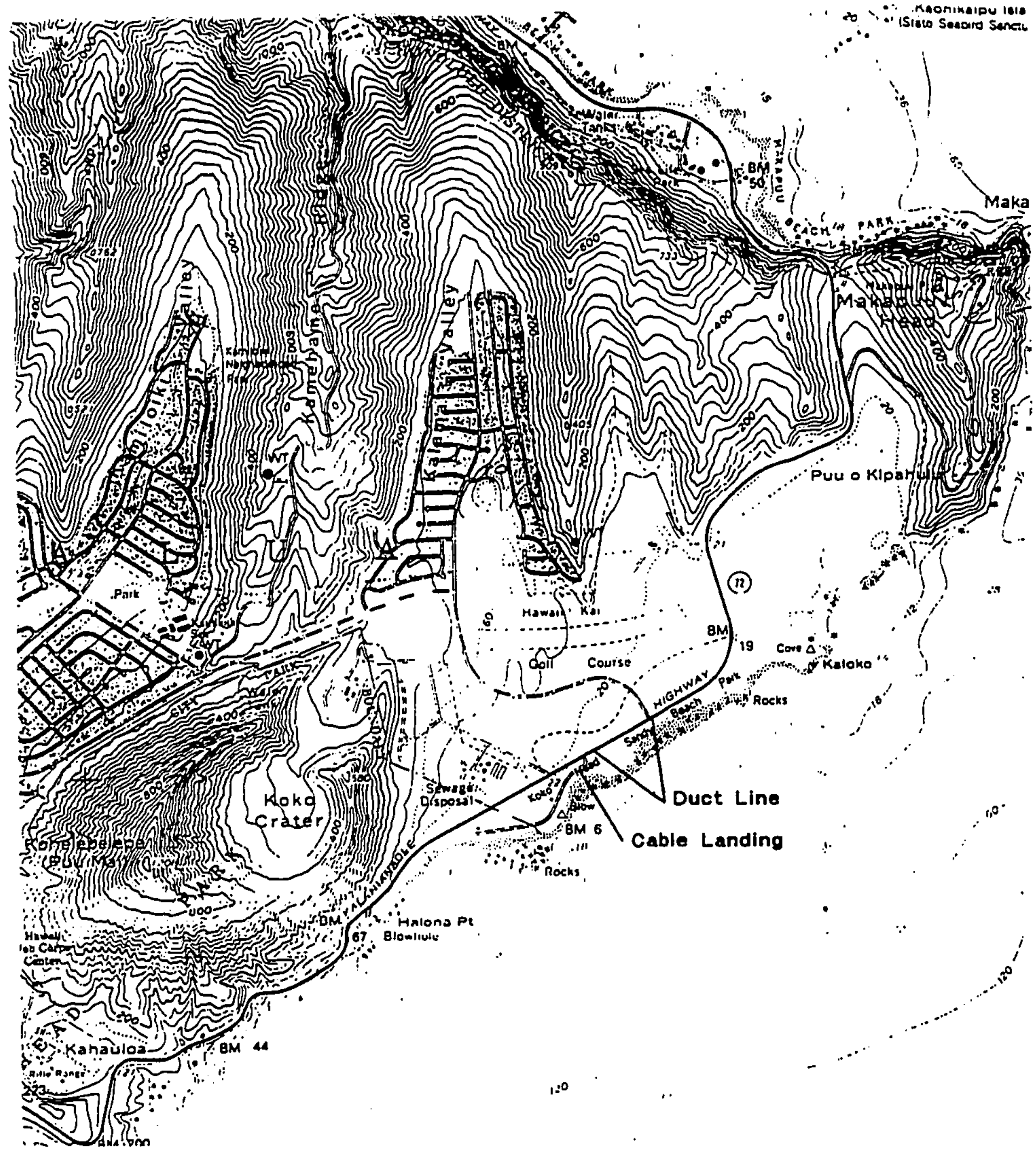

Figure 3 USGS Kokohead Quad Showing Proposed Cable Landing Site, Sandy Beach Park

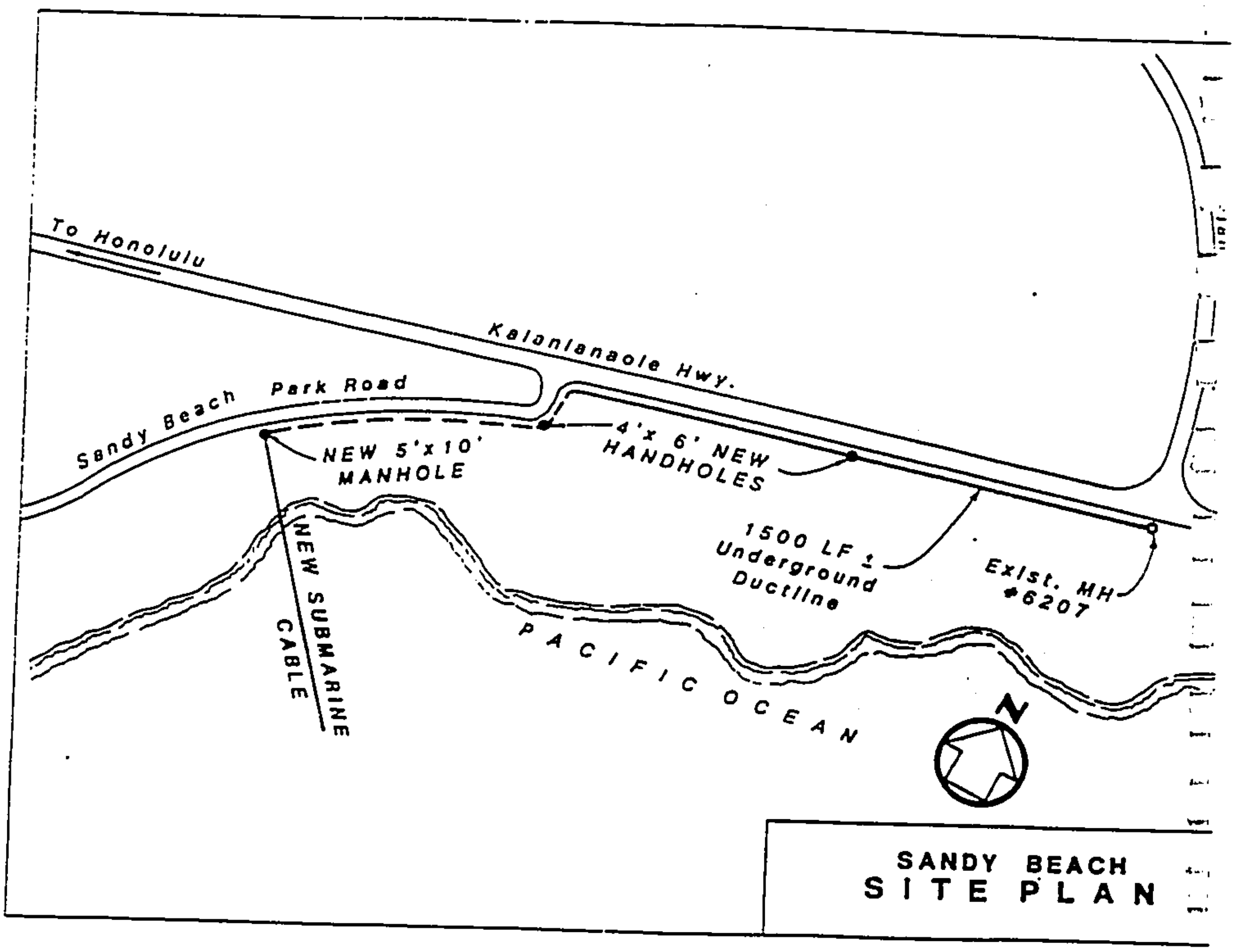

Figure 4 Plan of Project Area, Sand Beach Fiber Optic Cable, from R.M. Towill Corp.

B. Scope of Work and Methods

Specific to the Sandy Beach Fiber Optic assessment, the scope of work included surface survey, sub-surface testing, and review of pertinent literature.

Surface survey and sub-surface testing were conducted on January 24, 1992. The generalized cable corridor (Fig. #4) was followed utilizing an aerial photo supplied by R.M. Towill Corp. The sub-surface testing included a 50cm x 50cm test unit and a four (4) meter long faced, cut bank. Excavated material was screened through 1/4 wire mesh and all cultural material (midden and artifacts) observed was collected. Photographs of the excavations were taken and a representative stratigraphic profile was drawn.

Historic Background

Land Unit

The project area is situated within the traditional land unit of Maunalua ("two mountains"; Pukui, Elbert, Mookini, 1974:149).

There are two reports that detail the history, myths, and legends concerning Maunalua. The two documents are:

1) "Historical/Cultural Essay Report on the Kuapa Pond Area" by Anne H. Takemoto, Pauline King Joerger, Merie-Ellen Fong Mitchell, and Cassandra E. Bareng (1975). This report also includes a certified title search of the Maunalua area with specific references to Kuapa Pond by Herbert Poliala Ewaliko.

2) "Cultural Resources Overview for the Queens Beach Park Feasibility Study, Maunalua, Kona, Oahu" by Marion Kelly, Hiro Kurashima, and Aki Sinoto (1984).

These two reports give in-depth chronological reviews of the land use history of Maunalua. The following is a brief overview based on these reports as well as other sources.

The land unit of Maunalua, in which Sandy Beach Park is situated, is linked with both the Ko'olaupoko and Honolulu districts. Maunalua is recorded in some sources as an *'ili* (next largest land unit after the *ahupua'a*) of Waimānalo in the Ko'olaupoko District. However, even as early as the mid-1850s Maunalua was referred to, in references to Victoria Kamamalu's land claim (LCA 7713) for Maunalua, as being in the Kona District of O'ahu. The confusion was not cleared up till the 1920s. "The land of Maunalua is an *'ili* of the *ahupua'a* of Waimānalo and originally belonged to Ko'olaupoko District. Maps made as late as 1902 place it in that district. It is situated on the south side of the Ko'olau range and should really be a part of Honolulu District. The many previous acts referring to O'ahu Districts never did make this sufficiently clear, so in the above amendment (Revised Laws of Hawaii, 1925) of 1932, the descriptions of Honolulu and Ko'olaupoko Districts clarified this point" (J. W. Coulter in Sterling and Summers, 1978:257).

Land Title

Maunalua, as an *'ili* of Waimānalo, was originally part of the Crown Lands, a possession of Kamehameha III (Interior Department, List of Lands of the King by J. Kaeo Dec. 18, 1847). However, in 1850 Victoria Kamamalu, a granddaughter of Kamehameha I and sister of Kamehameha IV and V, was awarded the *'ili* of Maunalua as part of Land Commission Award (LCA) 7713. In 1883 Bernice Pauahi Bishop inherited Maunalua (and many other lands) as part of the estate of Ruth Keelikolani. The Bernice Pauahi Bishop Estate was created after her death in 1884 and Maunalua was a part of the overall land holdings. Sandy Beach Park, a City and County of Honolulu administered beach park, was acquired from Bishop Estate in 1928 and until the 1960's was an unimproved beach area.

Land Use

The Maunalua area is relatively dry, receiving between 20 and 30 inches of rain per year, and has no permanently flowing streams. Thus the type of agriculture practiced during pre-historic (pre A.D. 1776) and early historic times was probably exclusively dry land agriculture. Ethnographic evidence supports this proposition. "According to the last surviving *kama'aina* of Maunalua, sweet potatoes were grown in the small valleys, such as Kamilonui, as well as on the coastal plain. The plain below Kamiloiki and Kealakipapa was known as *ke-kula-o-Kamauwai*. This was the famous potato-planting place from which came the potatoes traded to ships that anchored off Hahaione in whaling days" (E.S.C. Handy, 1940:155).

Maunalua was probably best known for its large fishpond Keahupua-o-Maunalua (Kuapa Pond). The pond may have covered as much as 523 acres at one time (ca. 1850) (Sterling and Summers, 1978:270). The pond was an early source of revenue to the land owners. In 1856 the pond was leased to the Chun Hoon family for $300 per year, a large sum for those days. In 1873 David Kalakaua leased the pond for $150 per year for a ten- year period. The Kalakaua Estate still had control of the pond's lease into the late 1880s as in a 1889 document records a Chinese firm, Lau Tim & Co., requesting to know if their "application for the lease of the pond at Maunalua will be accepted" (Int. Dept. letter dated November 1889).

The pond is not the only source of fish for Maunalua. The coastline from Makapu'u Point to Maunalua Bay is a very productive near shore and off-shore fishery. This portion of O'ahu's coastline includes Hanauma Bay, which was "a favorite royal fishing resort" (Fornander Coll. Vol. V, p. 278; from Sterling and Summers, 1978:267). Queen Ka'ahumanu was said to have frequented Hanauma Bay as did Kamehameha V (*Ibid.*). Other evidence that the coastline was an important fishery includes the village site of Kaloko (Queen's Beach area), which J. Gilbert McAllister described in his 1930 *Survey of O'ahu Island*. Including in the survey findings at Kaloko were two fishing shrines (*ko'a*), a *heiau*, and a canoe house (*halau*) (J.G. McAllister, 1933:59-65). There were also at least 3 other fishing shrines observed by McAllister within Maunalua.

Commercially organized cattle ranching started ca. 1900 with the lease of most of Maunalua by Maunalua Ranch Co. However, by 1926 this enterprise had folded. In 1932 Alan S. Davis procured a lease for cattle ranching. Alan Davis also went about building a ranch center at the Kaloko area (Queen's Beach). The ranch center included a breakwater and a saltwater swimming pool. These structures, as well as numerous Hawaiian sites at Kaloko were mostly washed away during the 1946 tidal wave with only a few remnants still visible.

Military use within Maunalua has included the Marconi Wireless Station which was first operated ca. 1914, the Coast Guard lighthouse at Makapu'u Point, and the Nike Missile Tracking Station (ca. 1950s-1960s) on Kamehame Ridge.

Since the 1960s Maunalua has been part of the fast-paced urbanization of O'ahu. The Kuapa Pond, Kamilonui and Kamiloiki areas are generally defined as Hawaii Kai. The Kalama Valley portion of Maunalua includes housing and a golf course. Ridge top subdivisions are also progressing with Mariner's Ridge (i.e. Kaluanui Ridge) and more recently Kamehame Ridge. Sandy Beach Park, which was acquired from Bishop Estates in 1928, includes such improvements as parking, comfort stations, and grassed areas. The improvements were begun in the 1960's and continue as conform stations were recently renovated. Presently Sandy Beach Park is one of the most heavily utilized beach parks on O'ahu.

Previous Archaeological Research

Archeological research relevant to Sandy Beach Park includes J. Gilbert McAllister, O'ahu Island Survey J (1933), the two aforementioned reports (Takemoto, Joerger, Mitchell, and Bareng 1975 and Kelly, Kurashima, and Sinoto 1984), a short letter report (Hammatt, 1987), and most recently a large scale testing project which included areas in which the proposed cable route will traverse.

The previous archaeological research has not recorded any sites within the beach park. J.G. McAllister's survey was done prior to the 1946 tidal wave and based on the number and type of sites he recorded elsewhere in Maunalua it would appear that had there been surface sites at Sandy Beach he would have recorded them. Subsurface testing within the park, adjacent to Kalanianaole Hwy also indicated the absence of subsurface cultural deposits.

Subsurface testing along the vehicle log barrier within Sandy Beach Park indicated an absence of subsurface cultural deposits in the eastern portion of the park adjacent to Kalanianaole Hwy. "No material of archaeological significance was found in any of the trenches and it is believed that modern highway construction and beach park landscaping, as well as excavating for water and electric lines has disturbed the upper portion of sand deposits that may once have contained archaeological material" (Hammatt, 1987). However, Hammatt does suggest the possibility of sites along the coast, "Remnants of prehistoric sites may survive in other areas along this coast" (*Ibid.*).

Recent work by Archaeological Consultants of Hawaii Inc. (1992), associated with the proposed eastward expansion of Sandy Beach Park, included 34 backhoe trenches and 50 auger holes. Backhoe excavation and augering were done in areas of active beach as well as areas adjacent to park roadways and Kalanianaole Hwy. Areas tested included sections in which the proposed fiber optic cable line will be located. The extensive testing by Archaeological Consultants did not discover "any significant historic remains" (ACH 1992:66). This was attributed "primarily to the building of the original and realigned Kalanianaole Highways" and tsunami action (*Ibid*:1).

Survey Results

The proposed cable landing and ductline (Fig. #4) were inspected for surface sites of which none exist. Observed during the survey were a number of backfilled backhoe trenches within and near the proposed ductline corridor. The backhoe trenches were associated with an archaeological survey for the proposed eastward expansion of Sandy Beach Park. Discussion of the expansion project is within the previous research section of this report.

The surface survey also revealed that the proposed landing corridor extends northward from the active beach zone to a cement culvert associated with the beach park roadway. The culvert construction has created a cut bank which was inspected for stratigraphic information.

Sub-Surface Testing

A four-meter long section of the cut bank was cleared of vegetation and partially excavated (faced-up) to clearly expose the stratigraphic soil profile. The profile included up to six stratigraphic units I, II, III, IV, V and VI. Stratum I represents modern A - horizon consisting of dark brown (7.5 YR 3/4) clay loam which contains some modern trash and a 10-20% sand component. Stratum II consists of loose coralline beach sand which contains approximately 10% water rounded coral and basalt gravel (pebbles to cobbles). This beach layer continues makai becoming the active beach to the shore line rocks. Stratum II also contains scattered modern trash. Stratum III consists of slightly compact strong brown (7.5 YR 4/6) sandy clay loam. Stratum III contains plentiful (20-30%) water rounded basalt and coral gravel (pebbles to cobbles). This layer appears to have been mechanically altered as it contains marbling and mottling as well as a few modern trash items. Stratum IV consists of a compact dark brown (7.5 YR 3/4) sandy loam with 10 to 15% sand and 20% rock content. The rock component includes both coral and basalt sub-angular to water rounded pebbles to cobbles. No artifacts or midden were observed in association with this layer (i.e. Stratum IV). Stratum V is actually the lower boundary of Stratum IV with IV material as the matrix around boulder-sized rocks. Stratum VI occurs only within active beach deposits and consists of a maxi of beach sand and Stratum IV. Stratum VI consists of a brown (7.5 YR 5/6 - 5/8) sandy loam with water-rounded basalt and coral gravel (pebbles to cobbles)

The stratigraphy observed clearly indicated modern alteration of the natural landscape. Modern era (ca. 1960s - 1970s) trash was observed to depths of 50 cms below surface. The other major observable characteristic within the stratigraphic profiles was the amount and size of the water-rounded gravel in what appeared to be natural or non-mechanically layered strata. This suggests that wave action (i.e., high surf and tsunami) has regularly inundated the section of shoreline in which the proposed fiber optic cable landing is situated.

Summary and Recommendations

Background research indicated an absence of archaeological sites within the proposed fiber optic cable landing and underground duct line. Recent archaeological investigations have, in general, confirmed this.

Test excavations, associated with the Sandy Beach log barrier (Hammatt, 1987), which is on the *makai* side of Kalanianaole Hwy found no archaeologically significant cultural deposits and indicated "that modern highway construction and beach park landscaping, as well as excavating for water and electric lines, has disturbed the upper portion of sand deposits that may once have contained archaeological materials" (*Ibid.*).

Inventory level subsurface investigations, for the proposed eastward expanses of Sandy Beach Park, which included areas that the fiber optic cable and duct line will traverse were also negative in terms of locating significant archaeological resources. Specific to the inventory survey were 34 backhoe trenches and 50 auger holes and "none of the subsurface excavations yielded any artifacts or sites of historic significance" (Archaeological Consultants of Hawaii, 1992:1).

Test excavations done for this project,, along the proposed cable landing corridor, were also negative in terms of locating archaeologically significant cultural deposits. The test excavations indicated that the portion of cable landing within the active beach consists of loose coralline sand overlying a brown sandy loam layer with plentiful water-rounded basalt and coral gravel that lies directly on the basalt bedrock. The portion of the cable landing and duct line by beyond the active beach (i.e., adjacent to park roadway and Kalanianaole Hwy) consists of mechanically altered strata associated with road(s) construction and beach park improvements.

Based on the observed absence of significant surface and subsurface archaeological resources within the proposed fiber optic cable landing and duct line for East O'ahu no further archaeological research appears warranted. However, this archaeological assessment was not specific to a surveyed and staked cable landing/duct line corridor and though we do not anticipate any significant findings, we recommend that an archaeological firm be contracted to provide on-site inspections during construction for the fiber optic cable landing and duct line.

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Appendix A - Photo Appendix Fiber Optic Cable Landing Site and Duct Line, East O'ahu

Figure 5 Cable Landing Corridor in Active Beach Park, Roadway Culvert in Background (View to Northwest)

Figure 6 Faced-up Cut Bank of Culvert Showing Mixed Stratigraphic Profile (View to North)

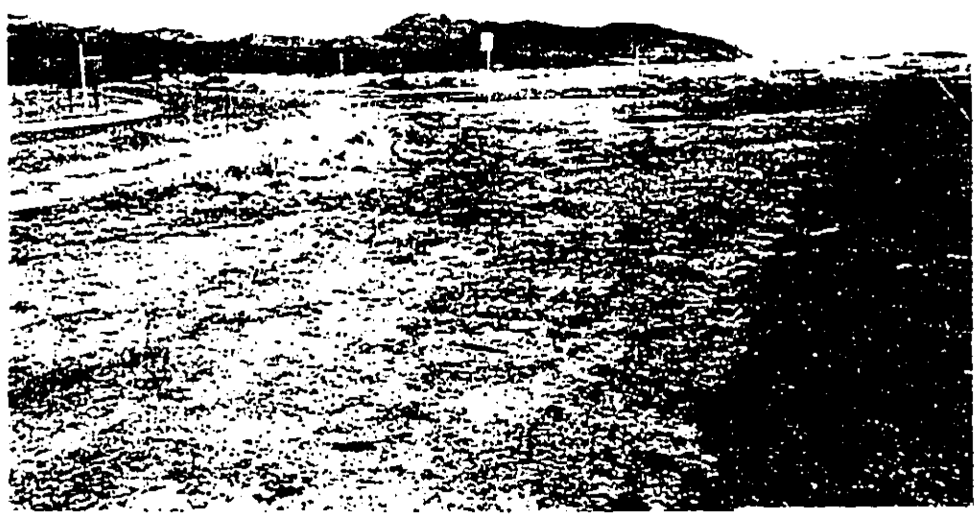

Figure 7 Route of Proposed Underground Fiber Optic Duct Line, Showing Backfilled Backhoe Trench Associated with Park Expansion Archaeological Testing (ACH. 1992) as Exposed Dirt in Center of Photo (View to North).

Figure 8 Kalanianaole Hwy Road Shoulder Portion of Proposed Duct Line (View to Northeast)

APPENDIX I

Archaeological Assessment of the Proposed Fiber Optic Cable Landing Mokapu Beach, Maui

Archaeological Assessment of the Proposed Fiber Optic Cable Landing at Mōkapu Beach, Paeahu Ahupua'a, Honua'ula, Maui (TMK 2-1-08:62)

by

Hallett H. Hammatt, Ph.D.
William H. Folk, B.A.

Prepared for

R.M. Towill Corp.

Cultural Surveys Hawaii
March, 1992

Abstract

Cultural Surveys Hawaii conducted an archaeological assessment for a proposed Fiber Optic Cable Landing at Mōkapu Beach, Honua'ula, Maui (TMK 2-1-08:62). The assessment included surface survey, sub-surface testing, and review of pertinent literature.

Cultural Surveys Hawaii conducted an archaeological surface survey of a corridor of land on the island of Maui extending from the ocean to Wailea Alanui Drive through the property known as TMK 2-1-08:62 for the proposed fiber-optic transmission cable. No surface archaeological sites were found. Previous archaeological studies on the property in 1987 conducted subsurface testing along the shoreline sand beach and dune deposits with negative findings of Hawaiian cultural material. A midden scatter located during that study was excavated at that time.

Introduction

A. Project Description

Cultural Surveys Hawai'i conducted archaeological assessments for five proposed fiber-optic cable landing sites on four of the Hawaiian islands. The proposed sites are located on O'ahu at Sandy Beach Park and Kahe Point Beach Park, on Hawai'i at Spencer Beach Park, on Kaua'i at the Wailua Golf course, and on Maui at Mōkapu Beach.

This report treats the Mōkapu Beach cable landing site on Maui (Fig. 1-4).

The assessments were requested by R.M. Towill Corp. and included background research and on-site inspections to determine the potential for encountering archaeological resources at the five proposed cable landing sites. Sub-surface testing was carried out at the Spencer and Sandy Beach Park Sites to gather additional information on stratigraphy.

Individual reports treat each of the proposed cable landing sites. Contained in each report are site-specific scopes of work, field methods, a review of previous research pertinent to the individual landing site, research results, and recommendations for mitigation of existing cultural-archaeological resources.

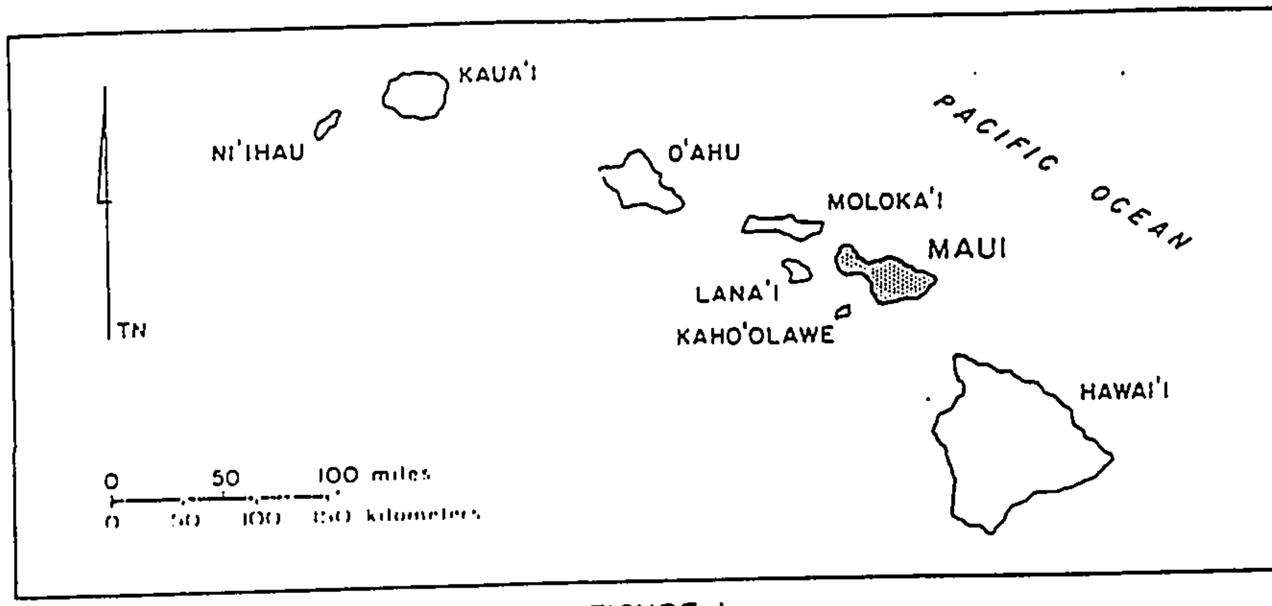

FIGURE I
Map of the State of Hawai'i

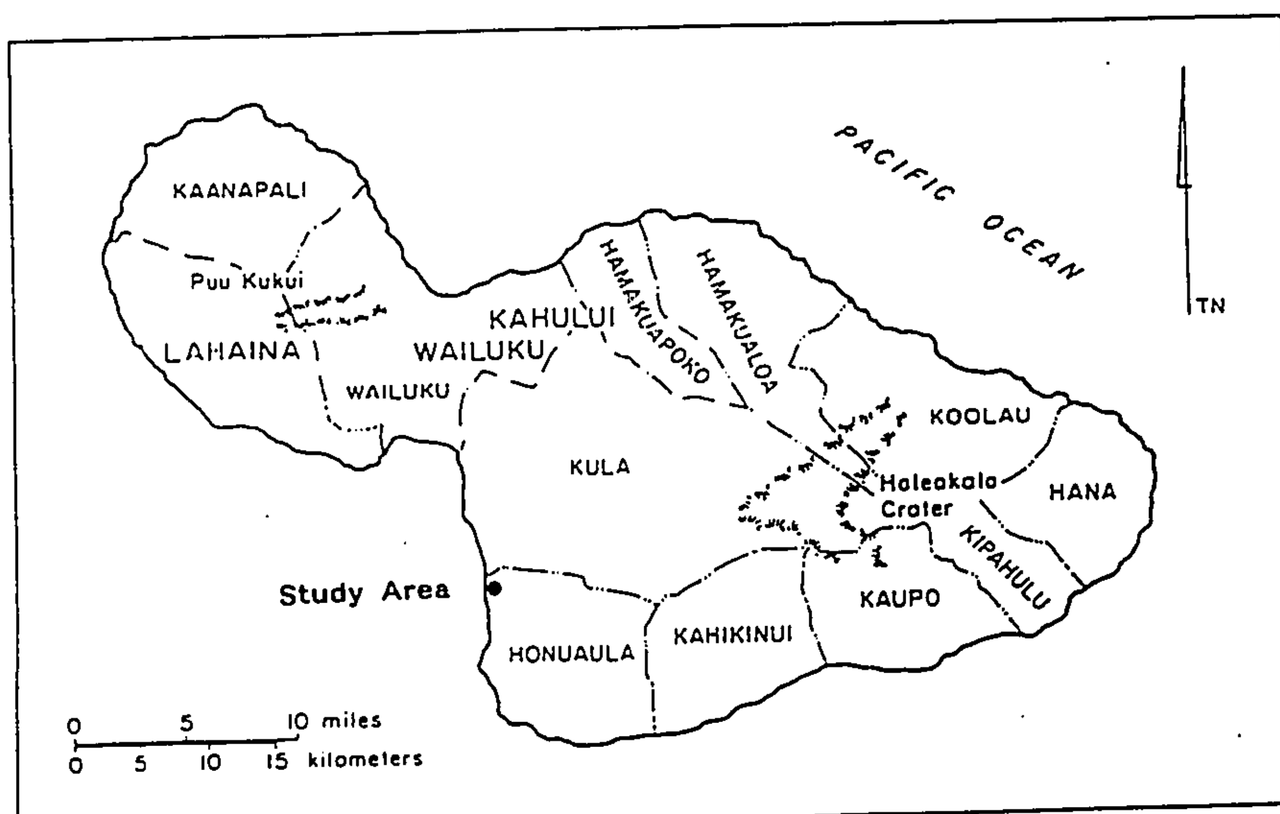

FIGURE 2
General Location Map, Maui Island

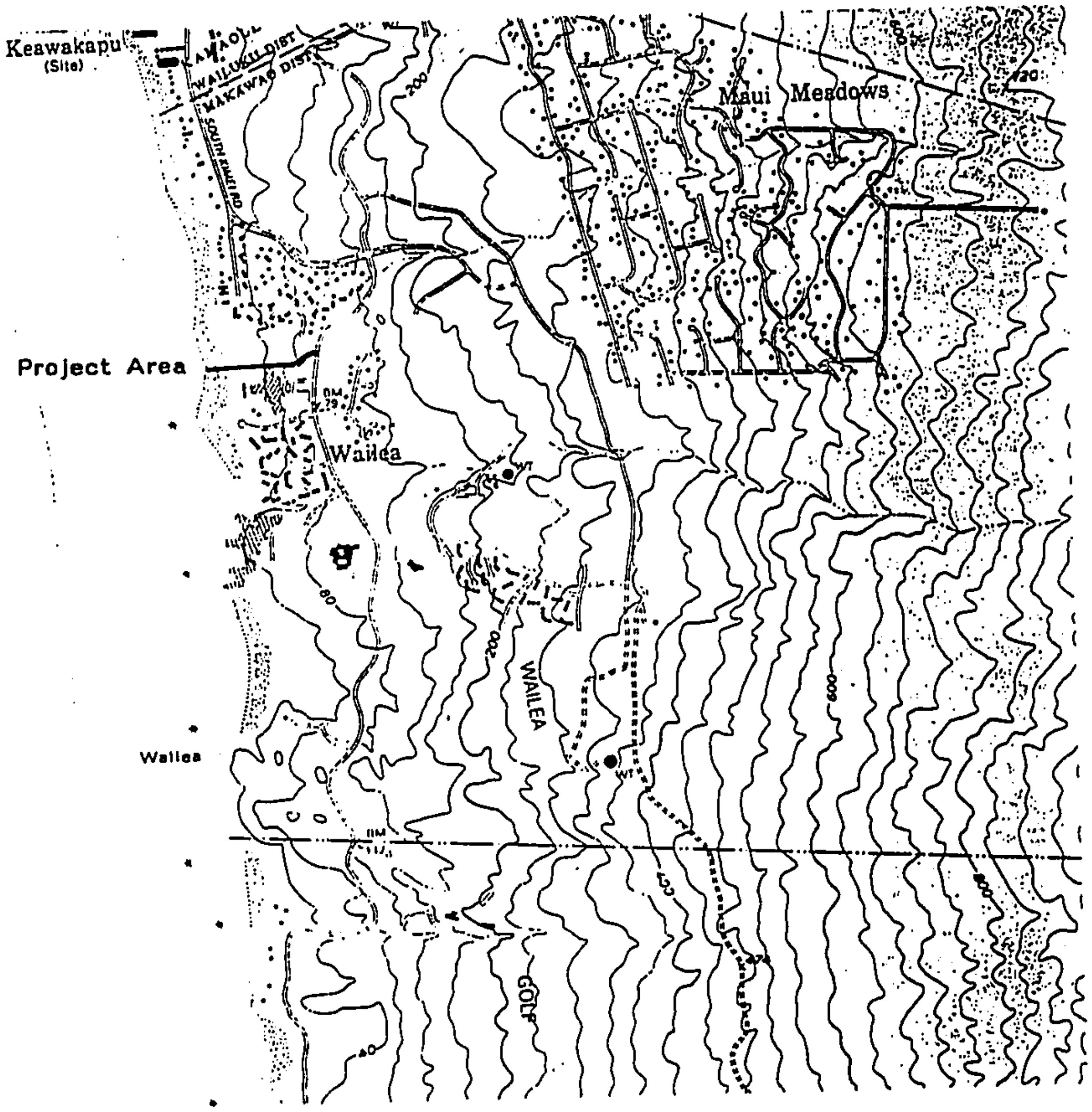

Figure 3 USGS Topographical Map, 7.5 Minute Series, Mākena Quadrangle. Showing Proposed Cable Landing Site Corridor at Mōkapu Beach.

B. Scope of Work

The scope of work at the cable landing site at Mōkapu, Maui consisted of the following:

A. A field check of the cable landing site and a corridor - up to one hundred feet wide - from the beach to Wailea Alanui Drive, including the profile of the wave cut bank along the shoreline.

B. A review of previous archaeological studies and historical research in the Wailea area.

Historic Background

A. Natural History

The project area is situated within the traditional land unit of Paeahu ("row [of] heaps," Pukui, *et al.*, 1974) in Honua'ula district on the west coast of East Maui Mountain (Haleakala). The shoreline Paeahu area is hot and dry, receiving annual rainfall of 10 inches to 20 inches, predominantly in the winter months of November through March.

Landform in the area consists of stony, Makena loam of 3% to 15% slope overlain along the shoreline by beach and dune sand deposits. These soils were used for pasture and wildlife habitat. The naturalized vegetation consists predominantly of exotic species of xerophytic trees and scrubs, grasses and a variety of noxious weeds. Remaining native plants include *ilima* (Sida fallax) and *koali* (Ipomoea sp.).

B. Cultural History

Events and activities in pre-contact Paeahu *ahupua'a* are generally unknown. In the post-contact or historic period, summarized by Barrère, the ahupua'a of Paeahu became government lands following the Mahele of 1848 and recipients of Land Commission Awards (*kuleana*) in the *ahupua'a* include nine individuals. According to Barrère the location of these *kuleana* are unknown although some may have been in the upland "Irish potato region" (Barrère, 1975:32).

There are no known references to habitation, agriculture or *kuleana* in the immediate area of the project area, where the active sand dune environment is generally not suitable for agriculture. However, the well developed sand beach and coral growth on the rocky sea bottom would suggest habitation along this coast line in pre-contact times. The presence of burials here is not expected certainly in line with traditional land use patterns.

C. Previous Archaeological Research

A considerable amount of archeological research for the Wailea area has been generated during the past two decades for the extensive development in this region of Maui. In general this research began in the late 1960s when Patrick Kirch (1969) conducted a reconnaissance survey of Alexander and Baldwin property surrouding Wailea. Kirch's survey was followed by piece work all about the Wailea area by Barrera (1974), Cleghorn (1976), Cordy (1977), Schilt and Dobyns (1980), Rosendahl (1981a - 1981e), Walker *et al.* (1985), and Spear (1987).

In 1987 an archaeological reconnaissance and limited subsurface testing (Walker & Haun, 1987) was conducted within the property (TMK 2-1-08:62) that is the subject of this study at Mōkapu beach in Wailea. The subsurface testing included seven (7) coring holes in the sand beach and dune deposit paralleling the shoreline. No cultural deposits were found during this testing. A surface midden scatter along the north edge of the property was tested and determined to be a habitation site remnant and that this work was sufficient to gather all available archaeological data from that site.

Survey Results

The proposed cable landing and corridor (refer to Fig.4) was walked over for its length and inspected for surface sites. No surface sites exist. The mauka portion of the proposed corridor has been bulldozed and is for the most part filled and graded for equipment baseyard and construction field office use. The *makai* end of the corridor at the shoreline has also been bulldozed and graded, thus the dune sand at that locality has been removed and replaced with crushed coral and is being used as a parking area.

Summary and Recommendations

Background research does not indicate the presence of archaeological sites within the proposed fiber optic cable landing site and proposed cable corridor to Wailua Alanui Drive at the *mauka* edge of the subject property. Recent archaeological investigations have, in general, confirmed that where sites may have been they are no longer present. No further archaeological study is recommended based on the disturbed nature of all deposits remaining within the proposed cable corridor.

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Appendix A - Photo Appendix Fiber Optic Cable Landing Site and Duct Line, Mōkapu Beach, Maui

Figure 4 Cable Landing Site at Mōkapu Beach Maui

Figure 5 *Makai* End of Proposed Cable Corridor Facing *Mauka*

Figure 6 Cable Corridor Facing *Mauka* Showing Previously Bulldozed Terrain

Figure 7 Proposed Cable Corridor Facing *Makai* Showing Previously Bulldozed Terrain

Figure 8 *Mauka* Portion of Cable Corridor Showing Graded Area. Facing *Makai*

Figure 9 *Mauka* Portion of Cable Corridor Showing Graded Area. Facing North

APPENDIX J

Archaeological Assessment of the Proposed Fiber Optic Cable Landing Spencer Beach Park, Hawaii

Archaeological Assessment of the Proposed Fiber Optic Cable Landing for Spencer Beach Park, Island of Hawai'i

TMK 6-2-01:8, 6 (por)

by

Douglas F. Borthwick, B.A.
Hallett H. Hammatt, Ph.D.

Prepared for

R.M. Towill Corp.

Cultural Surveys Hawaii
January 1992

Abstract

At the request of R.M. Towill Corp., Cultural Surveys Hawaii conducted an archaeological assessment for a proposed Fiber Optic Cable Landing at Spencer Beach Park, South Kohala, Hawai'i. The assessment included surface survey, sub-surface testing, and review of pertinent literature.

The proposed corridor is situated entirely within the active beach zone of the park.

No surface sites, other than modern beach park-associated structures (cement barbeques and open air showers) are within the proposed corridor. The sub-surface testing indicated that no significant intact, undisturbed (or non-mixed) cultural layer(s) exist within the cable corridor.

Background literature review did indicate that the Spencer Beach Park area w as within the coastal habitation zone of the *ahupua'a* of Kawaihae 2. The beach park is also relatively close (1,500 ft.) to the major religious sites of Pu'u Kohola and Mailekini *heiau* , and thus it would have been part of the late prehistoric/early historic political and population center of the Kawaihae area.

The beach park and its facilities have altered the landscape to a considerable degree which is evident within the portions of the beach that were tested. Based on the shallow beach deposits and observed absence of undisturbed beach strata no further archaeological investigations appear warranted. However, it is recommended that a qualified professional archaeological firm be contracted to be available for on-site inspections in the unlikely event significant cultural material is unearthed during construction.

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A. Project Area Description

Cultural Surveys Hawaii conducted archaeological assessments for four proposed fiber-optic cable landing sites on three of the Hawaiian islands. The proposed sites are located on O'ahu at Sandy Beach Park and Kahe Point Beach Park, on Hawai'i at Spencer Beach Park, and on Kaua'i at the Wailua Golf course.

The assessments were requested by R.M. Towill Corp. and included background research and on-site inspections to determine the potential for encountering archaeological resources at the four proposed cable landing sites. Sub-surface testing was carried out at the Spencer and Sandy Beach Park Sites to gather additional information on stratigraphy.

Individual reports treat each of the proposed cable landing sites. Contained in each report are site-specific scopes of work, field methods, a review of previous research pertinent to the individual landing site, research results, and recommendations for mitigation of existing cultural-archaeological resources.

The proposed Spencer Beach Park Fiber Optic Cable Landing Site (Figs. 1-4) is a narrow (20-foot) corridor within the northern section of 'Ōhai'ula Beach. The corridor is within the active beach zone, including the proposed telephone pole (i.e., Pole #12) terminus.

Spencer Beach Park, named after Samuel Mahuka Spencer who was Hawai'i County Chairman from 1924 to 1944, is located within the district of South Kohala on the dry leeward coast of Hawai'i Island. Average annual rainfall

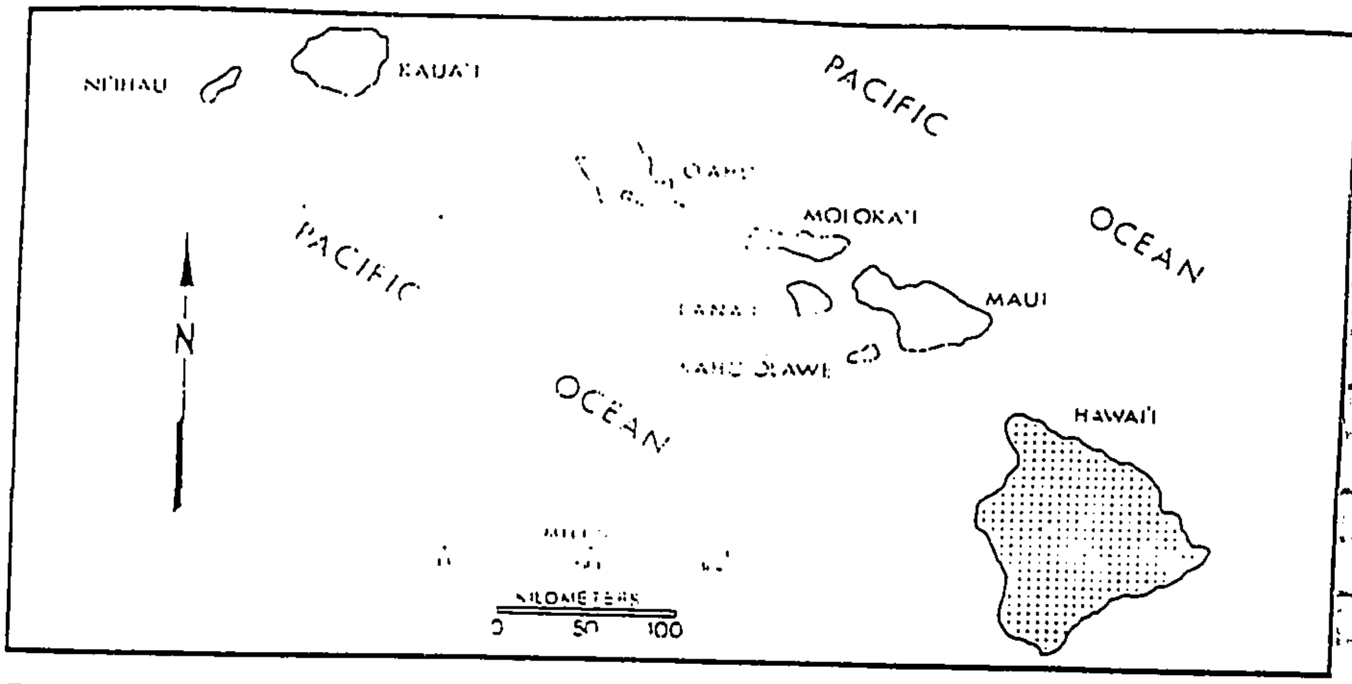

Fig. 1 State of Hawai'i

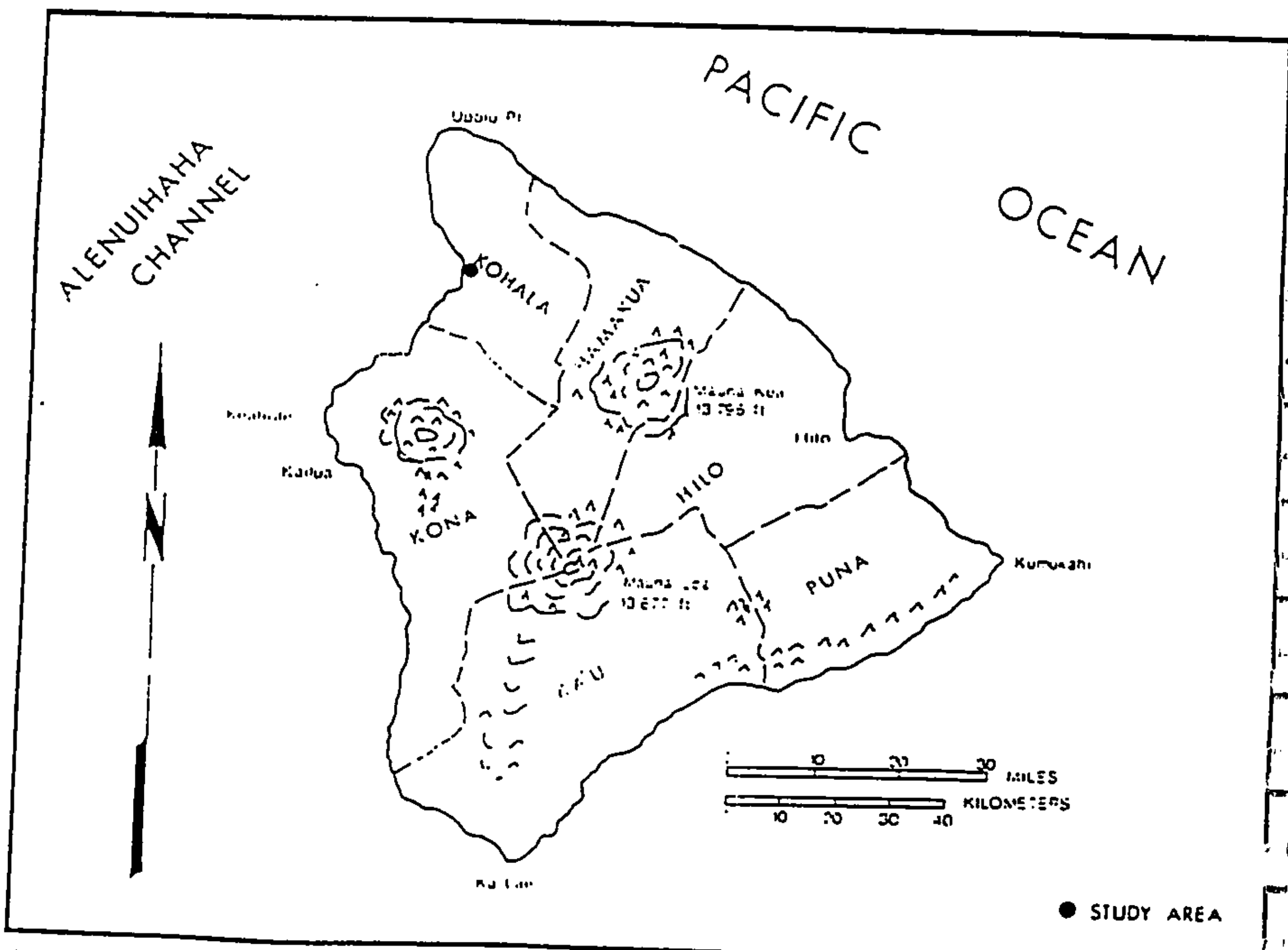

Fig. 2 General Location Map, Hawai'i Island

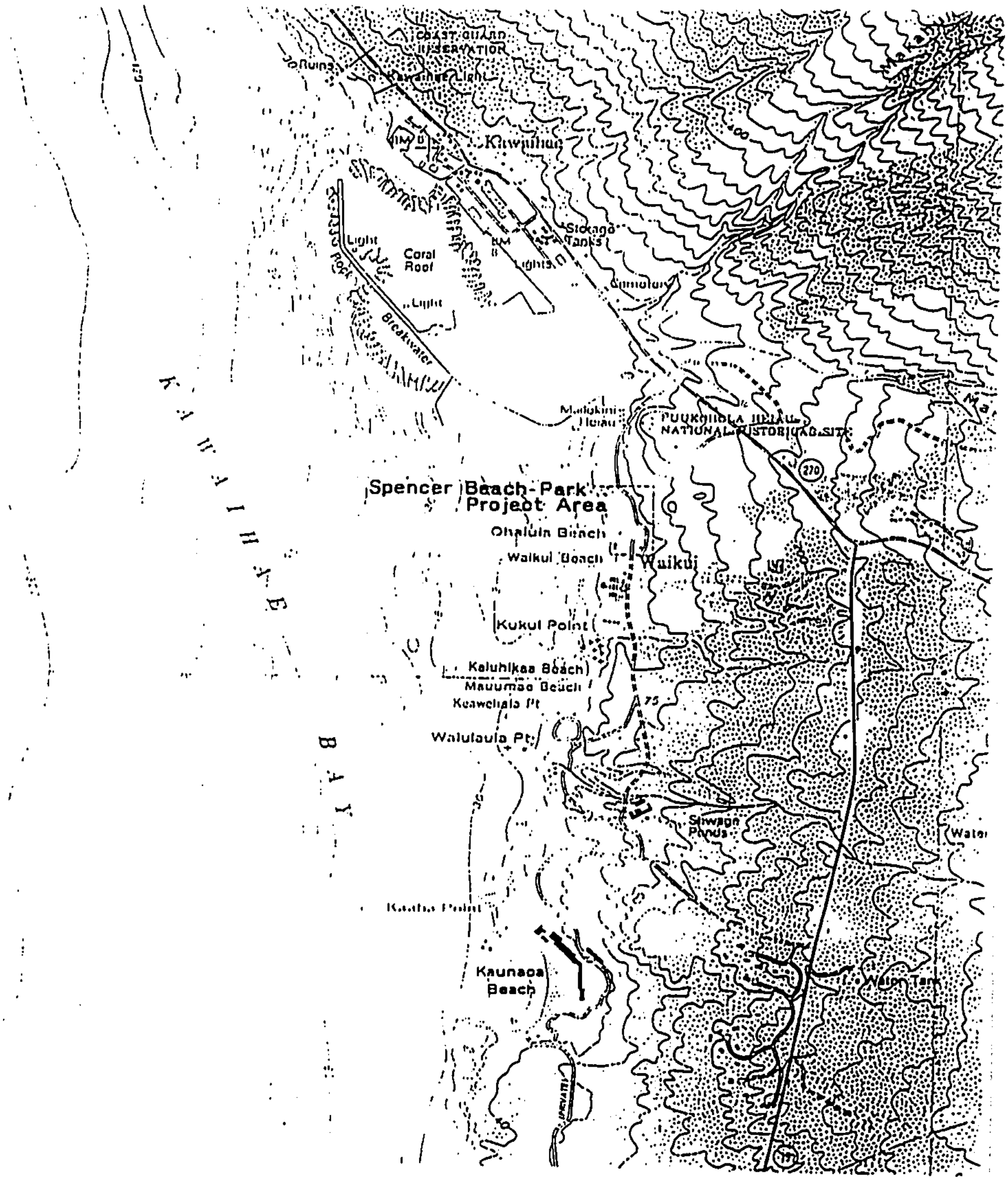

Fig. 3 USGS Kawaihae Quad Showing Proposed Cable Landing Site, Spencer Beach Park

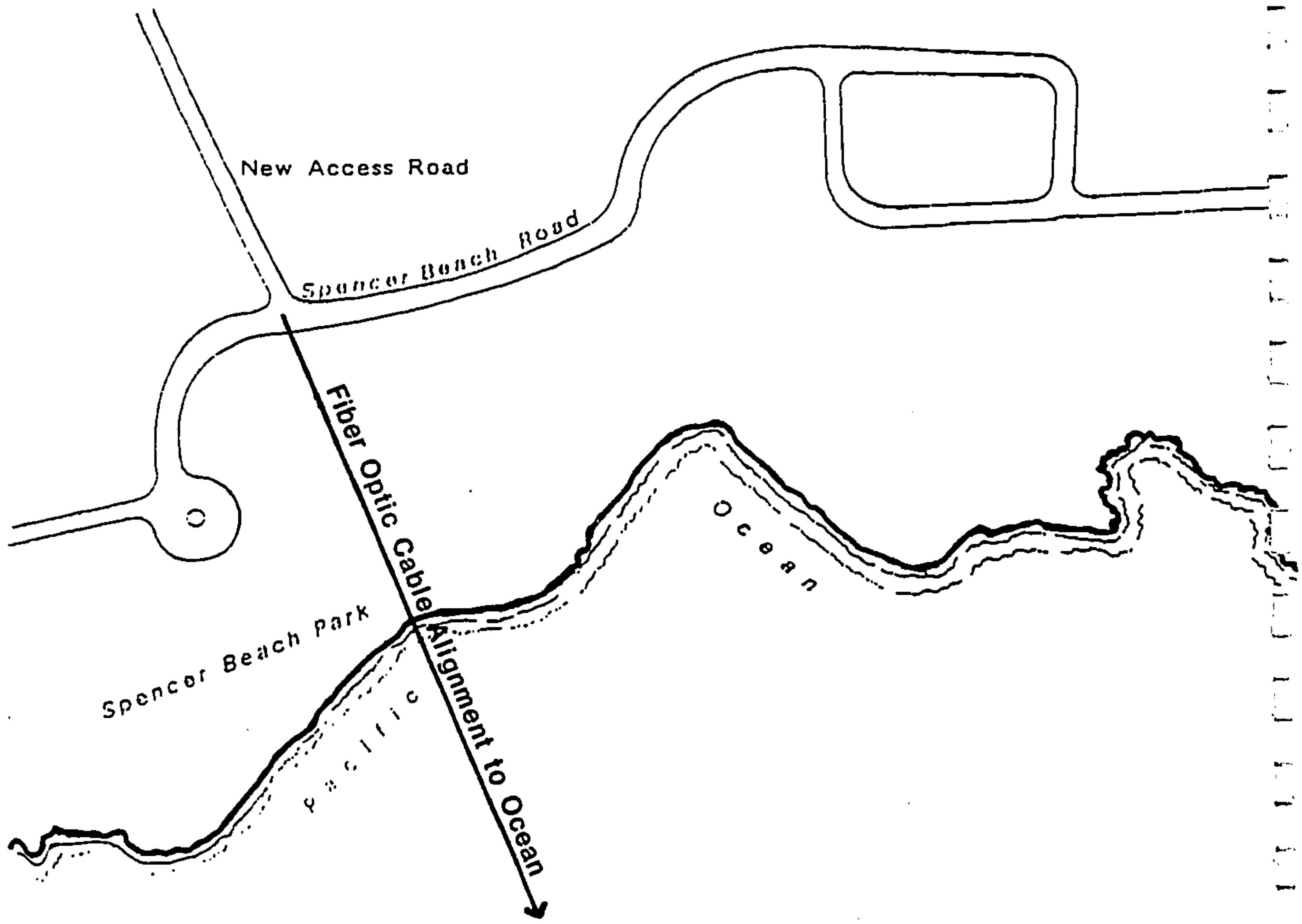

Fig. 4 Project Area Locational Map, Showing Proposed Cable Landing Corridor

is less than 10 inches per year. Soils in the vicinity are classified as aridisols and are part of the Kawaihae series (KNC). These soils are characterized as excessively drained and extremely stony to very rocky (Soil Conservation Service, 1973:6, 51). However, the actual landing site corridor, as mentioned previously, is within an active coralline sand beach which overlies the rocky substrata. The only vegetation along the corridor includes three large kiawe (*Prosopis pallida*) trees growing out of the sandy beach deposits. The place name for the main beach at the Park is ʻŌhaiʻula which literally means "red ʻōhai shrub" (Pukui, Elbert and Mookini 1974:168). The ʻōhai shrub lands are characterized as "lowland dry shrublands which are relatively intolerant to grazing pressure and fire and are replaced by alien dominated communities" (Wagner, Herbst, Sohmer 1990:72). This appears to be the case at Kawaihae as the only known remaining community of ʻōhai is on Leeward Molokai (*Ibid.*)

B. Scope of Work and Methods

Specific to the Spencer Beach Park cable landing site, the scope of work included investigation restricted to beach deposits. Cultural Surveys Hawaii's responsibility is confined to the short section (approximately 100 ft.) from the water line to Pole 11 (see Appendix B). The fiber optic cable would then connect to the existing overhead utility lines.

The corridor (actually the entire beach) was inspected for any surface sites, of which none exist. However, some associated park improvements, cement barbeque pits, picnic benches and open air showers are situated within the active beach zone. Testing of the beach deposits was accomplished by excavation of five test units. The test units were hand dug and the excavated material was screened through ¼-inch mesh screen. Samples were collected of the cultural material present (midden and artifacts). Representative soil profiles and photographs were taken, after which the test units were backfilled.

C. Implications of Previous Research

The Kawaihae area has been the focus of several detailed surveys of the historical and ethnographic record; the reader is invited to refer to these (Kelly 1974; Kelly and Nakamura 1981; Barrere 1983, Clark and Kirch 1983; Clark 1986; and Hammatt et al., 1991) for a more comprehensive overview. There have also been two reconnaissance-level surveys of areas surrounding Spencer Beach Park, both conducted by Lloyd Soehren: one in 1964, the other in 1980.

The previous research suggests that the Spencer Beach Park area (ʻŌhaiʻula and Waikui Beaches) supported at least a few permanent residences. The evidence includes proximity to the major religious and residential area of Kawaihae (Puʻukohola and Mailekini *heiau*), historic maps (Duperry 1819, Jackson 1883, and Loebenstein 1903), and the archaeological record(s).

Spencer Beach Park is located some 1,500 feet south of the *heiau* Puʻukohola and Mailekini. The beach at Spencer Park would have been an excellent canoe landing, offering easy access to these major religious structures.

Kawaihae, in general, had been well-known as a residence of kings. Alapaʻi

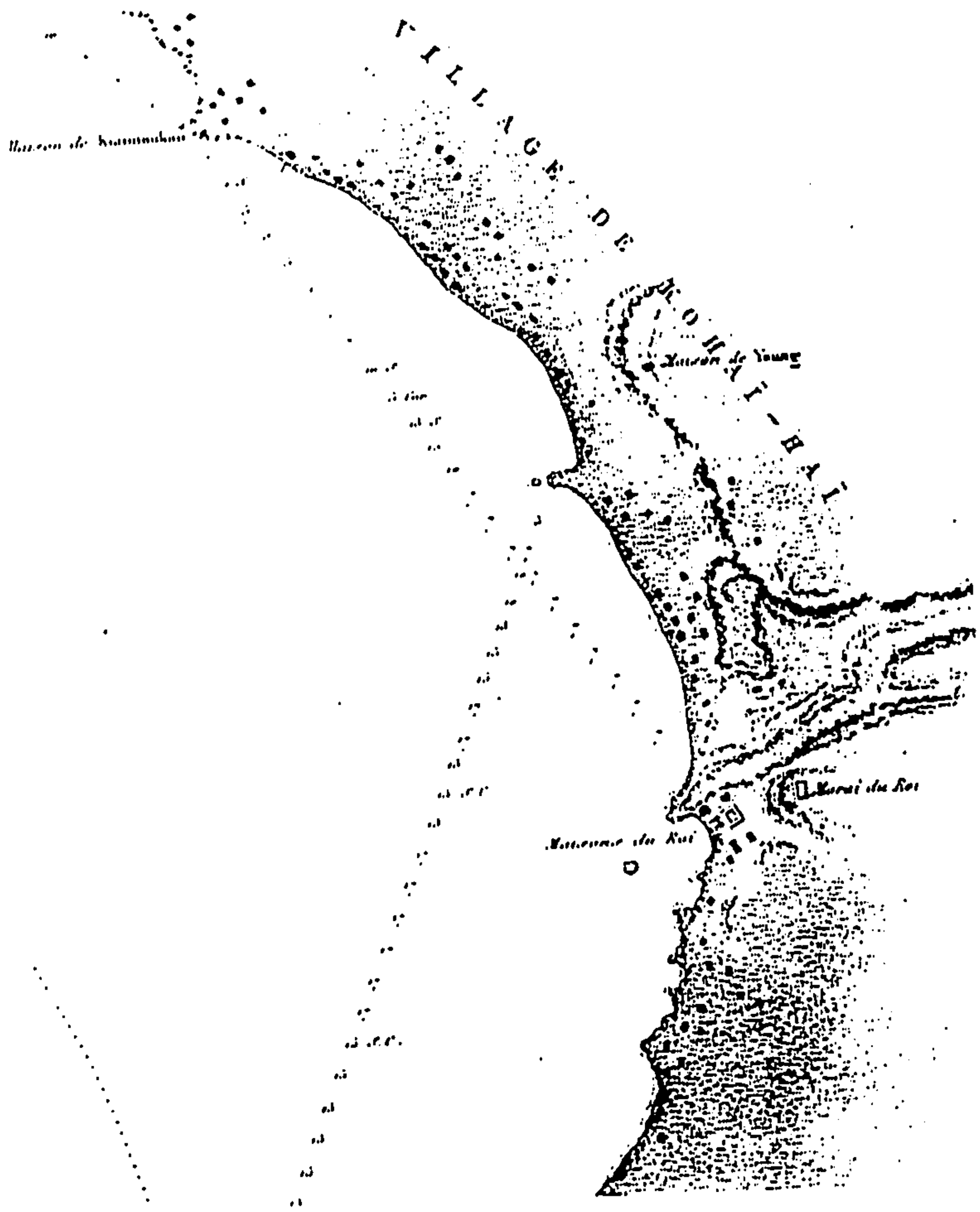

Fig. 5 Chart of the Bay of Kawaihae by Duperry under the French Captain de Freycinet, August 1819

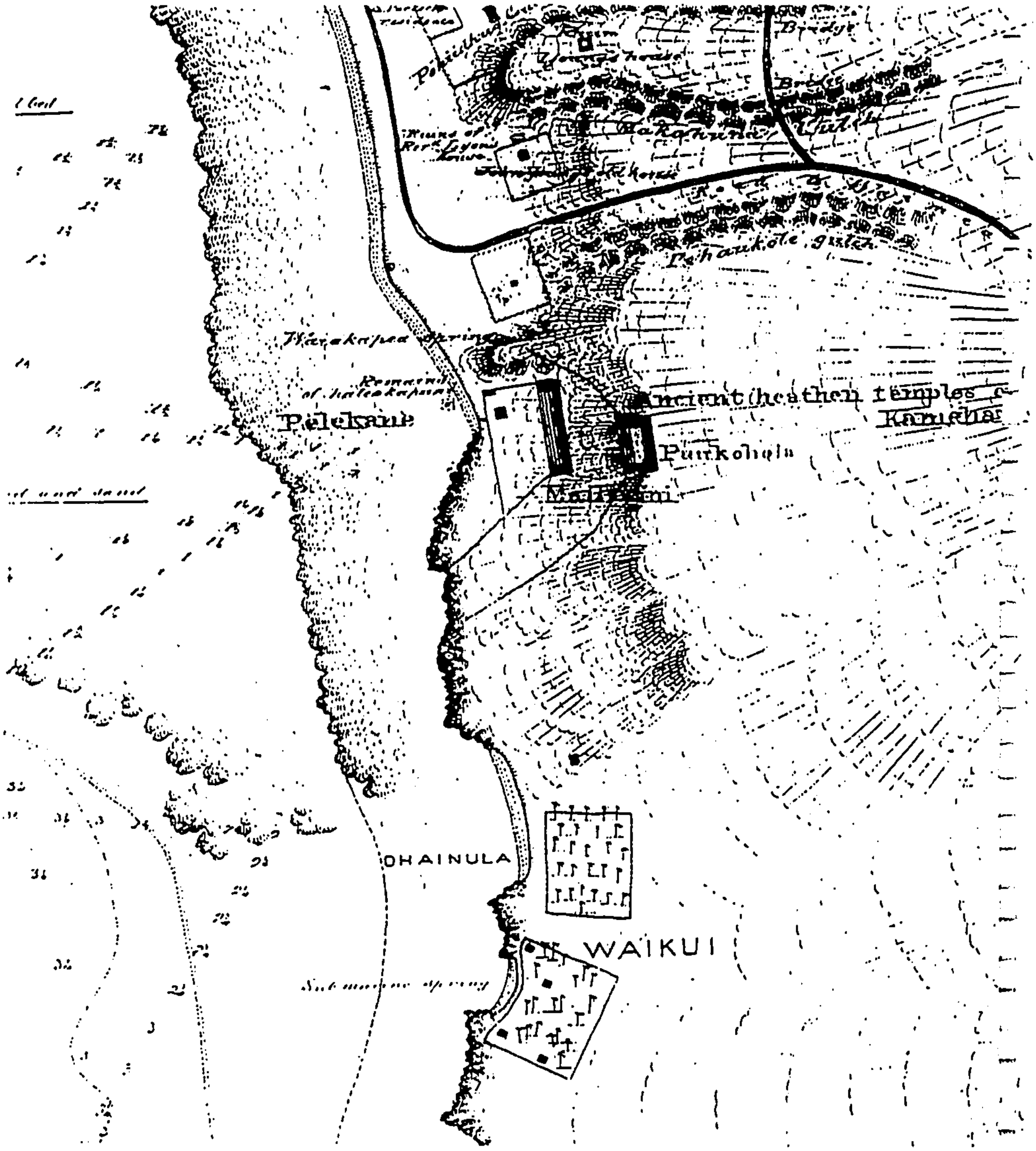

Fig. 6 Portion of Jackson's Map of Kawaihae, July 1883, Showing Spencer Beach Park ('Ōhai'ula) Area

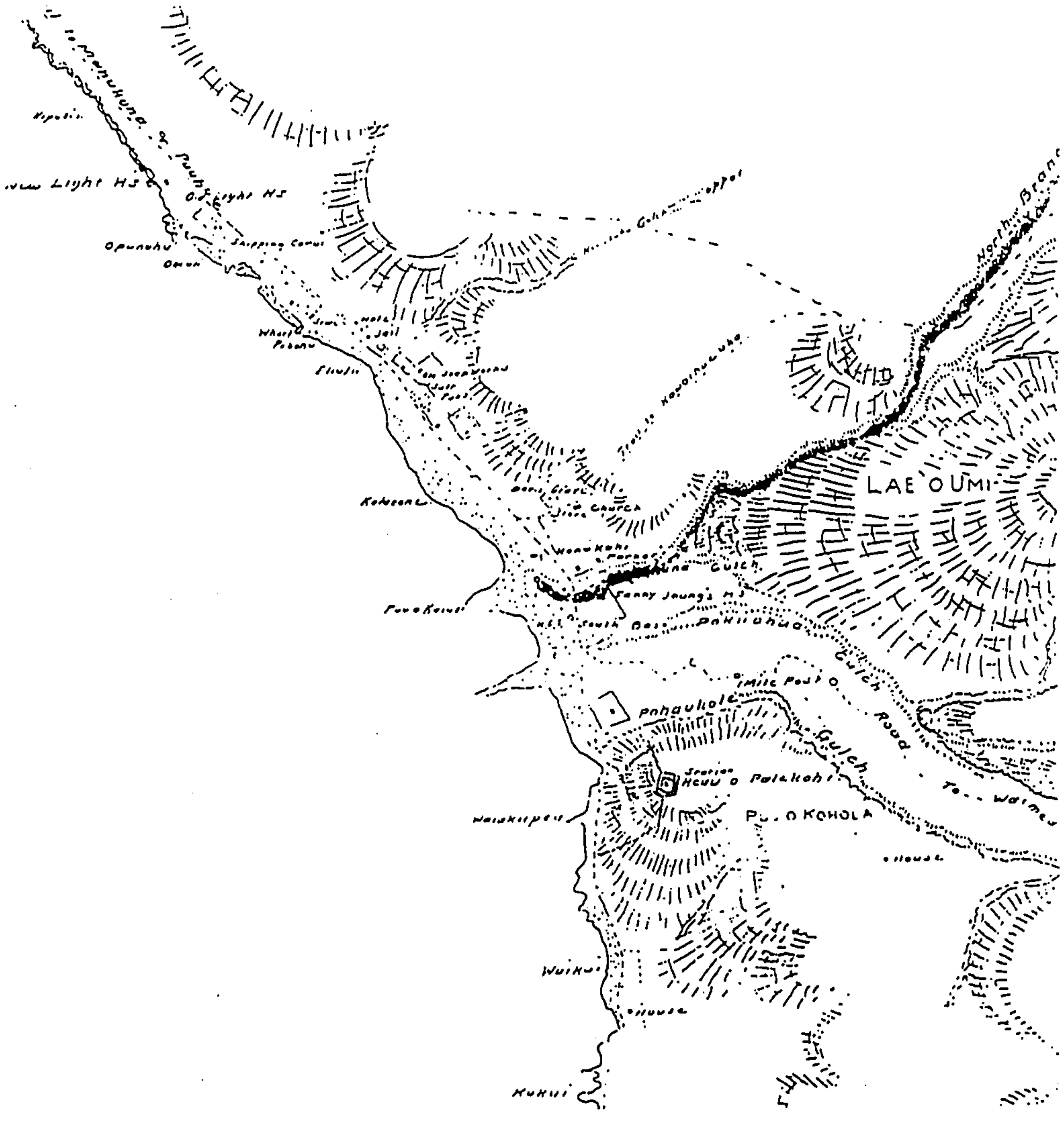

Fig. 7 Portion of Loebenstein's Map of Kawaihae, 1903

moved to Kikiakoʻi in Kawaihae and appointed his son Keaweʻopala to be his successor at Mailekini *heiau* in 1754 (Kamakau 1961:77-78). Kamehameha I and his entourage lived at Puʻukohola during its construction (renovation) *ca.* 1790. After the assassination of Keoua-Kuahuʻula in 1790, Kamehameha I become *aliʻinui* of Hawaiʻi Island and he occasionally "retired to the tabu district of Mailekini below Puʻu Kohola" (Kamakau 19761:350). The Kawaihae coast also included the residences of Kalanimoku (Kamehameha I's treasurer and war leader), Keʻeaumoku (Kamehameha I's general), John Young (Governor of Hawaii, 1802-1812), Kuakini (Governor of Hawaiʻi under Liholiho, Kamehameha II), and was the birthplace of Queens Kalama (wife and half-sister of Liholiho), and Emma (wife of Alexander Liholiho, Kamehameha IV).

In general, the residence of chiefs was below Puʻu Kohola (the "King's Residence" designated State site #50-10-04-2297) in the *ahupuaʻa* of Kawaihae 2 (Hikina) in which Spencer Beach Park is also located. Clearly, the beach of ʻŌhaiʻula (Spencer) would have been intensively utilized in association with these chiefly residences.

A map made during the early historic period (DuPerry 1819, Fig. 5) shows at least seven (7) major structures (*i.e.* permanent habitation sites) along the shore in the vicinity of the present-day Spencer Beach Park. Jackson's 1883 map of Kawaihae (Fig. 6) shows two large walled enclosures within the Waikui area, one with four interior structures. The large enclosures appear to be walled (fenced) coconut groves with associated habitation sites. The 1903 Loebenstein map (Fig. 7), of the same area, shows the same two enclosures, with the southern one containing a house structure. The Loebenstein map also shows the Kawaihae-Puako Trail, of which part later became the "old Kawaihae-Puako Road." The trail is indicated between the enclosures and the beach. This series of maps indicates a fairly large population, *ca.* 1819, which gradually declined over time, but still included permanent habitation into the early 20th century.

Historic occupation and associated agriculture in an area just *mauka* of Spencer Beach Park is reported in Soehren's two reports (Soehren 1964, 1980). These reports discuss the survey of over 400 acres, situated between the coast and Queen Ka'ahumanu Hwy. Soehren reported on over 100 sites that include a wide range of site types. Sites included temporary to permanent habitation features, historic graves, and agricultural features. Historic house sites, graves, and agriculture that Soehren reported were, in part, associated with the Laau family. The reports include information from Michael Laau which indicated that farming in the area utilized both spring water and runoff from streams. Irrigation ditches (*'auwai*) *makai* of Ka'ahumanu Hwy were noted. Michael Laau also related that farming lasted until the end of World War II (*ca.* 1945). Soehren did not record any sites within Spencer Beach Park; the closest site (E5-25 Bishop Museum system) was described as a "well preserved house site...with historic artifacts, located on the slope behind the Spencer Beach Park bathhouse on the east side (*mauka*) of the road" (Soehren 1964).

Archaeological research for the proposed Waimea-Kawaihae Highway included a focus issue of the settlement patterns in the Kawaihae and Waimea areas. This is summarized in Jeff Clark's Ph.D. dissertation (Clark 1986). In his compilation of chronometric determinations, Clark suggests that there was very little occupation at Kawaihae before the 15th century and that

> the dates provide no evidence of an early coastal occupation prior to the settlement of the uplands. In fact, the inland sites are slightly earlier than the dates for the coast, although the difference is probably not significant. (*Ibid.*)

However, it should be noted there are relatively few radiocarbon dates, with the majority of dated sites utilizing volcanic glass.

In general, the previous research indicates that the Kawaihae area contained permanent coastal habitation and major religious sites. The coastal zone in the Kawaihae area may not have been occupied by substantial numbers until the 15th century. The uplands, Waimea area, were also substantially occupied by this time or earlier. Kawaihae, because of its excessively dry climate, was not known for its agriculture and relied heavily on trade from more agriculturally productive lands like Waimea and North Kohala. However, some agriculture was practiced, even into historic times.

Spencer Beach Park itself was developed over a relatively long period of time. The park area, with an existing pavilion, was given to the County of Hawai'i by the Territory of Hawai'i in 1937. In 1969 the "new" stone bath house was completed along with other improvements (Glen Miyao, Hawai'i County Parks and Recreation, per comm. 8/12/92). Park Maintenance Supervisor William DeRego reported that Mauna Lani Resort had recently (1991) finished a stone wall which separates the sand beach from the grassed area of the park. Mauna Lani also deposited "many loads of sand" to increase the sand area. Mr. DeRego indicated that regular high winter surf washes the entire beach area up to the new wall, and went beyond that prior to the Mauna Lani wall. Mr. DeRego also indicated that the old Kawaihae-Puako Road went through the park (sandy area) where the utility poles (*i.e.* poles 11 and 12) are today. The old road, in part, followed an older (pre-historic) Kawaihae-Puako Trail. Portions of this trail are supposed to extend between the park's northern boundary and Mailekini *heiau*, however we did not confirm this as it would be well outside of the proposed corridor.

Survey Results

Five test units were dug within the beach sand deposits of Spencer Beach Park. The test units were dug on the seaward side(s) of utility poles 11 and 12, with Pole 11 as the proposed cable landing terminus. All areas seaward of the utility poles as well as the poles themselves are within the active beach zone.

All test unit excavations revealed similar stratigraphic profiles. The stratigraphy clearly indicated mixed strata due to both mechanical and wave action. Test units were 50 cm. squares which averaged 50 cm. deep. The stratigraphic sequence includes four (4) strata (I, II, III, and IV) with one trench containing a fifth stratum.

Strata I and II were very pale brown to white medium to fine coralline sand. Based on informant information Stratum I is of recent deposition, associated with Mauna Lani Resort construction activities. Stratum II represents ʻŌhaiʻula beach sand.

Stratum III consists of a mixed layer of beach sand and dark reddish brown gravelly sandy loam soil. Mixing has created a mottled, marbled, and bedded sand layer which contains historic artifacts, waterworn pebbles and cobbles, and what appears to be shell midden. The midden component is difficult to distinguish from the mix of naturally occurring waterworn shell component in this mixed layer. However, the occurrence of historic era artifacts, including fragments of what appears to be Budweiser Beer bottle glass, indicates considerable mixing which is probably due to both wave and mechanical action. Mechanical activities would have included intensive land grading and construction for the park and park facilities with high surf action mixing into existing sand layers. After such activities wave action and purposeful sand redeposition would have restored the beach sand as a clearly definable surface layer. As noted previously, cement barbeques, and showers with underground water lines exist within close proximity to the proposed cable corridor and this probably also attributed to the mixed layering.

Stratum IV consists of very dark brown to dark reddish brown gravelly sandy loam which directly overlies bedrock. No artifacts or midden were observed in this layer which essentially becomes the soil matrix in which the uppermost bedrock boulders sit. The bedrock layer includes a conglomerate of angular to rounded basalt gravel (pebbles to boulders) that can, with much effort, be broken loose, exposing a pahoehoe substrata (*i.e.*, actual bedrock).

The testing revealed that the beach deposits within the proposed cable corridor are generally shallow (average 50 cm.), indicating insufficient depth for human burials, besides being in the active beach zone. Stratigraphically, the testing indicated no intact undisturbed cultural layer(s), though cultural material was present within mixed strata. Cultural material present included historic era artifacts and a midden component. In some cases both the artifacts and midden showed evidence of being reworked by wave action as marine shells and some glass fragments were water-rounded.

Summary and Recommendations

No significanct archaeological resources were observed within the proposed fiber optic cable landing corridor in Spencer Beach Park. The corridor is within the active beach zone of the park and when the cable is attached to Pole #11 it will become part of the existing overhead utility lines (see Appendix B).

Background research indicates that the Spencer Beach Park area (‘Ōhai‘ula/Waikui) was part of the coastal Kawaihae 2 residential zone from pre-historic times (*i.e.*, pre-1778) and well into historic times (*ca.* 1945). The *ahupua‘a* of Kawaihae 2 which contains the *heiau* of Pu‘ukohola and Mailekini was given to heirs of John Young at the time of the Mahele (*ca.* 1850). Presently, it is part of the Queen Emma Foundation.

The park itself has a long history and much construction and land alteration has taken place, the latest within the last two years. This latest phase of construction and land alteration includes a new access road, seawall, landscaping, and beach sand deposition.

Recommendations

Based on the results of this archaeological assessment which includes survey, sub-surface testing, and review of pertinent literature, it is felt that no further survey or data recovery work is necessary. Clearly, there are no surface sites to be impacted. Subsurface testing indicated shallow sandy and mixed strata which contain some cultural materials of midden and historic artifacts. However, the mixed components, including modern beer bottle glass, water-rounded glass fragments, and marine shells, indicate that no intact, undisturbed cultural layer(s) exist within the active beach zone where the proposed cable corridor is situated.

Though no further research is recommended specific to the corridor examined, any alternative corridor alignment should be investigated.

Cultural Surveys Hawaii does recommend that a qualified professional archaeological firm be contracted to be available for on-site monitoring in the unlikely event significant cultural material is unearthed during construction of the fiber optic cable landing site.

Cultural surveys would also recommend that the National Park Service be notified about the proposed fiber optic cable landing project. Though the project is outside of the National Park's boundary and no direct impacts are foreseen, notification would allow for any of their concerns to be addressed. These concerns could include possible impact to *Hale o ka Puni Heiau,* from a submarine cable. This heiau is situated just offshore in waters fronting *Mailekini Heiau* (see Figure #13).

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Appendix A - Photo Appendix Fiber Optic Cable Landing Site
(Beach Area)

Fig. 8 Spencer Beach Park Pole #12 in Foreground, Pole 11 in Background (View to North)

Fig. 9 Photo Showing Pole 11, Proposed Cable Landing Terminus (View to West)

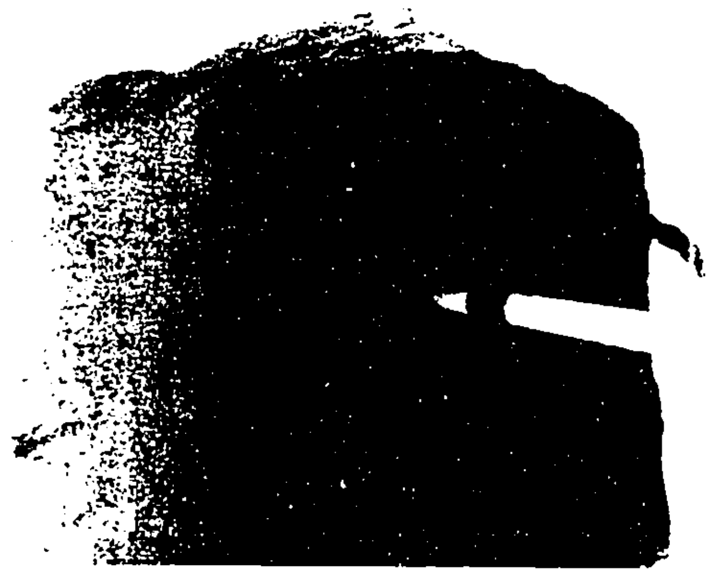

Fig. 10 Stratigraphic Profile showing Beach Sand Overlying Mixed Layers and Bedrock Bottom

Fig. 11 Typical Stratigraphic Profile of Test Unit Within Spencer Beach Park

Appendix B - Proposed Underground Ductline
Spencer Beach Park to Akone Pule Hwy

Cultural Surveys Hawaii was requested to assess the potential impacts to archaeological resources for a proposed underground fiber optic cable duct line at Spencer Beach Park. The proposed duct line will extend eastward, from utility pole #11 (Fig. #4) through the park, then within the newly completed Spencer Beach Park Access Road right-of-way to Akone Pule Highway (Fig. #12). The request for this assessment was made after both fieldwork and the original report were completed. To address the additional request it was decided that an addendum section dealing specifically with the duct line would be sufficient.

The proposed duct line will traverse through heavily graded portions of Spencer Beach Park and new access road. The park area through which the duct line will be excavated has been graded and planted in grass. The grading cut on the mauka (eastern) side of the park is up to 6 feet.

The duct line will then stay within existing road right-of-ways, adjacent to the edge of asphalt pavement. The roadways include a portion of the "old" access road immediately adjacent to the park, then an approximately 2,000 foot long section within the newly constructed Spencer Beach Park Access Road.

The new access road was constructed so that the existing road, between *Mailekini* and *Pu'u Kohola Heiau*(s) can be shut down and the roadway be incorporated into the *Pu'u Kohola Heiau* National Historic site complex.

Archaeological surveys had identified six sites within the new access road right-of-way (r.o.w.). These six sites were the subject of archaeological test excavations in February 1989 (Carter 1989).

In summarizing the findings and assessing the individual sites after the test excavations, Carter states:

"The objectives initially proposed by Gary Somers have been met for this project. Based on surface data it was impossible to assess the significance of these features. Therefore, test excavations were conducted to obtain additional data to make such an assessment. The results of the test excavations demonstrated that Features T1, T2, T3 and T4 were important for their informational content and that Features T5 and T6 were not significant. In the process of determining that Features T1, T2, T3 and T4 were likely to yield information important in prehistory or history, however, that potential was realized and the information was adequately recorded. Therefore, they are no longer significant. Since Features T5 and T6 were not significant and Features T1, T2, T3 and T4 are no longer significant, no further data recovery at these features is warranted." (Carter 1989; 23,24)

Based on the above information concerning the new access road r.o.w., and our observation of major land modifications associated with Spencer Beach Park and existing "older" roadway(s), Cultural Surveys Hawaii does not anticipate any impact to archaeological resources within the proposed duct line corridor. However, a finalized corridor has yet to be determined. Therfore we recommend that a survey of the cable route take place, after the route has been determined and staked (surveyed) on the ground.

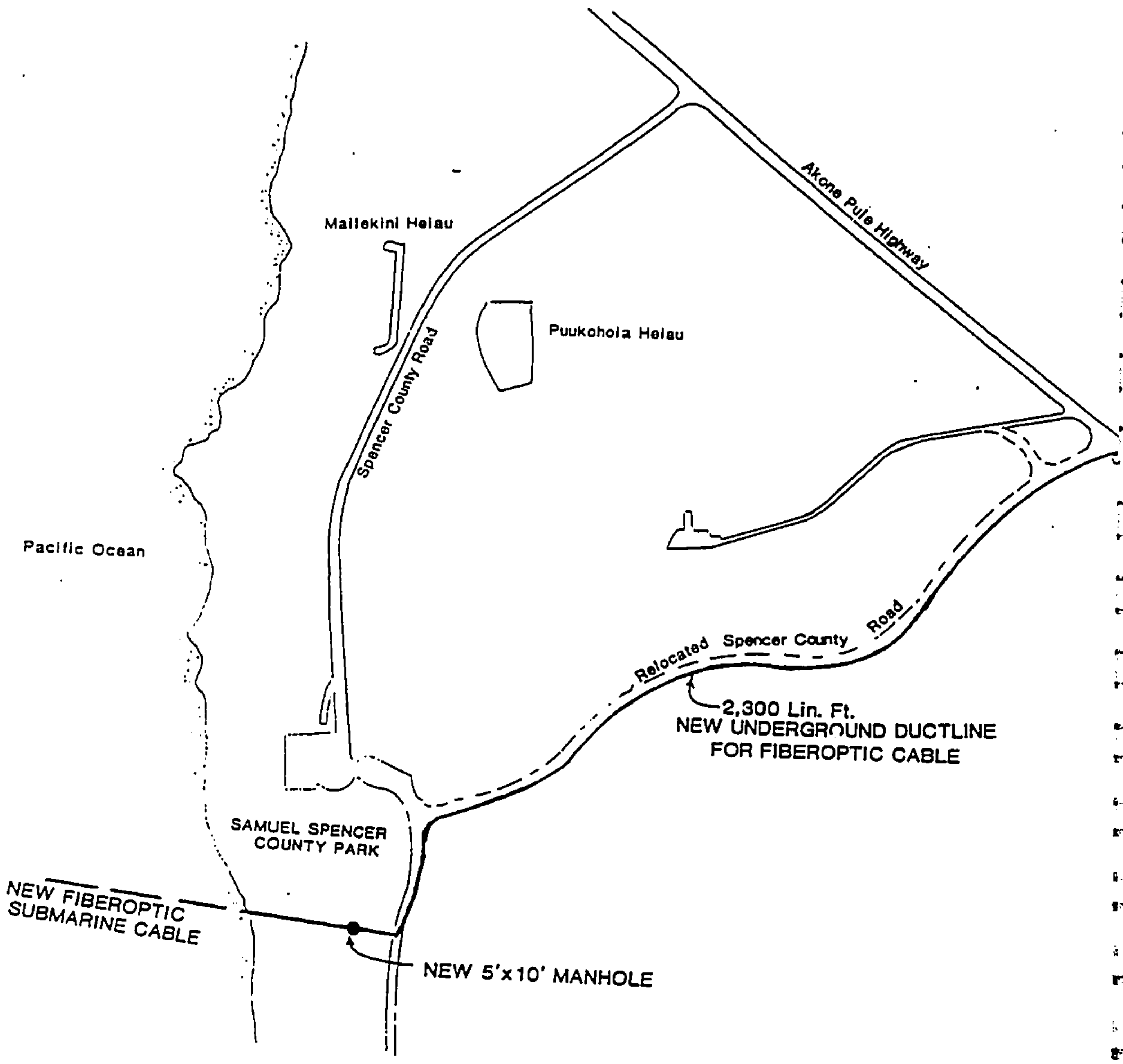

Fig. 12 Proposed Duct Line Route, From R.M. Towill Corp.

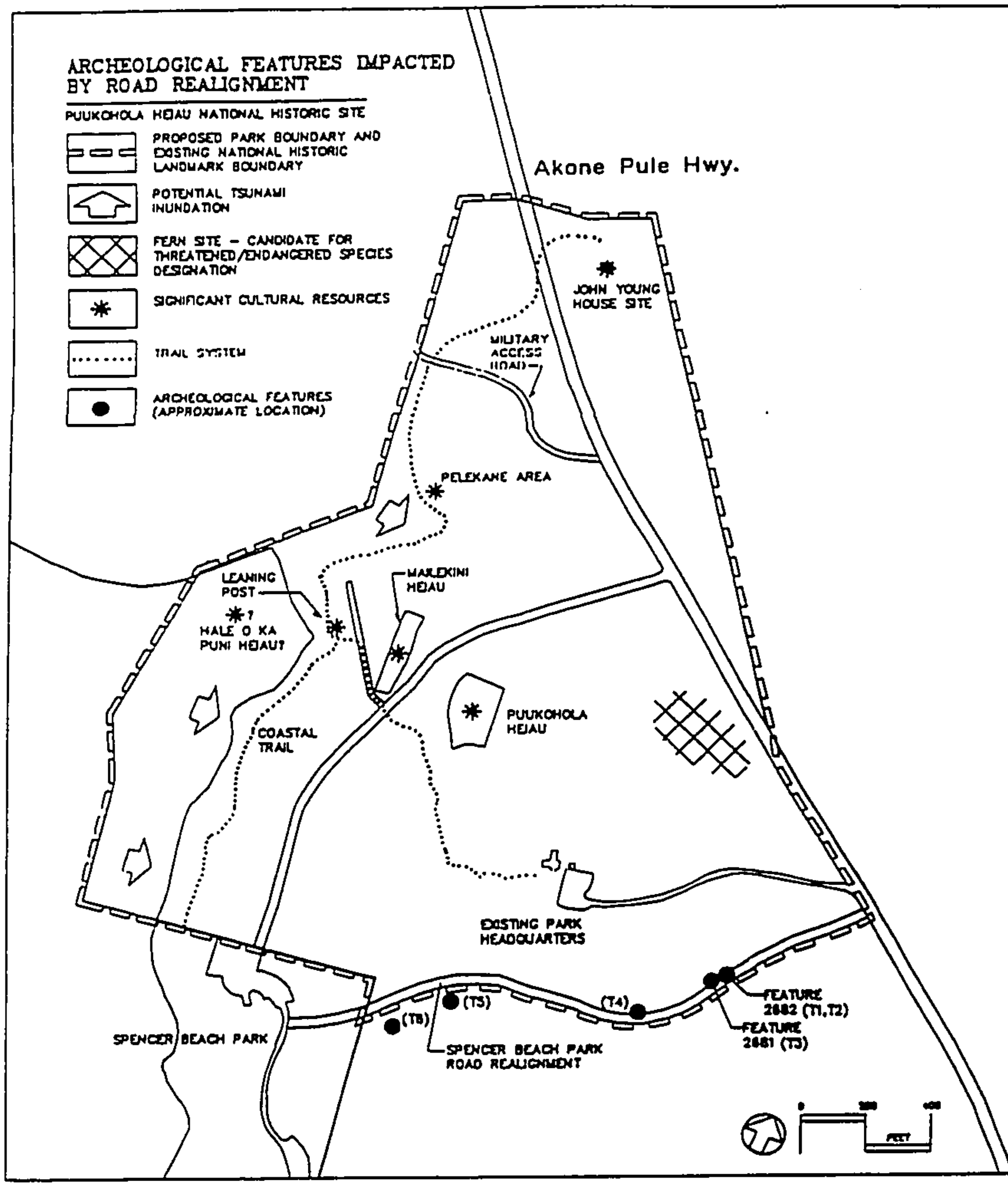

Fig. 13 Archaeological Sites Impacted by New Spencer Beach Park Access Road and Showing Major Sites and Boundary for *Pu'u Kohola Heiau* National Historic Park (From Carter 1989: Figure 2)

CULTURAL SURVEYS HAWAII
Archaeological Studies

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July 19, 1992

Mr. Brian Takeda
R.M. Towill Corporation
420 Waiakamilo Road, #411
Honolulu, HI 96817

Subject: Field Inspection of Spencer Beach Park, for Fiber Optic Cable, South Kohala, Hawai'i Island

Dear Sir:

Cultural Surveys Hawaii conducted, at your request, a field inspection for the newly proposed Fiber Optic Cable route at Spencer Beach Park, South Kohala, Hawai'i Island. Cultural Surveys Hawaii had previously completed the archaeological assessment for the Spencer Beach Park Cable landing site (Borthwick and Hammatt, January 1992). However, subsequent to the completion of that report changes in the actual route or cable corridor have been proposed.

The newly proposed corridor is to be located approximately forty (40) feet north from the previously assessed corridor. The new corridor, like the original corridor, will include the landing site within the sandy beach deposits of the park, then traverse through the grassy lawn area (as an underground duct line), then as an approximately 2,000 foot long underground duct line within the new Spencer Beach Park access road right-of-way to Akoni Pule Highway.

During the original assessment five (5) test units were excavated within the sandy beach deposits at the park. No intact (i.e., undisturbed) cultural layers were observed. The excavations indicated that the beach deposits were generally shallow (average 50 cm.) but did contain some midden and artifacts. However, the cultural materials observed included modern bottle glass, some of which was water-rounded, indicative of an active beach where wave action regularly reworks the beach deposits. The mixed strata observed was also indicative of the amount of land alteration that has taken place at Spencer Beach Park, the latest (wall building and new sand deposition) within the last two years.

The grassy lawn area of the beach park was not tested during the assessment as existing overhead utilities lines were to be utilized. Though the degree of land modifications (major grading and underground utilities) appear to preclude the existence of any intact sub-surface cultural deposits within the park lawn, affirmation of this assumption is neccessary.

The proposed duct line within the newly completed park access road right-of-way does not pose a threat to any archaeological resources. The access road was the subject of archaeological survey and excavations after which all previously recorded sites (total of six) within the right-of-way were deemed no longer significance (Carter 1989:23,24). Presently no sites exist in the graded and filled right-or-way.

In summation, we do not anticipate any significant sub-surface cultural remains to be impacted by the newly proposed Fiber Optic Cable landing and duct line. The relocation of the landing area and park associated duct line, some forty feet north of the present original corridor, would appear to place them in areas even more disturbed than the original corridor. The cable landing area, within the beach, is closer to the existing bath house and its associated features (i.e., waterlines, sidewalk, and rock wall). The proposed duct line in the grassy lawn is also closer to the existing underground utility lines (i.e., sewer and electricity) and where the duct line exits the park, there is a cut and filled embankment with a storm drain outlet associated with the newly constructed access road. However no testing has taken place within the new corridor, either within the sandy beach area or on the grassy lawn portion of the park.

Thus, we recommend that after the actual corridor is set, as a staked line, archaeological testing take place prior to any ground disturbance to accurately assess sub-surface conditions.

This letter report should be viewed as an addendum to the archaeological assessment (Borthwick and Hammatt, January 1992) which contains information including project location maps, implications of previously research, historical maps and general recommendations.

Sincerely,

Douglas F. Borthwick
Hallett H. Hammatt, Ph.D.

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Fig. 14 Grassed Beach Park Area, Showing Major Grading Cut on Right Side of Photograph (View to North)

Fig. 15 View of New Access Road Cut (Background) and Associated Beach Park Improvements (View to East)