6852

JOHN WAIHEE
GOVERNOR OF HAWAII

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

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
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File No.: TV-93-3
DOC. ID.: 1955

DEC 30 1992

Mr. Brian J. J. Choy, Director
Office of Environmental Quality Control
220 S. King Street, 4th Floor
Honolulu, Hawaii 96813

Dear Mr. Choy:

Subject: Negative Declaration for Exploratory Well and Geotechnical Boring at the Keahole Generator Station

The Department of Land and Natural Resources has reviewed the comments received during the 30-day public comment period which began on November 8, 1992. We have determined that this project will not have significant environmental effect and has issued a negative declaration. Please publish this notice in the January 8, 1993 OEQC Bulletin.

We have enclosed a completed OEQC Bulletin Publication Form and four copies of the final EA.

Please contact Don Horiuchi at 587-0381 if there are any questions.

Very truly yours,

WILLIAM W. PATY

Encl

1993-01-23-HI-FEA-Keahole Exploratory Well Drilling and Geotechnical Investigation at Generating Station

JAN 23 1993

Keahole Generating Station
North Kona, Hawaii

Conservation District Use Application
(Temporary Variance)
and
Environmental Assessment for Exploratory Well Drilling and Geotechnical Investigations

Applicant:

Hawaii Electric Light Company, Inc.

For submittal to:

Department of Land and Natural Resources

Prepared by:
CH2M HILL

September 1992

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February 1983

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

FOR DLNR USE ONLY
Reviewed by _____
Date _____
Accepted by _____
Date _____
Docket/File No. _____
180-Day Exp. _____
EIS Required _____
PH Required _____
Board Approved _____
Disapproved _____
Well No. _____

DEPARTMENT MASTER APPLICATION FORM

(Print or Type)

I. LANDOWNER/WATER SOURCE OWNER
(If State land, to be filled in by Government Agency in control of property)

Name Hawaii Electric Light Co., Inc.

Address P.O. Box 1027

Hilo, HI 96721-1027

Telephone No. (808) 935-1171

SIGNATURE Karen T. Stebenow

Date 29 September 1992

II. APPLICANT (Water Use, omit if applicant is landowner)

Name _____

Address _____

_____

_____

Telephone No. _____

Interest in Property _____

(Indicate interest in property; submit written evidence of this interest)

*SIGNATURE _____

Date _____

*If for a Corporation, Partnership, Agency or Organization, must be signed by an authorized officer.

III. TYPE OF PERMIT(S) APPLYING FOR

( ) A. State Lands

(x) B. Conservation District Use

( ) C. Withdraw Water From A Ground Water Control Area

( ) D. Supply Water From A Ground Water Control Area

( ) E. Well Drilling/Modification

IV. WELL OR LAND PARCEL LOCATION REQUESTED

District North Kona

Island Hawaii

County Hawaii

Tax Map Key 7-3-49:36

Area of Parcel 14.988 acres
(Indicate in acres or sq. ft.)

Term (if lease) N/A

Section 1

Introduction

1.1 Introduction

This Conservation District Use Application and Environmental Assessment is for exploratory test wells and geotechnical investigations at Keahole Generating Station in the North Kona District of the Island of Hawaii. The project will include exploratory drilling for two injection wells, one supply well, and six observation wells; 20 geotechnical borings located throughout the site for proposed structures; and six percolation tests for a sewage disposal system. The purpose of the exploratory wells, geotechnical borings, and percolation tests is to obtain information that will be used in determining the feasibility of the proposed generating station expansion.

1.2 Project Summary

Applicant and Landowner:	Hawaii Electric Light Company, Inc. (HELCO) 54 Halekauila Street Hilo, Hawaii 96721-1027
Location:	North Kona District, County of Hawaii, Ahupuaa of Kalaoa 1-4, 750 feet mauka of Queen Kaahumanu Highway
Tax Map Key:	7-3-49: 36
Size:	14.998 acres
Existing Land Use Regulations:	State Land Use Classification: Conservation District, General Subzone County Zoning Designation: Open Special Management Area: No
Existing Land Use:	Keahole Generating Station
Approving Agency:	Board of Land and Natural Resources
Request:	Temporary Variance and Conservation District Use Permit
Other Approval:	Commission on Water Resource Management

1.3 Alternatives Considered

The alternative considered was the "no-action" alternative. Under the "no-action" alternative, Keahole Generating Station would continue to operate at its present capacity. There is an immediate need to increase generating capacity for electrical power in West Hawaii by 1994. The Keahole Generating Station has the available area and infrastructure to accommodate the system expansion within the required time frame.

1.4 Agencies Consulted

Agencies consulted in preparing the EA include the following:

- State of Hawaii, Department of Land and Natural Resources, Office of Conservation and Environmental Affairs
- State of Hawaii, Department of Land and Natural Resources, Land Management Division
- State of Hawaii, Department of Land and Natural Resources, Department of Water and Land Development
- County of Hawaii, Planning Department
- Natural Energy Laboratory of Hawaii

The project will be coordinated with Natural Energy Laboratory of Hawaii.

1.5 Determination

In accordance with Chapter 343, Hawaii Revised Statutes (HRS) and Chapter 200 of Title 11, Department of Health, and based on the information and analysis in this Environmental Assessment, the proposed action was determined to not have a significant adverse effect on the environment.

Section 2

Project Description

2.1 Background

In 1973, the Conservation District Use Application (CDUA) for a new electric generating and switching station on the 14.998-acre site at Keahole was approved by the State Board of Land and Natural Resources. The generating capacity approved was three 2.75-megawatt (MW) diesel generators. The following amendments to the CDUA were subsequently approved to provide additional capacity:

- February 1984—two additional 2.75-MW diesel generators
- February 1987—one additional 2.75-MW diesel generator
- September 1988—one 13.75-MW combustion turbine (CT) engine and ancillary facilities

The original CDUA and the three amendments resulted in a total capacity of 30.25 MW at the existing Keahole Generating Station. The developed portion of the generating station site is approximately 3 acres and consists of a generating plant area and a switching station area. The generating plant area has a control house, two switchgear buildings, the six 2.75-MW diesel engines, a 13.75-MW CT, and two fuel oil storage tanks. The switching station area has a switchyard, two transformers, and a cesspool.

HELCO plans to expand its generating capacity from 30.25 MW to 86.25 MW in three phases. Phase 1 would be a 20-MW, simple-cycle CT unit. In Phase 2, a second 20-MW, simple-cycle CT would be added. Phase 3 would convert the two simple-cycle CTs to a combined-cycle unit by adding two heat recovery steam generators and a 16-MW steam turbine generator. Together, these components would constitute a 56-MW, dual-train, combined-cycle unit.

HELCO plans for the Phase 1 20-MW CT to be operational in 1994. Future units will be installed at a later date. The timing of the subsequent units will depend on future load growth and the availability of power from independent producers.

2.2 Project Location

The Keahole Generating Station is located in the North Kona District approximately 1 mile mauka of Keahole Airport and about 750 feet mauka of Queen Kaahumanu Highway, as shown in Figure 1. The project site, Tax Map Key 7-3-49: 36, contains 14.998 acres and is owned-in-fee by HELCO. Access to the generating station from Queen Kaahumanu Highway is from a 16-foot-wide, paved roadway. The project is located makai of the Underground Injection Control (UIC) line.

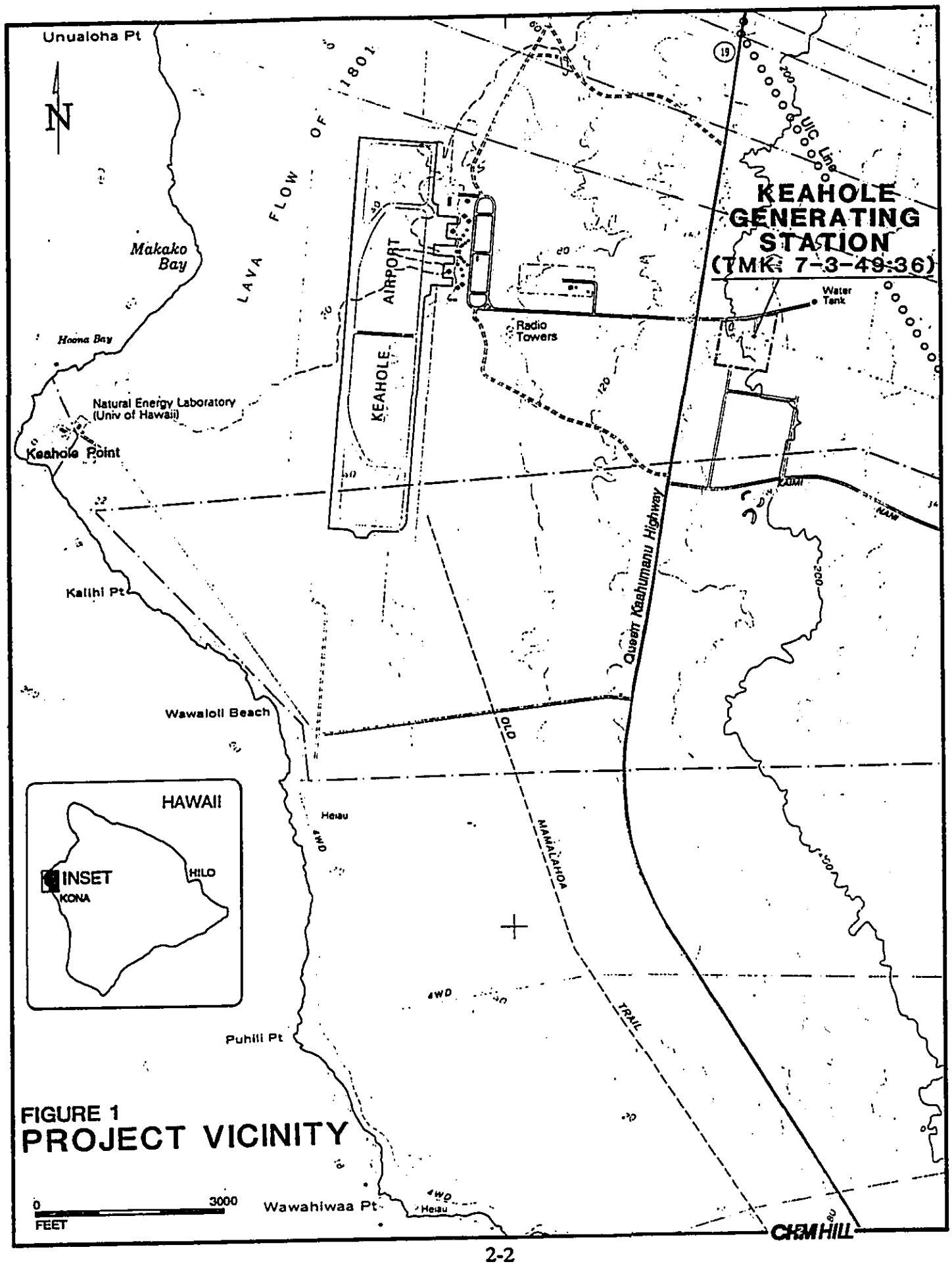

FIGURE 1
PROJECT VICINITY

2.3 Proposed Project

For HELCO to begin operation of a 20-MW combustion turbine in 1994, collection of site-specific data is required. The exploratory wells will be drilled to gather information on groundwater conditions. Geotechnical borings will provide data that will be used in designing the structures. Percolation tests will be performed for designing a sewage disposal system. The locations of the proposed wells, borings, and percolation tests are shown in Figure 2.

2.3.1 Exploratory Wells

The two injection wells will be drilled on the southern portion of the site. The wells will be 10 inches in diameter with a 6-inch casing, and will be drilled to a depth of 500 feet. A cross section of an injection well is shown in Figure 3.

One water supply well will be drilled in the northeastern portion of the site. The well will be 16 inches in diameter with an 12-inch casing and will be drilled to a depth of 265 feet. A cross section is shown in Figure 4.

The injection and supply wells will be tested to obtain data on aquifer characteristics and water quality. This information will be used to determine the ability to withdraw and reinject the groundwater. The wells will be pump tested for a minimum of 72 hours.

2.3.2 Observation Wells

Six observation wells will be drilled on the site. The wells will be 3 inches in diameter; three wells will be drilled to a depth of 300 feet, and three will be drilled to a depth of 500 feet. The observation wells will be used for measuring the level of groundwater. No water will be withdrawn or reinjected.

2.3.3 Geotechnical Borings

Twenty test borings to depths of 20 to 50 feet will be located throughout the project site. They will be primarily located in the vicinity of new equipment and buildings. The borings will be 3 or 4 inches in diameter and will be drilled with rotary or airtrack drilling equipment. After the borings are completed, they will be filled with grout or gravel.

2.3.4 Percolation Tests

The percolation tests involve drilling six holes, approximately 2 to 5 feet deep, filling each hole with water, and measuring the rate of fall of the water level.

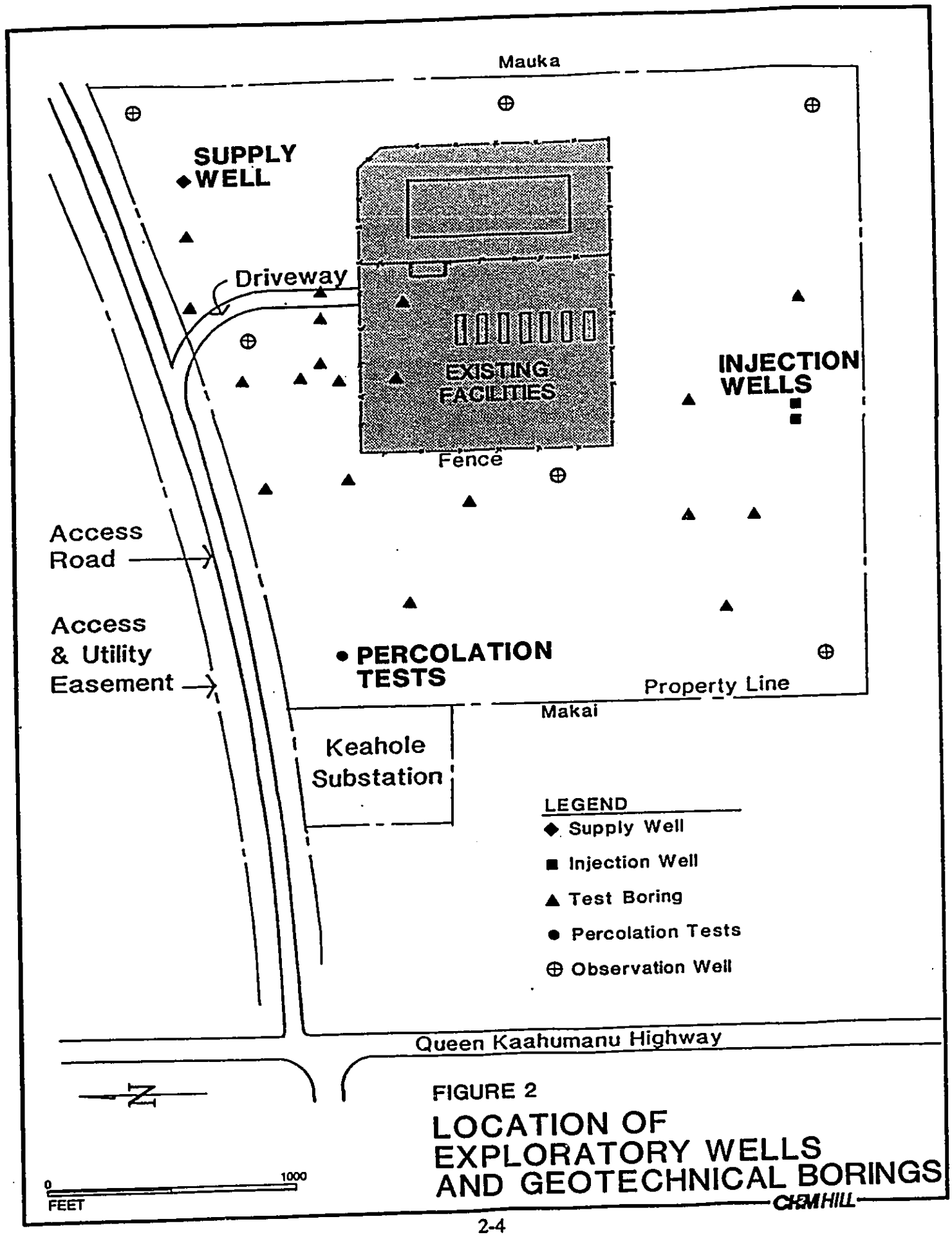

FIGURE 2

LOCATION OF EXPLORATORY WELLS AND GEOTECHNICAL BORINGS

CH2M HILL

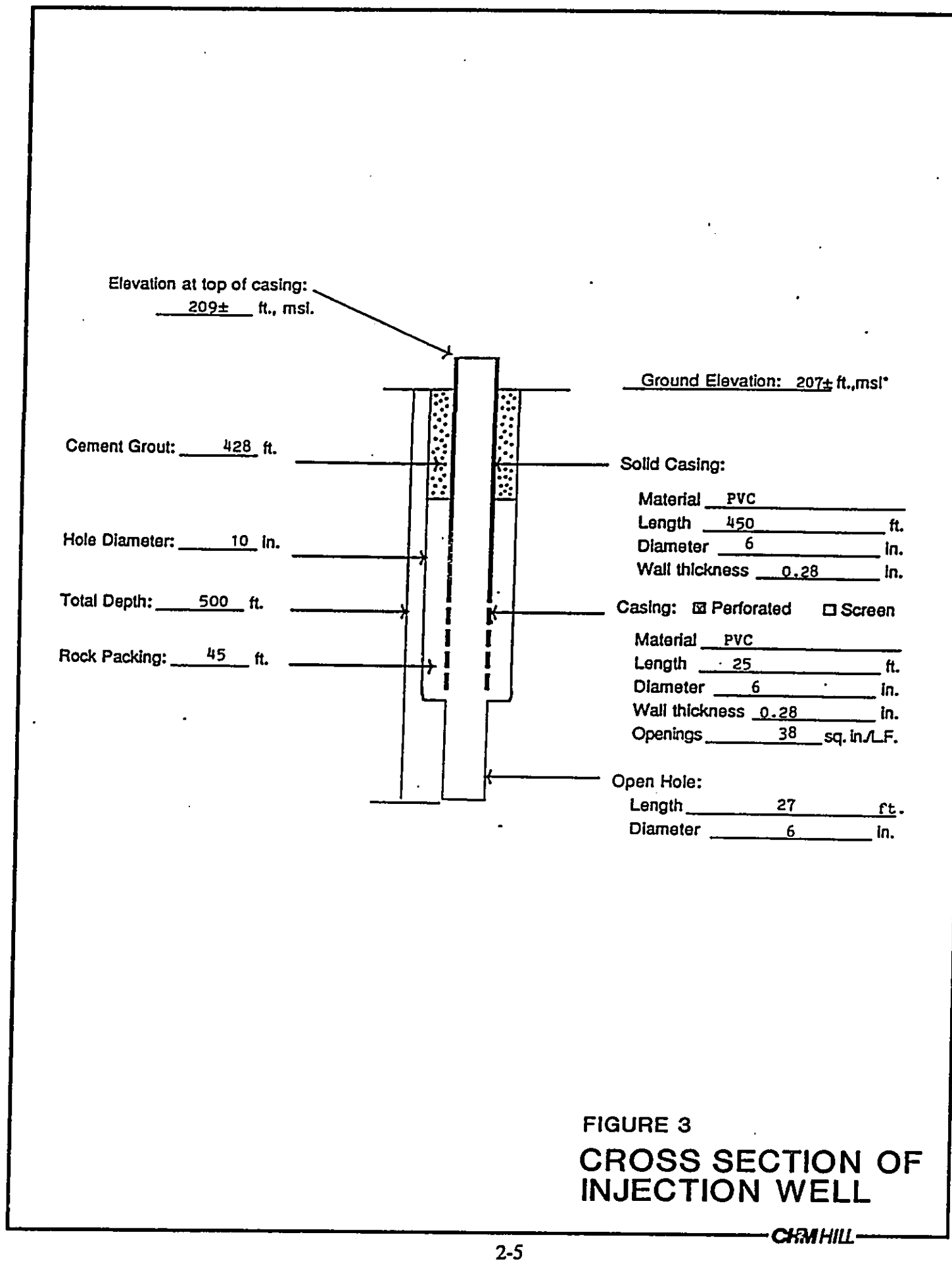

FIGURE 3

CROSS SECTION OF INJECTION WELL

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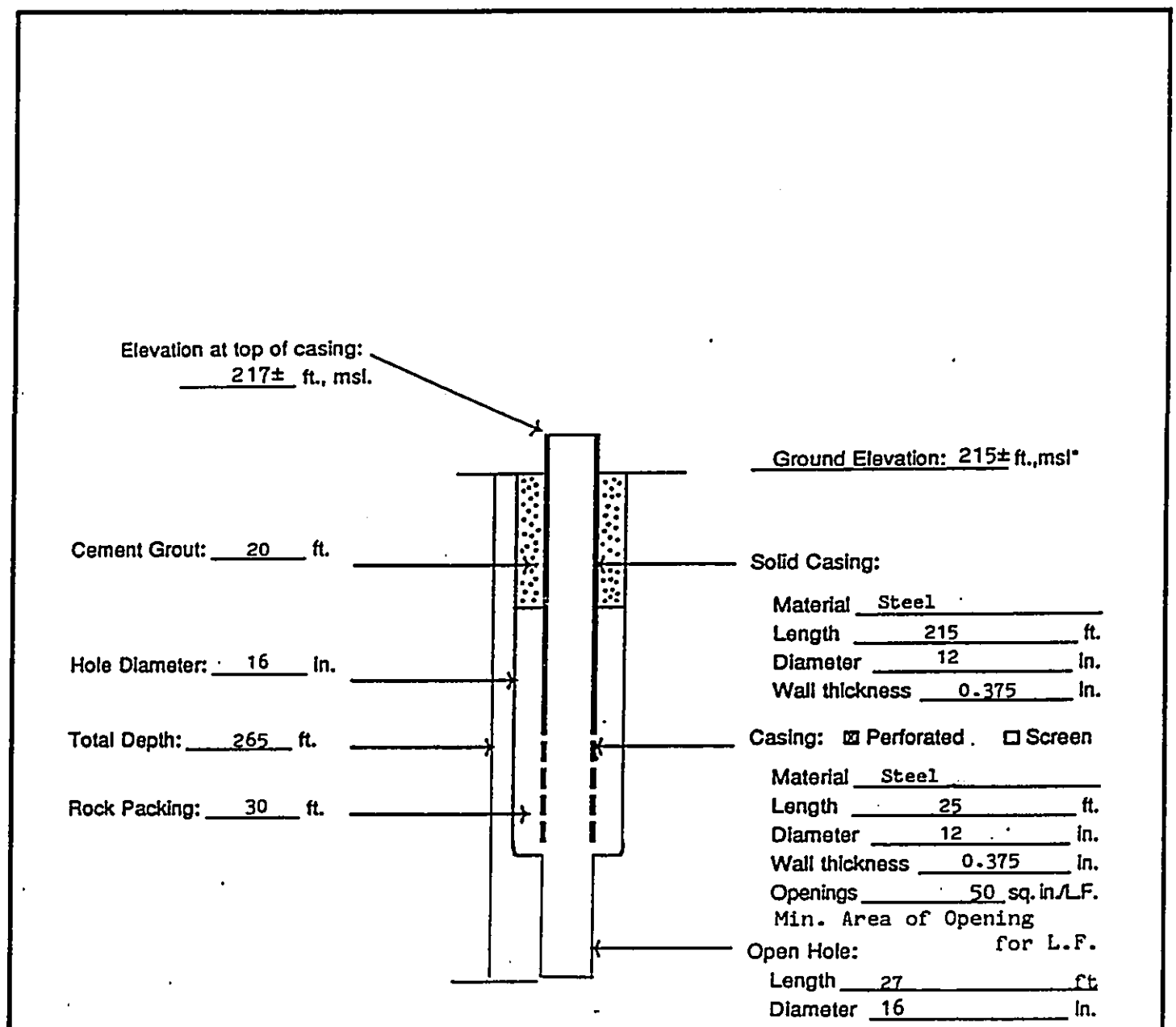

FIGURE 4

CROSS SECTION OF SUPPLY WELL

CH2MHILL

2.4 Project Schedule

One drill rig is expected to be on the site for approximately 6 months to drill exploratory wells and conduct geotechnical investigations. Collection of data is anticipated to take 2 to 3 months. The total elapsed time of the project is not expected to exceed 9 months. The proposed work will start when HELCO receives approval from the Department of Land and Natural Resources.

Section 3

Affected Environment

3.1 Climate and Air Quality

3.1.1 Existing Environment

Topography

The existing Keahole Generating Station is located approximately 1 mile mauka of the Keahole Airport and approximately 1.6 miles mauka of the North Kona coast. The facility is located on a site that ranges in elevation from 190 feet to 230 feet above sea level. The slope of the site is approximately 5 percent. The North Kona coastline is oriented southwest-northeast, and the terrain rises steadily inland to more than 13,000 feet at the peak of Mauna Loa, approximately 20 miles mauka.

Meteorology/Climate

The Island of Hawaii is located in the tradewind band. For most of the year, a clockwise wind circulation results in a large-scale flow pattern over the State of Hawaii that is from the east to northeast. These tradewinds are modified along the North Kona coast.

Wind patterns in the general area of the Keahole Generating Station show a strong diurnal flow for much of the year. Wind direction in the vicinity of the project reverses itself between daytime and nighttime hours. In the afternoon and early evening, air moves inland on a sea breeze that can be brisk. Late at night and very early in the morning, the air drifts back from land to sea.

Average monthly temperatures at the Keahole Generating Station site are expected to range from the low 70s (°F) in the coldest month (February) to the upper 70s in August and September. Annual rainfall at the site is estimated at 10 to 20 inches.

3.1.2 Project Impacts

The exploratory drilling for the test wells and the geotechnical investigations will not have an effect on climate and air quality.

3.1.3 Mitigation Measures

No mitigation measures are proposed or required.

3.2 Soils and Geology

3.2.1 Existing Environment

The Keahole Generating Station is situated on the western coastal slopes of Hualalai Volcano. Hualalai Volcano is a dormant volcano that erupted last in 1801 when pahoehoe lava flowed from two vents along the crest of the volcano. The vents are located along the northwest rift of Hualalai. The northwest rift zone represents the major geologic structure in the area. At its nearest point, the rift is located 4.5 miles northeast of the site. One of the eruptions at the 1,500-foot elevation produced lava flows that spread out along the coast as far south as the Keahole Airport in 1801.

The site is located on the older prehistoric lava flows of Hualalai. The surface consists of aa and pahoehoe lava that slopes to the west in the direction of the coastline. Aa flows normally consist of a surface layer of loose clinker overlying a dense basalt core. The average thickness of aa flows measured on the Island of Hawaii is approximately 15 feet. Pahoehoe lava flows consist of dense vesicular basalt with a ropy or smooth surface.

Aa basalt lava occurs in the northeast portion of the site. Pahoehoe lava flows cover approximately 95 percent of the site surface, including the areas of proposed facility expansion. A characteristic feature of pahoehoe lava flows is the development of lava tubes, which range from a few feet to more than 40 feet in diameter and may stretch for miles in the subsurface. No lava tube entrances were observed at the surface of the site. However, lava tubes are known to exist in nearby pahoehoe flows.

Soil development on the aa and pahoehoe is sparse. Soils, where present, consist of thin accumulations of windblown sand and silt.

3.2.2 Project Impacts

The proposed wells and geotechnical investigations are expected to encounter both aa and pahoehoe lava flows. Either type of formation will be stable for supporting a well structure and conducting the proposed tests, and the testing will not have a significant impact on soils and geology.

3.2.3 Mitigation Measures

No mitigation measures are proposed or required.

3.3 Water Resources

3.3.1 Existing Environment

Groundwater

Rainfall on the upper slopes of Kona above an elevation of 2,500 feet is the source of most of Kona's groundwater. The rainfall, averaging 40 to 75 inches per year, occurs in a 4- to 5-mile-wide mauka rainbelt that is parallel to the coast and centered approximately 4 miles inland. Much of the rainfall percolates quickly into the ground to become groundwater. There is relatively little, if any, runoff to the sea, even during times of heavy rainfall.

Groundwater in the coastal area occurs as a thin, buoyant, unconfined lens of brackish water floating on salt water. Groundwater movement in the aquifer in the Keahole area is believed to be perpendicular to the coast. The project site is located within the Keauhou aquifer system.

Potable Water

The Keahole coastal and mauka areas are served municipal water by the Hawaii County Department of Water Supply. The County water is supplied from groundwater wells and a water shaft.

Brackish Water

Three brackish water wells have been drilled at mid-slopes in the Keahole area. The three wells are currently unused and have chloride contents that range from 740 to 950 ppm.

3.3.2 Project Impacts

Conducting the geotechnical investigations (borings and percolation tests) will not affect groundwater resources. The testing will include 72-hour pump tests for the two injection wells and one supply well, and the water is expected to be disposed of by flowing through the injection well. The exploratory well drilling and testing are not expected to have a significant effect because the amount of water removed and reinjected will be limited to 72 hours of pumping. The water removed will be from the brackish zone. The volume removed will be small in comparison with the groundwater volume.

3.3.3 Mitigation Measures

No mitigation measures are proposed or required.

3.4 Flora

A botanical inventory survey report of the Keahole Generating Station site was prepared by Char & Associates, which is in Appendix A.

3.4.1 Research Methods

A search of the pertinent literature was conducted to determine the extent of other botanical studies conducted in the general area. In addition, topographic maps and a project map were examined to determine terrain characteristics, access, boundaries, and reference points.

3.4.2 Field Survey

A survey of the Keahole Generating Station site was conducted on July 9, 1992. The undeveloped area was intensively surveyed using a walkthrough method. The vegetation on the project site is dominated by introduced species. Native plants, in general, occur as scattered individuals. Species, both indigenous (native to the Hawaiian Islands and elsewhere throughout the Pacific) and endemic (native only to the Hawaiian Islands), can be found throughout West Hawaii and in similar habitats in the Hawaiian Islands.

Two plant communities are located onsite. Substrate on the proposed expansion area consists of undisturbed pahoehoe lava. Low scattered patches of fountain grass and a few shrubs are found on the undeveloped portion of the site. A variety of landscape plantings are located along the outside perimeter of the facility fence. These two plant communities are described in more detail below.

Fountain Grass

Vegetation cover on the pahoehoe flow is dominated by fountain grass. Shrubs are somewhat denser on the southern and eastern portions of the project site. The most common shrubs include the following:

- native caper or maiapilo (*Capparis sandwichiana*)
- 'ilima (*Sida fallax*)
- 'uhaloa (*Waltheria indica*)
- indigo (*Indigofera suffruticosa*)
- koa-haole (*Leucaena leucocephala*)

Less common are the following:

- partridge pea (*Chamaecrista nictitans*)
- *Pluchea symphytifolia*
- Christmas berry (Schinus terebinthifolius)
- noni (*Morinda citrifolia*)
- klu (*Acacia farnesiana*)
- a'ali'i (*Dodonaea viscosa*)

Fountain grass (*Pennisetum setaceum*) and piligrass (*Heteropogon contortus*) are scattered throughout the site. A few smaller herbaceous species were recorded and include coat buttons (*Tridax procumbens*), lovegrass (*Eragrostis tenella*), red pualele (*Emila fosbergii*), and hairy spurge (*Chamaesyce hirta*). In addition, a few clumps of the hairy sword fern (*Nephrolepis multiflora*) occur in the somewhat moister microhabitats found in the larger cracks and crevices on the lava flow.

Planted Area

The area along the outside perimeter of the fence is landscaped. Groupings of cultivated specimens are found on the north, west, and south perimeter. The east perimeter is not planted. The most common ornamental plants onsite are coconut trees (*Cocos nucifera*), two *Erythrina* species, oleander (*Nerium oleander*), and orange and red-colored *Bougainvillea* hybrids, which together provide a visual screen for the facility.

The *Pluchea,* Christmas berry, and the noni grow tall and luxuriant because the landscaped area is irrigated. Also abundant are various grasses and weeds such as Natal redtop grass (*Rhynchelytrum repens*), wild bittermelon (*Momordica charantia*), puncture vine (*Tribulus terrestris*), wild spider flower (*Cleome gynandra*), red pualele (*Crassocephalum crepidioides*), and Spanish needle (*Bidens pilosa*).

3.4.3 Project Impacts

None of the plants inventoried on the site are officially listed as threatened or endangered species; nor are any proposed or candidates for such status. The botanical survey concludes that there is little of botanical interest or concern on the proposed project site. The proposed exploratory wells and geotechnical investigations, therefore, are not expected to have a significant impact on botanical resources.

3.4.4 Mitigation Measures

No mitigation measures are proposed or required.

3.5 Fauna

A bird and mammal survey of the Keahole Generating Station site was prepared by Phillip L. Bruner, Environmental Consultants–Faunal Surveys, which is in Appendix B.

3.5.1 Research Methods

Published and unpublished reports of birds known from similar habitat elsewhere were consulted to acquire a more complete picture of the possible species that might occur in the region of the proposed project.

3.5.2 Field Survey

A bird and mammal inventory survey of the 15-acre Keahole Generating Station site was conducted on July 14, 1992. The survey consisted of a walkthrough of the property and nearby lands. Most of the property is covered in dry grass, and the present fenceline of the electrical generating facility is planted with a variety of introduced trees and shrubs. No wetland habitat exists at this site.

No endemic birds were observed on the survey. The only species that might occasionally occur in this area are the Short-Eared Owl or Pueo (*Asio flammeus sandwichensis*) and the Hawaiian Hawk or 'Io (*Buteo solitarius*). No migratory birds were recorded on the survey. The two most common migrants that may visit this property from September to April are Ruddy Turnstone (*Arenaria interpres*) and the Pacific Golden Plover (*Pluvialis fulva*). No waterbirds or seabirds were found on this property. Ten species of exotic (introduced) birds were recorded during the field survey. Other species that may also occur on or near the property include the following:

- Barn Owl (*Tyto alba*)
- Saffron Finch (*Sicalis flaveola*)
- Yellow-billed Cardinal (*Paroaria capitata*)
- Warbling Silverbill (*Lonchura malabarica*)

One Small Indian Mongoose (*Herpestes auropunctatus*) was observed. Although the endemic and endangered Hawaiian Hoary Bat does occur on the Island of Hawaii, no bats were found during the survey. This species would not likely forage or roost at this site.

No threatened or endangered bird or wildlife species were identified as inhabiting the Keahole Generating Station site.

3.5.3 Project Impacts

No significant impact on bird or mammalian species is anticipated because no waterbirds, endemic birds, unusual exotic birds, unusual concentrations of mammals, and no particularly special or unique bird or mammalian habitats or wetlands were discovered on site.

3.5.4 Mitigation Measures

No mitigation measures are proposed or required.

3.6 Population and Employment

3.6.1 Existing Environment

The population of the Island of Hawaii has been increasing since 1970, and growth is expected to continue into the next century. The population of the County of Hawaii, according to the 1990 census, is 120,317. Projections made by the County of Hawaii in the 1989 General Plan indicate that the population of Hawaii County will increase to between 173,000 and 258,000 by the year 2005.

The growth of West Hawaii has been largely responsible for the increase in the County's population and is closely tied to the visitor industry. In 1970, West Hawaii had a population of 14,472 residents. In 1990, the population reached 43,373, an increase of approximately 200 percent over 1970.

The Island of Hawaii is divided into nine districts and the proposed project would be located in the North Kona district. The County projects that, by the year 2005, 25 percent of the Island's population will be located in the North Kona district, and 46 percent will be living in West Hawaii.

Despite the dominance of tourism in the district's economy, diversified agriculture continues to develop. Coffee, macadamia nut, and avocado farming, as well as ranching, are the major agricultural activities in North and South Kona.

3.6.2 Project Impacts

The purpose of the exploratory wells and geotechnical investigations is to collect data to determine the feasibility of expanding the Keahole Generating Station. The proposed testing and investigations would not induce additional population growth.

The proposed exploratory well drilling and the geotechnical investigations will provide temporary full-time jobs.

3.6.3 Mitigation Measures

No mitigation measures are proposed or required.

3.7 Noise

3.7.1 Background

A noise monitoring study was performed at Keahole Generating Station by Y. Ebisu & Associates in 1990. This study was required as a condition for approval of HELCO'S Conservation District Use Application in 1988 for expansion of the generating station. The CDUA approval for the addition of a 13.75-MW combustion turbine required "that HELCO monitor the noise level at their property line after installation of the mufflers and provide additional noise abatement measures if the noise level exceeds 70 dBA." The results of the study showed that after installation of the mufflers on the diesel generators, the noise level at the property line was less than 70 dBA.

3.7.2 Existing Environment

The existing background noise levels in the vicinity of Keahole Generating Station originate from the diesel and combustion turbine generators and from aircraft at Keahole Airport. Sensitive receptors in the vicinity of the generating station are the homes in Keahole Agricultural Park. As shown in Figure 5, Keahole Airport is approximately 1 mile west of the generating station, and Keahole Agricultural Park is adjacent to the generating station on the west and south boundaries. Keahole Agricultural Park is owned by the State and leased for agricultural purposes. The park is 179 acres and divided into 34 5-acre lots. Thirty-one of the lots are leased. The park is classified as diversified agricultural, and the use is primarily for growing flowers and trees. One residential dwelling unit is allowed per parcel, and there are 21 residences in the park.

In July and August 1992, noise measurements were taken at 30 locations at the generating station site, the property line, and surrounding properties. The locations and measurements are shown in Appendix C. These measurements, together with the 1990 noise readings, were used to develop noise contours for the generating station site and the surrounding area. Figure 6 shows the 75, 70, 65, 60, and 55 dBA noise contours. The 70 dBA contour line is within the HELCO property line. The 65 dBA contour is within the boundary line on the makai (west) and south sides. The nearest existing residences are within the 55 to 60 dBA noise contour lines.

3.7.3 Project Impacts

The wells will be drilled using rotary or cable drilling equipment. The major noise sources of rotary well drilling equipment are the air compressor and its diesel engine, the hydraulic pump and its diesel engine, the hydraulic motor on the drill rig, and the air hammer within the drill bit. The primary noise sources from the cable drilling equipment are the diesel engine and the impact noise from the drill bit.

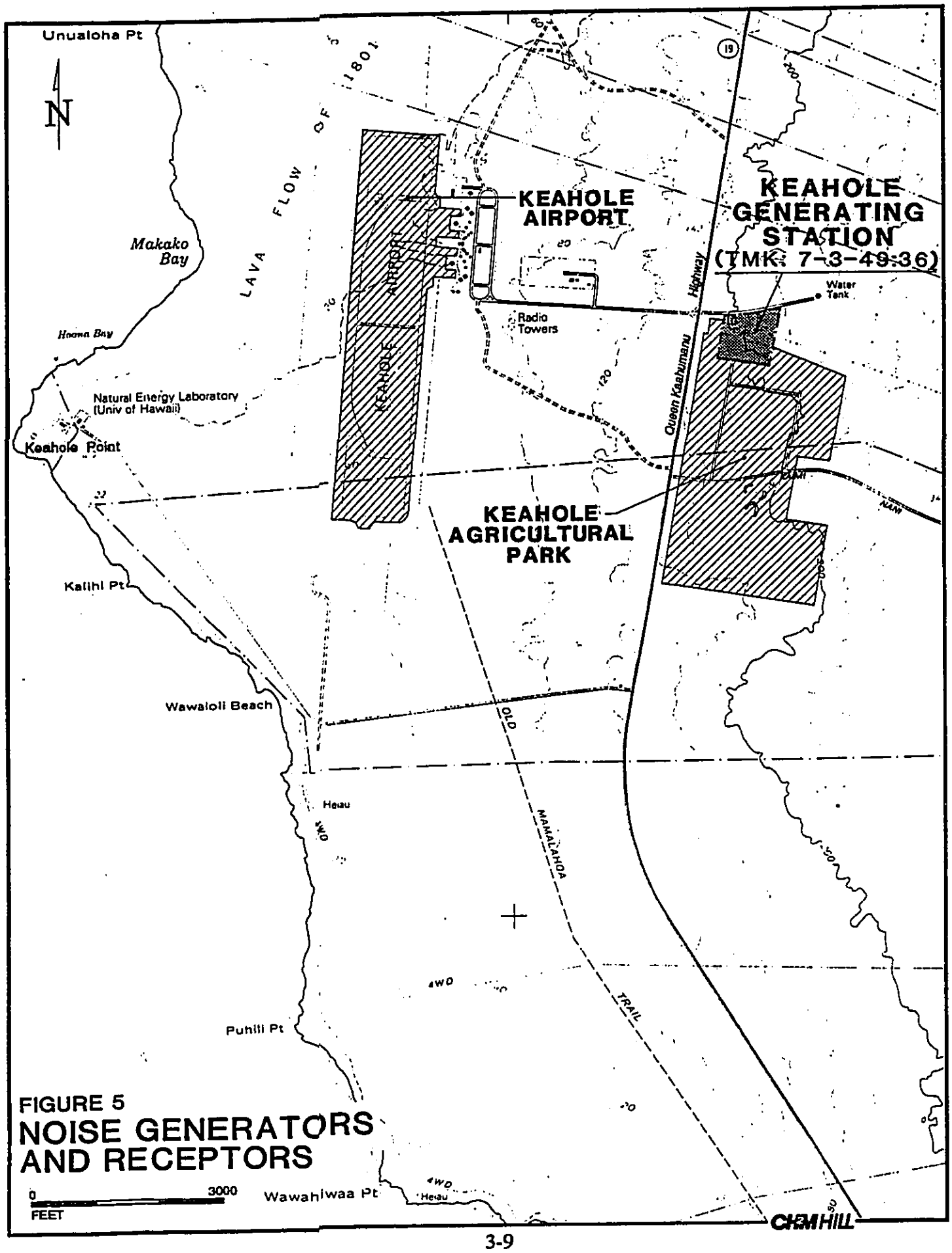

FIGURE 5
NOISE GENERATORS AND RECEPTORS

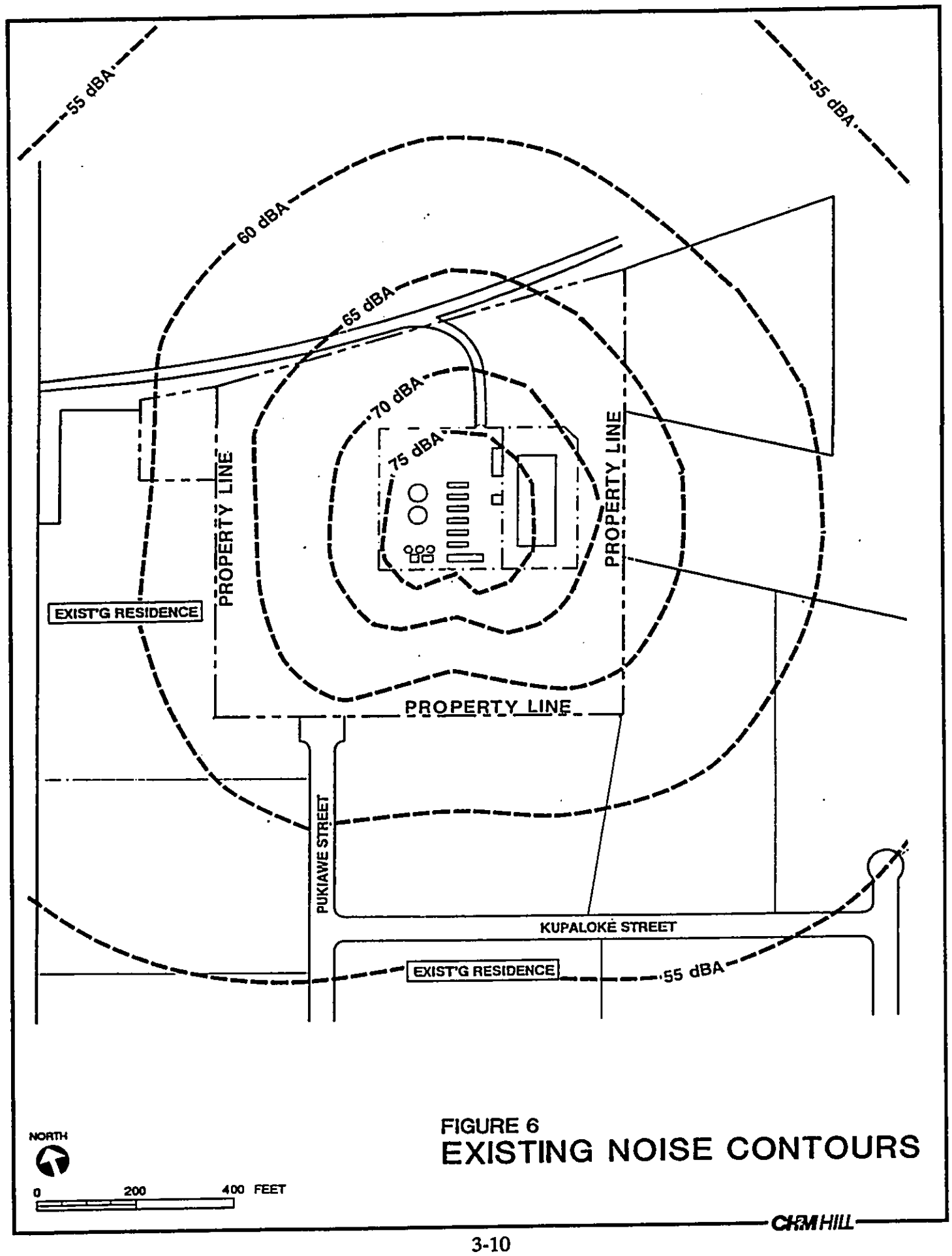

FIGURE 6
EXISTING NOISE CONTOURS

Noise levels for rotary and cable drilling equipment are shown in Table 1. The noise levels of cable drilling equipment are less than those of rotary drilling equipment. Compliance with the 70 dBA noise limit is possible during rotary drilling operations that are located at least 200 feet from the property line. For cable drilling operations, the setback distance from the property line can be reduced to approximately 70 feet.

Table 1
Noise Levels for Rotary and Cable Drilling Equipment

Rotary Drill		Cable Drill	
dBA	ft	dBA	ft
80	70	80	25
75	125	75	40
70	200	70	70
65	350	65	125
60	600	60	200
55	1,000	55	350

Noise sensitive properties that are predicted to experience the highest noise levels during construction activities are the existing agricultural subdivision lots west and south of the project site. Impacts to these properties from construction noise are not expected to be significant due to the temporary nature of the work and the requirement that the noise level not exceed 70 dBA at the generating station's property boundary.

3.7.4 Mitigation Measures

The following mitigation measures are included:

- Properly muffled construction and testing equipment will be used.
- Noise limits of 70 dBA at the property line will be met.
- If 24-hour well drilling operations are required, it is suggested that drilling equipment noise levels be limited to approximately 65 dBA (the FHA/HUD noise standard) at the noise sensitive residences near the generating station.

3.8 Archaeological and Cultural Resources

An archaeological inventory survey report of the Keahole Generating Station site was prepared by Paul H. Rosendahl, Ph.D., Inc. (PHRI), which is in Appendix D.

3.8.1 Research Methods

PHRI researched existing archaeolcgical and historical literature relevant to the project area. Fourteen archaeological studies in the project vicinity were conducted between 1973 and the present.

3.8.2 Field Survey

An archaeological inventory survey of the 15-acre Keahole Generating Station site was conducted June 29, 1992. The survey consisted of four persons walking north-south and east-west transects at a maximum distance of 66 feet apart.

Four prehistoric sites, with seven component features, were identified in the project area during the survey. All identified sites and features were pahoehoe excavations that were interpreted to have been prospect pits rather than productive quarries. These site types have not been previously documented in Kalaoa, although they are widespread elsewhere in Kona.

The archaeological remains found within the proposed project site are significant solely for information content. All sites identified during the survey were determined to be of low significance for research value, interpretive value, and cultural value. No further work is recommended for these sites because the information recovered is considered sufficient and of low significance.

3.8.3 Project Impacts

Because all sites identified during the survey were determined to be of low significance, no significant impact on archaeological and cultural resources is expected.

3.8.4 Mitigation Measures

If any historic or prehistoric surface or subsurface archaeological features or deposits are uncovered during drilling, boring, or testing activities, HELCO will stop work in that immediate vicinity and contact the Department of Land and Natural Resources–State Historic Preservation Division for a determination of significance.

Section 4

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Section 5
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Appendix A

BOTANICAL SURVEY
KEAHOLE GENERATING STATION EXPANSION
NORTH KONA DISTRICT, ISLAND OF HAWAI'I

by

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July 1992

BOTANICAL SURVEY
KEAHOLE GENERATING STATION EXPANSION
NORTH KONA DISTRICT, ISLAND OF HAWAI'I

INTRODUCTION

The proposed expansion of the Keahole generating station will involve about 11 acres, roughly centered around the existing power plant site. The project site is bounded to the north by the "Reservoir Road"; to the west by undeveloped lands and a plant nursery business; and to the south and east by undeveloped lands covered by fountain grass and scattered shrubs.

Field studies to assess the botanical resources on the area proposed for expansion were conducted on 09 July 1992. The primary objectives of the survey were to: 1) describe the major vegetation types, 2) inventory the flora, and 3) search for threatened and endangered plants protected by Federal and State endangered species laws.

SURVEY METHODS

Prior to undertaking the field studies, a search was made of the pertinent literature to familiarize the principal investigator with other botanical studies conducted in the general area. Topographic maps and a project map (1" = 50') were examined to determine terrain characteristics, access, boundaries, and reference points. Prior to the field studies, the property line had been surveyed and staked. The existing power plant is serviced by the "Reservoir Road" which connects to the Queen Ka'ahumanu Highway.

The undeveloped, fountain grass-dominated area was intensively surveyed as it is more likely to harbor native plant communities and, perhaps, rare plants. The planted area located just outside the perimeter fence of the existing facility was less intensively surveyed as it is somewhat periodically maintained.

A walk-through survey method was used. Notes were made on plant associations and distribution, substrate types, topography, exposure, drainage, etc. Plant identifications were made in the field; plants which could not be positively identified were collected for later determination in the herbarium and for comparison with the most recent taxonomic literature.

The species recorded are indicative of the season ("rainy" vs. "dry") and the environmental conditions at the time of the survey. A survey taken at a different time and under varying environmental conditions would no doubt yield slight variations in the species list, especially of the weedy, annual plants.

DESCRIPTION OF THE VEGETATION

Two studies have been conducted on or adjacent to the HELCO project site. The first study involved the lands immediately mauka of the existing generating station and the Queen Ka'ahumanu Highway (Linney 1987); this was for the Keahole Airport Master Plan. The second included a 1 km square area around the generating station (Char 1988). The general physiognomy of the two areas was described as sparsely-vegetated lava fields dominated by fountain grass.

Substrate on the 11-acre expansion area consists of pahoehoe lava, not weathered greatly as there are no pockets of fine soil and an oxidized surface. These more or less undisturbed pahoehoe areas support low, scattered patches of fountain grass and a few shrubs. Along the outside perimeter of the fence which surrounds

the generating facility is a varied assortment of landscape plantings; these plantings occur on soil and cinder brought to the site. The two "plant communities" are described in more detail below. A checklist of all those plants inventoried during the studies is presented at the end of the report.

Fountain Grass Grassland

Vegetation cover on the pahoehoe flow is about 40 to 50%. Fountain grass (Pennisetum setaceum), introduced from northern Africa, forms course, densely tufted patches, from 1 to 3 ft. tall. Locally common on the tops of the lava hummocks is the native piligrass (Heteropogon contortus). Scattered through this grassland are shrubs and subshrubs, 1 to 6 ft. tall. The most common of these include the native caper or maiapilo (Capparis sandwichiana), 'ilima (Sida fallax), 'uhaloa (Waltheria indica), indigo (Indigofera suffruticosa), and koa-haole (Leucaena leucocephala). Less common are partridge pea (Chamaecrista nictitans), Pluchea symphytifolia, Christmas berry (Schinus terebinthifolius), noni (Morinda citrifolia), klu (Acacia farnesiana), and a'ali'i (Dodonaea viscosa). Shrubs become somewhat denser on the southern and eastern portions of the project site.

The smaller herbaceous species recorded are few, probably because the study was conducted during the dry, summer months. Among the few are coat buttons (Tridax procumbens), lovegrass (Eragrostis tenella), red pualele (Emila fosbergii), and hairy spurge (Chamaesyce hirta). A few clumps of the hairy sword fern (Nephrolepis multiflora) occur in the somwhat moister microhabitats found in the larger cracks and crevices on the lava flow.

Planted Area

This is the landscaped area along the outside perimeter of the

of the fence and is infrequently maintained. Groupings of cultivated specimens are found on the north, west, and south perimeter. The "back-end" of the facility (east perimeter) is not planted.

The most commonly used ornamental plants are coconut trees (Cocos nucifera), two Erythrina species, oleander (Nerium oleander), and orange and red-colored Bougainvillea hybrids. This dense growth of trees and shrubs provides a visual screen for the facility.

Weedy shrubs, such as Pluchea and Christmas berry, and the Polynesian-introduced noni grow tall and luxuriant here because the landscaped area is watered. Also rather abundant are various grasses and weeds such as Natal redtop grass (Rhynchelytrum repens), wild bittermelon (Momordica charantia), puncture vine (Tribulus terrestris), wild spider flower (Cleome gynandra), red pualele, Crassocephalum crepidioides, Spanish needle (Bidens pilosa), etc.

DISCUSSION AND RECOMMENDATIONS

The vegetation on the project site is dominated by introduced species. Native plants, in general, occur as scattered individuals. The native species, indigenous and endemic, can be found throughout west Hawai'i and in similar habitats in the Hawaiian Islands. None of the plants inventoried on the site are officially listed threatened or endangered species; nor are any proposed or candidate for such status (U.S. Fish and Wildlife Service 1989, 1990).

For the most part, there is little of botanical interest or concern on the project site and the proposed HELCO expansion is not expected to have a significant negative impact on the botanical resources.

There are no botanical reasons to impose any restrictions or impediments to the proposed project. It is recommended that native plants be considered for use in some of the landscaping. These include trees such as wiliwili (Erythrina sandwicensis) and lowland 'ohi'a (Metrosideros polymorpha); shrubs such as naio (Myoporum sandwicense), maiapilo, a'ali'i, and alahe'e (Canthium odoratum). They are well-adapted to the local growing conditions of the site and would require less water. Some of these species already occur on the adjacent lands.

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PLANT SPECIES LIST -- Keahole Generating Station

A checklist of all those terrestrial, vascular plant species inventoried on the project site during the field studies is presented below. The species are arranged alphabetically within each of three groups: Ferns, Monocots, and Dicots. The taxonomy and nomenclature of the Ferns follow Lamoureux (1984); the *flowering plants, Monocots and Dicots*, are in accordance with Wagner et al. (1990), for the most part.

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name(s), when known.
3. Biogeographic status. The following symbols are used:
   E = endemic = native only to the Hawaiian Islands
   I = indigenous = native to the Hawaiian Islands and also elsewhere throughout the Pacific
   P = Polynesian = plants originally of Polynesian introduction prior to Western contact (1778); not native
   X = introduced or alien = all those plants introduced by humans to the islands, intentionally or accidentally, after Western contact; not native.
4. Presence (+) or absence (-) of a particular species within each of two vegetation types recognized on the project site (see text for discussion):
   f = Fountain Grass Grassland
   p = Planted Area

Scientific name	Common name	Status	Vegetation type f	p
FERNS				
NEPHROLEPIDACEAE (Sword Fern Family)				
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern	X	+	-
FLOWERING PLANTS				
MONOCOTS				
AGAVACEAE (Sisal Family)				
Sansevieria trifasciata Prain	snake plant, mother-in-law's tongue	X	-	+
ARECACEAE (Palm Family)				
Cocos nucifera L.	coconut, niu	P	-	+
CYPERACEAE (Sedge Family)				
Cyperus rotundus L.	nutgrass, nut sedge	X	-	+
LILIACEAE (Lily Family)				
Aloe vera L.	aloe	X	-	+
POACEAE (Grass Family)				
Cenchrus echinatus L.	common sandbur, 'ume 'alu	X	-	+
Digitaria sp.	crabgrass	X	-	+
Eleusine indica (L.) Gaertn.	wiregrass, goosegrass	X	-	+
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	lovegrass	X	+	+
Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult.	pili, piligrass	I	+	-
Pennisetum setaceum (Forssk.) Chiov.	fountaingrass	X	+	+
Rhynchelytrum repens (Willd.) Hubb.	Natal redtop	X	+	+

Scientific name	Common name	Status	Vegetation type f	Vegetation type p
ZINGIBERACEAE (Ginger Family)				
Hedychium sp.	ginger	X	-	+
DICOTS				
ANACARDIACEAE (Mango Family)				
Mangifera indica L.	mango, manako	X	-	+
Schinus terebinthifolius Raddi	Christmas berry	X	+	+
APOCYNACEAE (Periwinkle Family)				
Nerium oleander L.	oleander, 'oleana	X	-	+
Plumeria rubra L. (hybrid)	plumeria	X	-	+
ASCLEPIADACEAE (Milkweed Family)				
Calotropis procera (Ait.) Ait. f.	small crown flower	X	-	+
ASTERACEAE (Sunflower Family)				
Bidens pilosa L.	Spanish needle, beggar's tick, ki	X	-	+
Conyza bonariensis (L.) Cronq.	hairy horseweed	X	-	+
Crassocephalum crepidioides (Benth.) S. Moore	crassocephalum	X	-	+
Emilia fosbergii Nicolson	red pualele	X	+	+
Pluchea symphytifolia (Mill.) Gillis	pluchea, sourbush	X	+	+
Tridax procumbens L.	coat buttons	X	+	+
BORAGINACEAE (Borage Family)				
Heliotropium amplexicaule Vahl	heliotrope	X	-	+
CAPPARACEAE (Caper Family)				
Capparis sandwichiana DC.	maiapilo, puapilo	E	+	-
Cleome gynandra L.	wild spider flower, honohina	X	-	+

Scientific name	Common name	Status	Vegetation type f	Vegetation type p
CARICACEAE (Papaya Family)				
Carica papaya L.	papaya, mikana	X	-	+
CONVOLVULACEAE (Morning-glory Family)				
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	+
CUCURBITACEAE (Squash Family)				
Momordica charantia L.	wild bittermelon	X	-	+
EUPHORBIACEAE (Spurge Family)				
Chamaesyce hirta (L.) Millsp.	hairy spurge	X	+	+
Chamaesyce prostrata (Aiton) Small	prostrate spurge	X	-	+
FABACEAE (Pea Family)				
Acacia farnesiana (L.) Willd.	klu	X	+	-
Chamaecrista nictitans (L.) Moench.	partridge pea, lauki	X	+	+
Erythrina fusca Lour.	columnar erythrina	X	-	+
Erythrina variegata Stickm.	tiger's claw	X	-	+
Indigofera suffruticosa Mill.	indigo, 'iniko	X	+	-
Leucaena leucocephala (Lam.) de Wit	koa-haole, ekoa	X	+	+
Macroptilium lathyroides (L.) Urb.	wild bushbean, cowpea	X	-	+
MALVACEAE (Mallow Family)				
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	X	-	+
Sida fallax Walp.	'ilima	I	+	+
MOLLUGINACEAE (Carpetweed Family)				
Mollugo cerviana (L.) Ser.	threadstem carpetweed	X	-	+
MORACEAE (Mulberry Family)				
Ficus microcarpa L. f.	Chinese banyan	X	-	+
NYCTAGINACEAE (Four-o'clock Family)				
Bougainvillea hybrid	bougainvillea	X	-	+

Scientific name	Common name	Status	Vegetation type f	Vegetation type p
PORTULACACEAE (Purslane Family)				
Portulaca oleracea L.	pigweed, common purslane, 'ihi	X	+	+
Portulaca pilosa L.		X	-	+
RUBIACEAE (Coffee Family)				
Morinda citrifolia L.	noni	P	+	+
Paederia scandens (Lour.) Merr.	maile pilau	X	-	+
SAPINDACEAE (Soapberry Family)				
Dodonaea viscosa Jacq.	a'ali'i	I	+	-
SOLANACEAE (Nightshade Family)				
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato, 'ohi'a ma ka nahele	X	-	+
STERCULIACEAE (Cacao Family)				
Waltheria indica L.	'uhaloa, hi'aloa, kanakaloa	I?	+	-
ZYGOPHYLLACEAE (Caltrop Family)				
Tribulus terrestris L.	puncture vine	X	-	+

Appendix B

SURVEY OF THE AVIFAUNA AND FERAL MAMMALS AT KEAHOLE, NORTH KONA, HAWAII

Prepared for

CH2M HILL

by

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17 July 1992

INTRODUCTION

The purpose of this report is to summarize the findings of a one day (14 July 1992) bird and mammal field survey conducted at the Keahole Generating Station, North Kona, Hawaii (Fig.1). Also included are references to pertinent literature as well as unpublished faunal reports.

The objectives of the field survey were to:

1- Document what bird and mammal species occur on the property or may likely be found there given the type of habitats available.

2- Provide some baseline data on the relative (estimated) abundance of each species.

3- Determine the presence or likely occurrence of any native fauna particularly any that are listed as "Endangered" or "Threatened".

4- If any special or unique wildlife habitat occurs on the property locate such sites and note their possible value for birds and mammals in this region of the island.

GENERAL SITE DESCRIPTION

Figure One indicates the limits of the area surveyed for birds and mammals. The majority of the property is covered in dry grass. The present fenceline of the electrical generating facility is planted with a variety of introduced trees and shrubs. No wetland habitat

exists at this site.

Weather during the field survey was warm and clear with NE winds 10-15 mph.

STUDY METHODS

The survey consisted of a walkthrough of the property and nearby lands. Field observations were made with binoculars and by listening for vocalizations. These observations were concentrated during the peak bird activity periods of early morning and late afternoon/early evening. At various locations eight minute counts were made of all birds seen or heard (Fig.1). Between these count (census) stations any special observations of birds were also noted. These data provide the basis for the relative (estimated) abundance figures given in this report (Table 1). Published and unpublished reports of birds known from similar habitat elsewhere were also consulted in order to acquire a more complete picture of the possible species that might occur in this region (Bruner 1989a, 1989b, 1989c, 1990, 1991); Pratt et al. 1987; Hawaii Audubon Society 1989; David 1989, 1990). Observations of feral mammals were limited to visual sightings and evidence in the form of scats and tracks. No attempts were made to trap mammals in order to obtain data on their abundance and distribution. One evening was devoted to searching for the presence

of owls and the Hawaiian Hoary Bat (Lasiurus cinereus semotus).

Scientific names used herein follow those given in Hawaii's Birds (Hawaii Audubon Society 1989); Field Guide to the Birds of Hawaii and the Tropical Pacific (Pratt et al. 1987) and Mammal Species of the World (Honacki et al. 1982).

RESULTS AND DISCUSSION

Resident Endemic (Native) Birds:

No endemic birds were observed on the survey. The only species which might occasionally occur in this area are: Short-eared Owl or Pueo (Asio flammeus sandwichensis) and Hawaiian Hawk or 'Io (Buteo solitarius). These two birds forage in open grasslands as well as forests and agricultural fields (Pratt et al. 1987; Hawaii Audubon Society 1989).

Migratory Indigenous (Native) Birds:

No migratory birds were recorded on the survey. This was no unexpected since most of these birds are on their arctic breeding grounds at this time of year. The two most common migrants that may visit this property from September to April are: Ruddy Turnstone (Arenaria interpres) and Pacific Golden Plover (Pluvialis fulva). The latter species has been intensely studied here in Hawaii and has been shown to be strongly site attached and territorial (Johnson et al. 1981, 1989).

Resident Waterbirds and Seabirds:

No waterbirds or seabirds were found on this property. The absence of wetlands and the accessibility of predators precludes the occurrence of these species.

Exotic (Introduced) Birds:

Ten species of exotic birds were recorded during the field survey (Table 1). The relative abundance of these species was similar to data gathered on nearby lands (Bruner 1989a, 1989b, 1989c, 1990, 1991). Other species which may also occur on or near the property include: Barn Owl (Tyto alba), Saffron Finch (Sicalis flaveola), Yellow-billed Cardinal (Paroaria capitata) and Warbling Silverbill (Lonchura malabarica) (Pratt et al. 1987; Hawaii Audubon Society 1989; David 1989, 1990; Bruner 1989a, 1989b, 1989c, 1990, 1991).

Feral Mammals:

One Small Indian Mongoose (Herpestes auropunctatus) was observed. No trapping was conducted in order to assess the relative abundance of mammals.

Records of the endemic and endangered Hawaiian Hoary Bat are relatively limited but the species does occur on the island of Hawaii (Tomich 1986; Kepler and Scott 1990). No bats were found on the survey. The natural history of this bat and its ecological requirements here in Hawaii is poorly known. They generally roost solitarily in trees and forage for flying insects at dusk often over bays and ponds

or forest clearings. It is unlikely that this species would forage or roost at this site.

CONCLUSION

A brief field survey such as this one can provide only a limited perspective of the wildlife which utilize the area. The number of species and the relative abundance of each may vary throughout the year due to available resources and reproductive success. Birds which are migratory will quite obviously be found only at certain times during the year. Exotic species sometimes prosper for a time only to later disappear or become a less significant part of the ecosystem (Williams 1987; Moulton et al. 1990). Thus only long term studies can provide a comprehensive view of the bird and mammal populations in a particular area. Nevertheless some general conclusions related to bird and mammal activity on this site are:

1- The survey was conducted by walking the site and stopping periodically to conduct eight minute counts of all birds seen or heard. These data provided the numbers necessary to calculate the relative abundance estimates given in Table One.

2- No endemic species were recorded, however, Pueo and 'Io may occur at times at this location.

3- The absence of migratory birds particularly plover was not unexpected due to the time of year.

4- The numbers of exotic birds were typical of this type of habitat. No unusual exotic species were found.

5- No wetlands exist on this site thus no waterbirds were found.

6- In order to obtain more definitive data on mammals a trapping program would be necessary. No unusual concentrations of mammals were noted. The endangered Hawaiian Hoary Bat was not recorded at this site.

7- No particularly special or unique bird or mammal habitat was discovered at this site. Dry grasslands and open lava flows are abundant along this sector of the island.

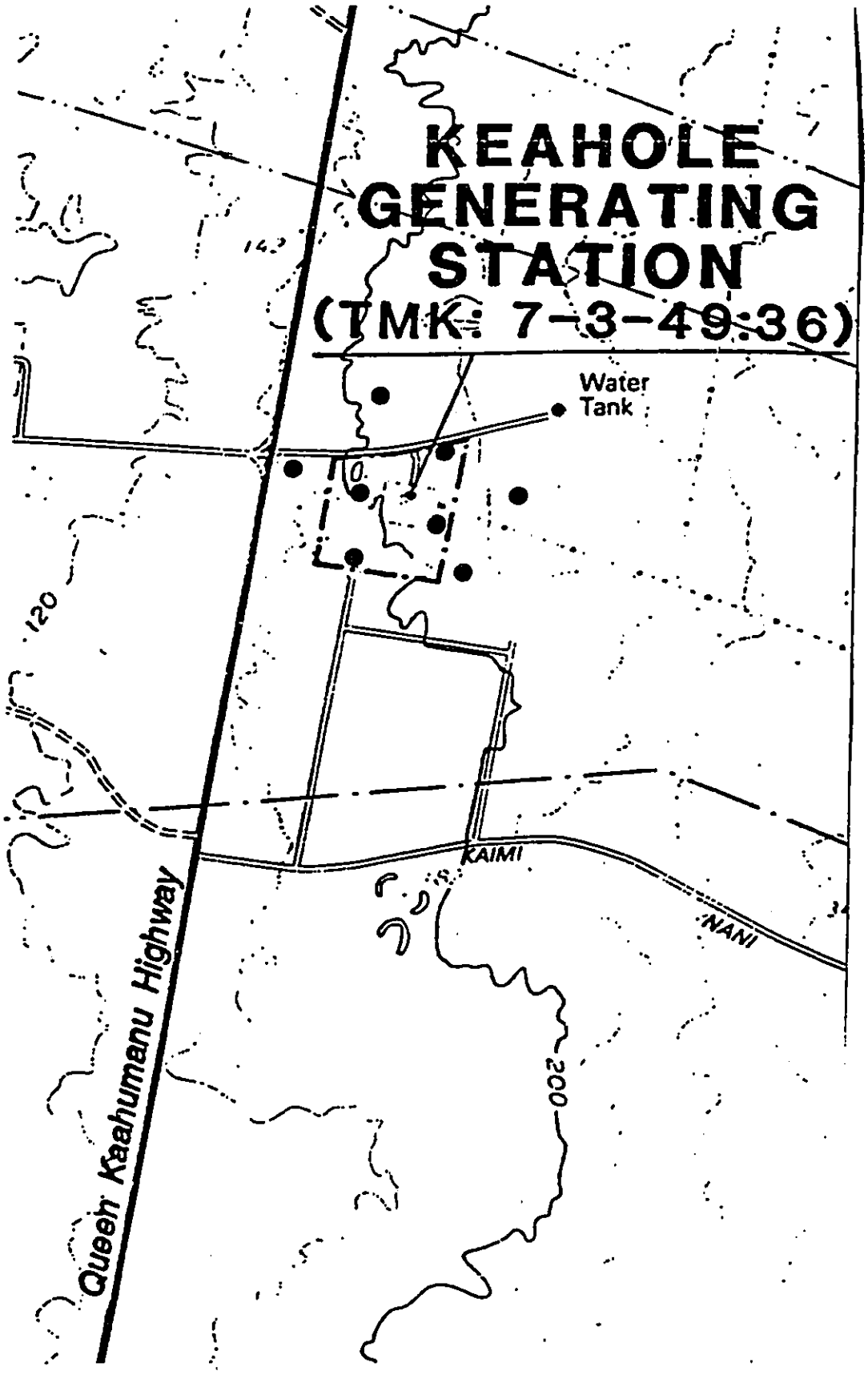

Fig. 1. Location of faunal survey with census stations shown as solid circles.

TABLE 1

Exotic (introduced) birds recorded at Keahole, North Kona, Hawaii

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE *
Black Francolin	Francolinus francolinus	C= 6
Gray Francolin	Francolinus pondicerianus	R= 3
Spotted Dove	Streptopelia chinensis	U= 2
Zebra Dove	Geopelia striata	C= 6
Common Myna	Acridotheres tristis	C= 7
Northern Cardinal	Cardinalis cardinalis	R= 2
Japanese White-eye	Zosterops japonicus	U= 3
Nutmeg Mannikin	Lonchura punctulata	C= 8
House Finch	Carpodacus mexicanus	U= 4
House Sparrow	Passer domesticus	R= 7

* (see page 9 for key to symbols)

KEY TO TABLE 1

Relative abundance = Number of times observed during survey or average number on eight minute counts in appropriate habitat.

A= abundant (ave. 10+)

C= common (ave. 5-10)

U= uncommon (ave. less than 5)

R= recorded (seen or heard at times other than on 8 min. counts or on one count only) Number which follows is the total number seen or heard over the duration of the survey

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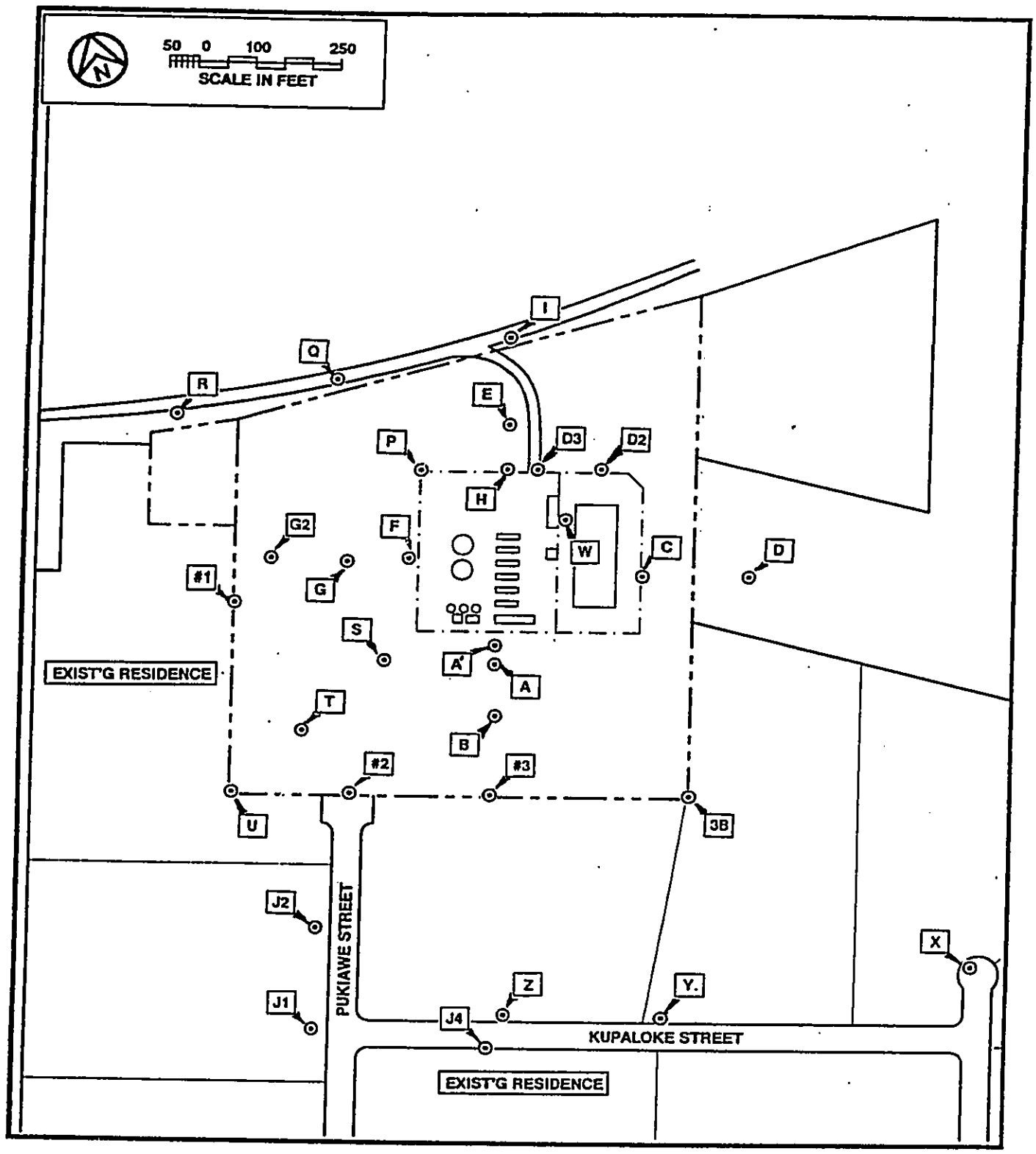
Appendix C



LOCATION OF NOISE MONITORING AND MEASUREMENT SITES

RESULTS OF NOISE MEASUREMENTS AT VARIOUS LOCATIONS AROUND GENERATING STATION

LOCATION	DATE	TIME (HRS)	NO. OF OPERATING DIESEL GENERATORS*	Leq (dB)
#1	7-9-92	1315-1330	5	56.5
#2	7-7-92	1846-2002	5	60.6
#2	7-7-92	2010-2127	5	61.3
#2	7-9-92	0855-0955	5	59.5
#2	7-9-92	1000-1053	5	59.4
#2	7-9-92	1330-1345	5	56.9
#2	8-3-92	2004-2010	3	61.1
#3	7-9-92	0906-0910	5	58.8
#3B	8-3-92	2045-2052	2	62.1
A	7-7-92	1850-1905	5	67.6
A	7-9-92	0853-0908	5	67.1
A'	7-9-92	1300-1315	5	68.8
B	7-7-92	1850-0905	5	61.8
B	7-9-92	0855-0905	5	61.5
C	7-7-92	1912-1927	5	69.2
C	7-9-92	0913-0920	5	68.3
D	7-7-92	1915-1930	5	63.3
D	7-9-92	0917-0922	5	64.2
D2	7-9-92	1029-1034	5	69.2
D3	7-9-92	1020-1029	5	77.4
E	7-7-92	2032-2047	5	72.2
E	7-9-92	1000-1006	5	70.9
F	7-7-92	1942-1959	5	75.0
F	7-9-92	0931-0940	5	71.5
G	7-7-92	1938-1953	5	69.1
G	7-9-92	0933-0940	5	65.4
G2	7-9-92	0941-0944	5	60.6
H	7-7-92	2016-2031	5	77.4
H	7-9-92	0951-0958	5	76.8
I	7-7-92	2053-2108	5	66.7
I	7-9-92	1011-1021	5	66.1
J1	7-7-92	2013-2030	5	54.0

RESULTS OF NOISE MEASUREMENTS AT VARIOUS LOCATIONS AROUND GENERATING STATION

LOCATION	DATE	TIME (HRS)	NO. OF OPERATING DIESEL GENERATORS*	Leq (dB)
J1	7-9-92	0951-0952	5	50.3
J1	8-3-92	2153-2158	2	51.0
J2	7-7-92	2037-2110	5	58.6
J2	7-9-92	0958-1001	5	54.8
J2	8-3-92	2058-2104	2	53.4
J4	7-9-92	1245-1345	5	51.1
J4	7-9-92	1345-1352	5	50.0
P	8-3-92	2122-2128	2	66.1
Q	8-3-92	2132-2138	2	56.3
R	8-3-92	2141-2147	2	51.2
S	8-3-92	2030-2037	3	63.6
T	8-3-92	2020-2028	3	61.1
U	8-3-92	2012-2018	3	58.2
W	7-7-92	1034-1045	5	69.2
X	8-3-92	2212-2217	2	44.7
Y	8-3-92	2223-2228	2	50.5
Z	8-4-92	0430-0449	0	40.7
Z	8-4-92	0500-0553	2	51.8
Z	8-4-92	0600-0700	2	55.3
Z	8-4-92	0700-0751	2	51.9
Z	8-4-92	0800-0900	2	50.0
Z	8-4-92	0900-0947	2	51.1
Z	8-4-92	1000-1058	2	54.3
Z	8-3-92	1100-1158	2	52.4
Z	8-3-92	1200-1255	2	51.1
Z	8-3-92	1300-1352	2	51.8
Z	8-3-92	1400-1454	2	52.5
Z	8-3-92	1500-1600	3	54.3
Z	8-3-92	1600-1648	3	53.4
Z	8-3-92	1700-1759	3	53.2
Z	8-3-92	1800-1854	3	51.5
Z	8-3-92	1900-1951	3	52.3
Z	8-3-92	2000-2100	3	52.4

RESULTS OF NOISE MEASUREMENTS AT VARIOUS LOCATIONS AROUND GENERATING STATION

LOCATION	DATE	TIME (HRS)	NO. OF OPERATING DIESEL GENERATORS*	Leq (dB)
Z	8-3-92	2100-2151	2	49.5
Z	8-3-92	2200-2245	2	50.5

Note: * CT-2 also operating during all monitoring periods.

Appendix D

Report 1265-063092

Archaeological Inventory Survey
Helco Keahole Parcel Project Area

Lands of Kalaoa 1-4
North Kona District, Island of Hawaii
(TMK:7-3-49:36)

by

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SUMMARY

At the request of Ms. Carol Thompson, Senior Planner with CH2M HILL, Paul H. Rosendahl, Ph.D., Inc. recently conducted an archaeological inventory survey of 15 acres in the HELCO Keahole Parcel Project Area. The parcel is in the Lands of Kalaoa 1-4, North Kona District, Island of Hawaii (TMK:7-3-49:36). The basic objective of the survey was to provide information sufficient for satisfying all historic preservation regulatory review requirements of the Hawaii County Planning Department, and the Department of Land and Natural Resources-State Historic Preservation Division.

The inventory survey was conducted June 29, 1992. During the field work, four quarry sites consisting of seven pahoehoe excavations were identified. The sites ranged in physical condition from poor to good. Each of the four sites was recorded in detail. Subsurface testing was not conducted, as there were no cultural deposits within the identified features.

All four sites are assessed as significant for information content. No further work is recommended for the sites, however, as the data collected during the present survey is considered adequate mitigation of potential effects of the proposed project.

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BACKGROUND

At the request of Ms. Carol Thompson, Senior Planner with CH2M HILL, Paul H. Rosendahl, Ph.D., Inc. (PHRI) recently conducted an archaeological inventory survey of the 15-acre HELCO Keahole Parcel Project Area, Lands of Kalaoa 1-4. The parcel is in the North Kona District, Island of Hawaii (TMK:7-3-49:36). The overall objective of the survey was to provide information sufficient for satisfying all historic preservation regulatory review requirements of the Hawaii County Planning (HCPD) and the Department of Land and Natural Resources - State Historic Preservation Division (DLNR-SHPD).

The field work was conducted June 29, 1992 under the guidance of Supervisory Archaeologist James Head, B.A., and Crew Chief Sheryl Dowden, B.S. Crew members included Field Archaeologists Tom Carmody and Karen Wigglesworth, B.S. Principal Archaeologist Paul H. Rosendahl, Ph.D., provided overall direction for the project. The field work took 32 labor-hours to complete.

SCOPE OF WORK

The basic purpose of the survey was to identify—to discover and locate on available maps—all sites and features of potential archaeological significance. An *inventory survey* is an initial level of archaeological investigation. It is extensive rather than intensive in scope, and is conducted with the primary aim of determining the presence or absence of archaeological resources. A survey of this type indicates both the general nature and the variety of archaeological remains present, and the general distribution and density of such remains. It permits a general significance assessment of the archaeological resources, and facilitates formulation of realistic recommendations and estimates for any further work that might be necessary or appropriate. Such work could include further data collection involving detailed recording of sites and features, and selected test excavations. It might also include subsequent *mitigation*—data recovery research excavations, construction monitoring, interpretive planning and development, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

The basic objectives of the present survey were fourfold: (a) to identify (find and locate) all sites and site complexes present within the project area; (b) to evaluate the potential general significance of all identified archaeological remains; (c) to determine the possible impacts of proposed development upon the identified remains; and (d) to define the general scope of any subsequent further data collection and/or other mitigation work that might be necessary or appropriate.

Based on a review of readily available background literature, familiarity with the general project area, extensive familiarity with the current requirements of review authorities, and based on discussions with Ms. Carol Thompson of CH2M HILL and Mr. Kanalei Shun, DLNR-SHPD Staff Archaeologist for Hawaii Island, the following specific tasks were determined to constitute an adequate and appropriate scope of work for the proposed inventory survey:

1. Review archaeological and historical literature relevant to the project area and conduct historical documentary research (emphasis on readily available literature and documentary sources) and interviews with any appropriate and available local informant sources;

2. Conduct 100% coverage, variable intensity ground survey of the project area, with (a) relatively higher intensity coverage of naturally vegetated and unmodified portions, and (b) relatively lower intensity coverage of areas that have been historically cultivated and otherwise modified;

3. Conduct limited subsurface testing of selected sites and features identified within the project area (a) to determine the presence or absence (and general distribution) of potentially significant buried cultural features or deposits, and (b) to obtain suitable samples for age determination analyses; and

4. Analyze field and historical research data, and prepare appropriate reports.

The inventory survey was carried out in accordance with the standards for inventory-level survey recommended by DLNR-SHPD. The significance of the archaeological remains identified in the project area was assessed in terms of (a) the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60), and (b) the criteria for evaluation of traditional cultural values prepared by the National Advisory Council on Historic Preservation. DLNR-SHPD and the Hawaii County Planning Department use these criteria to evaluate eligibility for the Hawaii State and National Registers

of Historic Places. In addition, the significance of archaeological sites identified during the survey was evaluated in terms of the PHRI Cultural Resource Value Modes, which are described in the Conclusion section of this report.

PROJECT AREA DESCRIPTION

The project area comprises a single parcel of 15 acres, located just *mauka* (inland) of the Queen Kaahumanu Highway in Kalaoa 1-4 Ahupuaa, North Kona District, Island of Hawaii (Figure 1). Elevation of the project area is c. 200 ft (61 m) to 230 ft (70 m) AMSL (above mean sea level). The project area is part of the Kona Lava Plain, a low-cliffed volcanic coast, which is defined by Armstrong (1983:37) as coastline with wave-cut cliffs averaging about 20 ft. The project area surface was formed by Hualalai Volcanic Series flows, which may be late Pleistocene in age. The flows are highly permeable, but brackish water is found only along the coast (Stearns and MacDonald 1946:139-140).

The terrain in the project area is gently undulating, and the soils are composed of two series, the Kaimu extremely stony peat (6-20% slopes) and Punaluu extremely stony peat (6-20% slopes) (Sato et al. 1973). The Kaimu extremely stony peat represents the Kaimu series of well-drained, thin organic soils (about three inches thick) over fragmented aa lava. The Punaluu extremely rocky peat represents the Punaluu series of well-drained, thin organic soils (c. four inches thick) over pahoehoe bedrock.

Vegetation in the project area is generally very sparse and consists of fountain grass (*Pennisetum setaceum* [Forsk.] Chiov.), *noni* (*Morinda citrifolia*), *koa-haole* (*Leucaena glauca* [Lam.] de Wit), and *'ilima* (*Sida fallax* [L.]). Several recently planted exotics including plumeria (*Plumeria acuminata* Ait.), coconut palm (*Cocos nucifera* L.), and an unidentified shrub were noted.

PREVIOUS ARCHAEOLOGICAL RESEARCH

There have been numerous studies in the Kalaoa Ahupuaa 1-4 areas, these are summarized in Table 1. The earliest work was a reconnaissance survey of a section of the Kailua-Kawaihae Road in South Kohala, from Anaehoomalu Bay to Keahole Point, by Rosendahl (1973). He also conducted a general salvage of all endangered sites within and immediately adjacent to the highway alignment. There were 284 sites, including both those situated within the actual highway alignment and those of apparent value located adjacent to the alignment and within the original Road Corridor survey area. Most of the salvaged features were habitation (n=201), and low, C-shape shelters (n=149). According to Rosendahl, other types of habitation features included low, L-shaped shelters (n=5), natural depression shelters (n=12), small cave shelters (n=15), dwelling caves (n=7), platforms (n=10), a pavement (n=1), and surface midden areas (n=2). Other kinds of features Rosendahl encountered were enclosures of various sizes (n=14), cairns (*ahu*) (n=34), prehistoric foot trails (n=9), historic foot/cart trails (n=4), a cave burial (n=1), and a number of miscellaneous, unique, and/or minor types of features (n=21).

Cordy (1985) has also conducted surveys in the area and defined three environmental zones, based on location, elevation, bedrock, and present vegetation, that apply to archaeological work in the Ooma 1, Ooma 2, and Kalaoa 1-5 Ahupuaa. (1) The Coastal Zone is located 0-150 ft from shore, with elevations from 0-20 ft, and is characterized by low pahoehoe with some sand beaches and typical shoreline vegetation. (2) The Barren Zone, or Transitional Zone, according to Cordy, is located 150 ft to 1.5 miles from the shore with elevations from 20-430 ft above sea level. It is characterized by pahoehoe with pockets of aa, but contains no soil. Vegetation in the Barren Zone is extremely sparse in the seaward portion, but becomes denser in the upper regions, where grass and then lantana predominate. (3) The Upland Forest Zone is located 1.5 miles to 3.7 miles from shore, with elevations from 430 to 3,400 ft. It is characterized by a rough aa and soil terrain. Vegetation in the lower portion is dominated by *koa-haole* and Christmas-berry, and on the upper slopes by large forest trees.

While the HELCO Keahole Parcel project area is located at the northern border of Kalaoa 1-4, in the center of the Barren/Transitional Zone, previous studies within each of the environmental zones will be discussed in order to construct an *ahupua'a* settlement pattern.

A brief reconnaissance survey was conducted by Davis (1977) in portions of the various Kalaoa Ahupuaa for the Keahole Agricultural Park. The area of the survey included a narrow transect in the Kalaoa 4 Ahupuaa that ended at the 800 ft elevation level. Twenty-two site complexes and isolated archaeological features were identified. These sites included habitation caves, shelters, wind breaks, *ahu*, platforms, enclosures (one appears to be a historic homestead), walls, and an *ahupua'a* wall.

Hammatt and Folk (1980) conducted salvage excavations at 12 sites within the proposed Keahole Agricultural Park, in

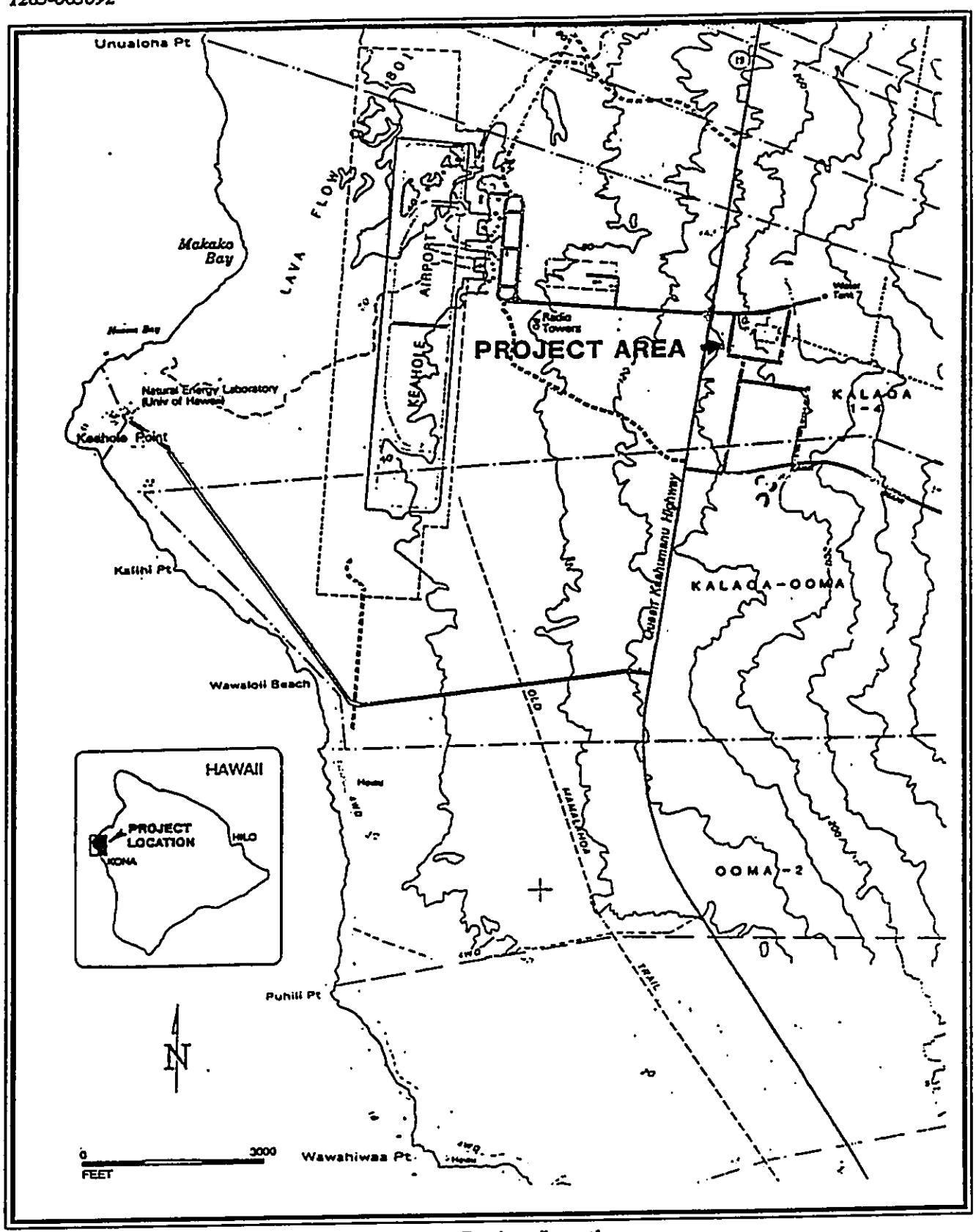

Figure 1. Project Location

Table 1.

SUMMARY OF PREVIOUS RESEARCH

Year	Author(s)	Type of Survey	Ahupua'a	Zone
1973	Rosendahl, P.H.	Reconnaissance Survey & Salvage	Hamanamana-Puuanamulu	Coastal-Barren
1977	Davis, B.	Reconnaissance Survey	Kalaoa 4 & var. Kalaoa	Upland
1980	Hammatt, H.H. & Folk, W.M.	Reconnaissance Survey	Kalaoa-O'oma	Barren
1982	Soehren, L.J.	Reconnaissance Survey	Kalaoa 3-4	Barren-Upland
1985	Soehren, L.J.	Reconnaissance Survey	Kalaoa 3-4	Barren-Upland
1987	Cordy, R.	Field Check	Kalaoa 3-4	Barren-Upland
1987	Telea, L.J. & Walker, A.T.	Survey	Kalaoa 3-4	Barren-Upland
1987	Walker, A.T. & Haun, A.E.	Reconnaissance Survey	Kalaoa 3-4	Barren-Upland
1988	Walker, A.T. & Haun, A.E.	Data Recovery	Kalaoa 3-4	Barren-Upland
1989	Walker, A.T.	Inventory Survey	Kalaoa 5	Coastal-Upland
1990a	Walker, A.T. & Rosendahl, P.H.	Inventory Survey	Kalaoa 3-4	Barren-Upland
1990b	Walker, A.T. & Rosendahl, P.H.	Inventory Survey	Kalaoa 3-4	Barren-Upland
1991	O'Hare, C.R. & Rosendahl, P.H.	Inventory Survey	Kalaoa	Coastal
1992	Thompson, L.W. & Goodfellow, S.T.	Data Recovery	Kalaoa	Upland

Kalaoa-O'oma, and a reconnaissance survey of a parcel north of the park. The project identified 18 sites including *ahu*, a small wall partially destroyed by bulldozing, an enclosure, a platform, a trail, and lava tubes. Little evidence of occupation was found in the lava tubes in the parcel north of the park. The excavations conducted on the 12 sites in the Agricultural Park itself demonstrated prehistoric occupation within sheltered areas around natural sinks and lava tubes. It appears from the radiocarbon dates that domestic occupation in the area occurred from AD 1480 to AD 1700. Petroglyphs within several lava tubes appear to predate at least the upper part of this occupation. One cave site was extensively modified to create a large refuge wall with a constricted entrance and an interior passageway leading to two large tubes. This refuge phase is thought to post-date 1700 and probably corresponds to a period of chiefly rivalry and warfare on the Big Island. Three sites provided evidence of historic period occupation, goat corralling and a homestead.

Several surveys have been conducted in Kalaoa 3 or 4 at elevations of 430 ft or more. These include two reconnaissance surveys by Soehren (1982 and 1985), an archaeological field check by Cordy (1987), a reconnaissance survey and subsequent limited data recovery by Walker and Haun (1987 and 1988), a survey by Telea and Rosendahl (1987), and two inventory surveys by Walker and Rosendahl (1990a and 1990b).

During his reconnaissance survey of 6.8 acres at 1000 ft AMSL in the Kalaoa 4 Ahupuaa (TMK: 3-7-3-05:13), Soehren (1982) recorded two structures, a house platform and a square enclosure, that he interpreted as an agricultural *heiau*. In a subsequent survey of another parcel in the Kalaoa 4 Ahupuaa (TMK: 3-7-3-10:33), Soehren (1985) recorded several historic roads and a coastal-inland foot trail.

Cordy (1987) conducted a field check of a parcel in the proposed Kona Coast Subdivision in the Kalaoa 3 Ahupuaa (TMK: 3-7-3-28:5). He recorded one large platform/terrace, which he interpreted as either an agricultural *heiau* or a historic house platform.

Walker and Haun (1987) identified 17 features from four sites during a reconnaissance survey conducted by PHRI on a parcel of land in the Kalaoa 4 Ahupuaa (TMK: 3-7-3-05:87). These features included two agricultural complexes that were identified by Walker and Haun as part of a northern extension of the Kona Field System. A habitation/burial cave and a historic-period boundary wall were also recorded. Subsequent detailed recording was conducted at the sites and eight test units were excavated at three of the sites (Walker and Haun 1988). Limited midden remains and one bone fishhook were recovered from the test units and four radiocarbon dates ranging from AD 1280 to 1955 were obtained from recovered charcoal.

In 1987 PHRI conducted a reconnaissance survey of a parcel (TMK:3-7-3-05:86) in the proposed Kona Palisades Subdivision in the Kalaoa Ahupuaa (Telea and Rosendahl 1987). Fourteen features at six sites were identified. A full inventory survey was later conducted in this parcel (Walker and Rosendahl 1990a) and 18 additional features were recorded. Fifteen pits, five platforms, four walls, two caves, three mounds, two terraces, and one C-shape were recorded. They were assigned an agricultural, habitation, or boundary function. One cave and one mound were tested, and midden and indigenous and historic artifacts were recovered. Charcoal recovered from an excavation in one cave and from the surface of another cave yielded radiocarbon age ranges from AD 1552 to 1956.

In 1989 PHRI conducted an inventory survey of a parcel (TMK:3-7-3-10:Por.27) in the Kalaoa 5th Development Parcel. Forty-three sites containing 83 component features were identified within or immediately adjacent to the project area. Walker and Rosendahl (1989) identified walls, enclosures, overhangs, retaining walls, pits, terraces, lava tubes, C-shapes, alignments, mounds, platforms, trails, paved areas, cairns, pahoehoe excavations, and modified features. Limited subsurface testing and surface collection of artifacts and radiocarbon dating samples was conducted, however, the dating results were not included in the report. Indigenous portable artifacts collected from the project area included abraders (coral and echinoid spine), *Cypraea* sp. shell scrapers, a lithified sandstone pounder fragment, and an octopus lure; no volcanic glass artifacts were recovered.

An inventory survey of an adjacent parcel of land in the Kalaoa 4 Ahupuaa was conducted in 1990 (Walker and Rosendahl 1990b). Twelve features were identified at seven sites. Five terraces, two caves, two walls, one platform, one mound, and one water trough were recorded. They were assigned to the functional categories of agriculture, habitation, boundary, refuge, bulldozer-push, or animal water trough. The two caves were tested and midden and indigenous artifacts were recovered. Three radiocarbon dates ranging from AD 1470 to 1955 were obtained.

Data recovery was conducted in the Kona Palisades Subdivision parcel in 1991 (Thompson and Goodfellow 1992). No additional features were recorded, but detailed recording took place at four of the sites previously identified by Walker and Rosendahl (1990a). Twenty-five test units were excavated in 14 features and in two areas near features.

Midden was recovered from seven of the features, indigenous artifacts were recovered from seven features, and historic artifacts from six. Eleven radiocarbon dates for seven features of the four sites were obtained from recovered charcoal (Thompson and Goodfellow 1992). These dates ranged from AD 1460 to 1955 for two temporary habitation cave shelters, from AD 1450 to 1950 for four permanent habitation platforms, and from AD 1410 to 1520 for one agricultural terrace. The sites and features were interpreted to be a northern extension of the Kona Field System.

O'Hare (in prep.) conducted inventory survey and testing in the Kalaoa View Estates Development Project, and identified seven sites consisting of 31 features. The 31 features comprised the following formal types: terrace, rock mound, cairn, C-shape, platform, enclosure, lava blister, and complex. The functional categories consisted of habitation, agriculture, boundary, trash pit and indeterminate. One temporary habitation feature, a C-shape, was dated to AD 1280-1430 and the other prehistoric temporary habitation, a modified lava blister, was dated to AD 1630-1890. The prehistoric permanent habitation feature, a platform, was dated to AD 1500-1680.

SUMMARY OF HISTORICAL DOCUMENTARY RESEARCH

PHRI Historical Researcher Lehua Kalima, B.A., conducted limited historical research on the HELCO Keahole Parcel project area. She reported that little information could be found on this area, specifically, and therefore she included information from the *ahupua'a* near Kalaoa 4, as well as more general information on the North Kona district. This information includes legends, early historic accounts, land use information and settlement patterns. Her work is presented in Appendix A, and is briefly summarized here with additional research from other sources.

Schilt (1984) wrote that in pre-contact times, an ancient chief, Umi-a-Liloa, used the numerous caves in the general vicinity of the project area as places of refuge. Cordy (1985) identified the Kalaoa area as home of the high priest, Kaluolapa, who presided over ceremonies in Haleohiu and Kalaoa. However, Cordy does not cite his source for this statement.

According to tradition, Kekaha was a region "valued by ruling chiefs, inhabited by attendant chiefs, and upon occasions abused by warring chiefs" (Kalakaua 1973:31). During the early 18th century there was war between Maui and Hawaii, and the Maui people were in the Kona area and "cut down the trees throughout the land of Kona." These acts of war were of no small consequence, for "to fell trees of such usefulness was considered truly inhuman" (Springer 1985:23).

During the early historical period, Menzies was in North Kona and described the area as "barren and rugged" (1920:99) although it is assumed that he never made it to the project area itself. Also, Ellis noted the 1801 Huehue Flow from Hualalai and how it destroyed villages, plantations, and fish-ponds (Ellis 1963:30-31).

During the Great Mahele of 1848, Kalaoa 4 was set aside as Government Land (Board of Commissioners 1929). This land, as well as Kalaoa 1-3, the lands of King Kamehameha III, who passed it to the government. Most of the land between the 1000 ft and 2400 ft elevation was soon sold, and from 1852 to 1864, a series of grants was issued in the *ahupua'a*. The grants were typically sold as lots of about 50 acres, and most of them were agricultural parcels (Cordy 1985:6 and Soehren 1982:3).

When Handy began a study of the Hawaiian planter in 1930, there were still some taro plantations above Kalaoa (Handy and Handy 1972:523). Several methods of dryland planting practiced in the Kona area are described by Handy and Handy (1972:105-109), most of which involved clearing the vegetation by weeding or burning, clearing the planting ground of stones, and mulching the ground over the planted crops with some type of vegetation (grass, ferns, sugar cane tops, *kukui* leaves, etc.) (Ibid:108). The stones that had been cleared from the fields were then piled into low walls or mounds. Garden areas at Kuakini (Schilt 1984:40) were characterized by such clearing piles stacked against natural outcrops. These piles might also have acted as agricultural features themselves, as the stones would act as mulch and retain surface moisture (Yen 1974:5). Sweet potatoes were grown on similar mounds (Ellis 1963:23), and although sweet potatoes were not reported to have grown on this land historically, they might have been grown here in prehistoric times.

Coffee was first cultivated in the Kona area in the 1840s. After the Great Mahele, foreigners were allowed to own land, and coffee plantations worked by Chinese and Hawaiian laborers were established in the areas above Kona, at elevations above 800 ft. Kelly (1971) reported that coffee was grown on three acres in the Kalaoas in 1880. Coffee grew best on the fertile leeward slopes of Hualalai and Mauna Loa, at elevations of 800-1700 ft, the same area in which upland taro thrived (Goto 1979:5). Coffee gradually replaced taro in these areas.

Coffee growers in the Kona area experienced booms and busts over the years. In the 1850s the coffee crop suffered

through drought and blight. In 1880, the crop rebounded and an "abundance of fruit" was found "on the hills behind [Kailua] town" (Bowser 1880:549). Most of the coffee in this period was grown on large plantations. In 1889, the world coffee market collapsed. This resulted in a shift from large plantations owned by Caucasians to smaller plots that were frequently owned and operated by Japanese immigrants, individuals or families, who had completed their three years of service on the sugar cane plantations (Lind n.d.:19). In 1918, a frost killed the coffee crop in Brazil and prices for Kona coffee soared.

SETTLEMENT PATTERN

A general chronology for the North Kona area, north of the Honokohau/Kaloko area has been presented in Donham (1987:142-145). Donham's chronology, which includes data collected by Cordy (1981, 1985, 1986), Hommon (1976), and Kirch (1980, 1985) is generally summarized here.

Initial occupation of the northern end of North Kona occurred at Anaehoomalu in c. AD 900 (Barrera 1971). By AD 900 population growth in agriculturally favorable windward environments reached the point that exploitation of areas less favorable to agriculture (such as the northern portion of Kona) became necessary (Kirch 1985). Initial occupation of sites for areas environmentally similar to the present project area dates to c. AD 1030, which generally conforms to the above time scale. Kirch (1985) states that the overall population in West Hawaii appears to have been low, and remained fairly stable, until c. AD 1200 (1985:288), when a significant increase probably occurred. Due to the generally arid, rocky environment, and the lack of fresh water in the North Kona District, the increase was probably restricted to certain areas in the northern end of the district, such as Anaehoomalu and probably Kiholo, Kaupulehu, and Kukio.

Cordy's work suggests that as the population increased in certain parts of North Kona, substantial uninhabited buffer zones remained between established residential areas (Cordy 1981:173). Initial settlement of these uninhabited buffer zones, and probably along the entire coast as well, began c. AD 1400 at Kohana-Iki and Ooma II (Cordy 1981:168). During this period the population began to expand; it is suggested that it nearly doubled each century between AD 1200 and 1600; the expansion was followed by an eventual equilibrium and finally a decline (Kirch 1985:288).

Based on cartographic evidence, Cordy suggests that a shift from coastal to upland habitation took place during the nineteenth century in the North Kona area (Cordy 1985:35). Cordy's cartographic evidence indicated that during the Great Mahele (c. AD 1848), significant concentrations of Kuleana Awards were granted in upland areas, in contrast to coastal areas, of North Kona (Cordy 1986:36). Claimants to these Kuleana Lands were required to provide evidence of residence on the land or land use rights. Based on the presence of upland habitation and agricultural sites in Kealakehe that date to c. AD 1511-1638 (Walker and Rosendahl 1988), it seems likely that initial upland occupation of Kaupulehu may have occurred by AD 1550-1650. Agricultural sites, although not dated, are also documented for upland Kalaoa 4 (Walker and Haun 1987). Upland expansion at Ooma II has been suggested to have begun c. AD 1650-1700 (Donham 1987:144)

In his study of prehistoric sites in the Ooma and Kalaoa Ahupuaa, Cordy (1985:38) proposed that populations were small until AD 1500-1600 and that intensive agriculture was not being developed in the area until AD 1500. Cordy reviewed dates from 24 sites, and listed the earliest date recovered from each *ahupua'a*. The earliest dates for Kalaoa 5 at that time were AD 1400 (for a temporary habitation feature) and AD 1510 (for a permanent habitation feature). The earliest possible date for Kalaoa 4 was AD 1610, for a temporary habitation feature, and AD 1680, for a permanent habitation feature. All of these dates were obtained from coastal sites. One radiocarbon date of AD 1645-1950 was recorded from a hearth in a habitation feature at Kealekehe by Hammatt (Hammatt et al. 1987). Dates recorded for habitation sites in the Kahaluu area (Shun and Walker 1984) indicated that the Kona Field System in this area was established by 1420-1660.

IMPLICATIONS FOR THE CURRENT PROJECT

Expectations for the current project were formulated based on previous archaeological research and historic documentation. A variety of site types have been identified in the Barren Zone defined by Cordy (1985). Within the vicinity of the current project, these site types include shelter caves and modified lava-tube sinks, low stone platforms, low-walled shelters, large *ahu*, enclosures, petroglyphs, cairns, C-shapes, platforms, terraces, trails, and "hunting blinds." Thus, the inventory survey was expected to locate prehistoric habitation and agricultural features as well as historic modifications to the landscape. It was also considered likely that the lava tube system identified by Hammatt and Folk (1980) would extend into the project area. More recent developments within the project area, i.e., an electrical generation facility, have altered at least three acres of the current project area and levelled most of the surrounding area.

FIELD METHODS AND PROCEDURES

The present project was an inventory survey and consisted of pedestrian sweeps of the project area to locate all sites of archaeological significance. The sweeps were conducted by four persons in north-south and east-west transects, no more than 20 m (66 ft) apart. There was very little vegetation in the project area, and visibility was excellent. Survey transects were flagged to insure complete coverage, using red/white striped surveyor's flagging tape. The approximate locations of newly identified sites were plotted on a field copy of a scaled plan map of the project area, provided by the client.

All sites were described on standard PHRI site survey record forms and were photographed using 35 mm black-and-white film (PHRI Roll Number 4206). Detailed recording of sites included written descriptions, measurements, and plan maps. Each site, or the primary feature within each site complex, was marked with pink-and-blue flagging tape, and with an aluminum tag bearing the site number, date, the letters "PHRI," and PHRI project number (92-1265). As an aid to site reidentification, another piece of pink-and-blue flagging tape, inscribed with the site number, was wrapped around a rock and placed on the sites.

All new sites were assigned PHRI temporary field numbers prefixed with 1265- (beginning with 1265-1). All sites were subsequently assigned permanent State Inventory of Historic Places* (SIHP) site numbers (Table 2).

Table 2.

CORRELATION OF SITE NUMBERS

SIHP Number	PHRI Number
18076	1265-1
18077	1265-2
18078	1265-3
18079	1265-4

**State Inventory of Historic Places (SIHP) numbers. SIHP numbers are five-digit numbers prefixed by 50-10-27 (50=State of Hawaii; 10=Island of Hawaii; 27=USGS 7.5' series quad map ["Keahole Point., Hawaii"]).*

FINDINGS

DISCUSSION

Four sites, with seven component features, were identified in the project area. Also, a modern house, which is occupied, is situated outside the project area on its western border. The locations of the sites are shown in Figure 2. The features and sites are described below. Sites consisting of more than one feature were considered complexes. All sites and features were pahoehoe excavations that probably functioned as quarries. A summary of identified sites and features is presented in Table 3.

The project area contained an abundance of recent trash, consisting of broken dishes, plastics, toys, metal, automobile tires, styrofoam, beer bottles, and other items, which may be associated with the house. A concentration of gourds and macadamia nut shells was found 13.0 m east of the house, within the project area. Some of the pahoehoe blisters near the house were filled with trash. At the north end of project area, 14.40 m north of the electrical facility and 20.0 m east of the dirt road, was a concentration of eight *opihi* shells on top of recent bulldozer push.

SITE DESCRIPTIONS

SITE NO.: State: 18076 PHRI: 1265-1
SITE TYPE: Pahoehoe Excavation
TOPOGRAPHY: Very gently sloping pahoehoe flows; exposed outcrops are common in the area.
VEGETATION: Fountain grass, *noni*, *koa-haole*, *'ilima*, plumeria, palm, unknown shrub.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry
DIMENSIONS: 3.68 m by 2.53 m by 0.45 m
DESCRIPTION: Pahoehoe blocks have been broken out of a pahoehoe outcrop to form a small, shallow, amorphous blister. The excavated blocks (c. 0.10 to 0.40 m diameter each) are lying along the east side of the excavation.

SITE NO: State: 18077 PHRI:1265-2
SITE TYPE: Complex (2 Features)

Table 3.

SUMMARY OF IDENTIFIED SITES AND FEATURES

Site/Feature Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
18076	Pahoehoe Excavation	Quarry	M	L	L	-	-	-
18077	Complex (2)	Quarry	M	L	L	-	-	-
A	Pahoehoe Excavation							
B	Pahoehoe Excavation							
18078	Pahoehoe Excavation	Quarry	M	L	L	-	-	-
18079	Complex (3)	Quarry	M	L	L	-	-	-
A	Pahoehoe Excavation							
B	Pahoehoe Excavation							
C	Pahoehoe Excavation							

Cultural Resource Management Value Mode Assessment
Nature: R = scientific research, I = interpretive, C = cultural
Degree: H = high, M = moderate, L = low

Field Work Tasks: DR = detailed recording (scaled drawings, photographs, and written descriptions), SC = surface collections, EX = limited excavations.

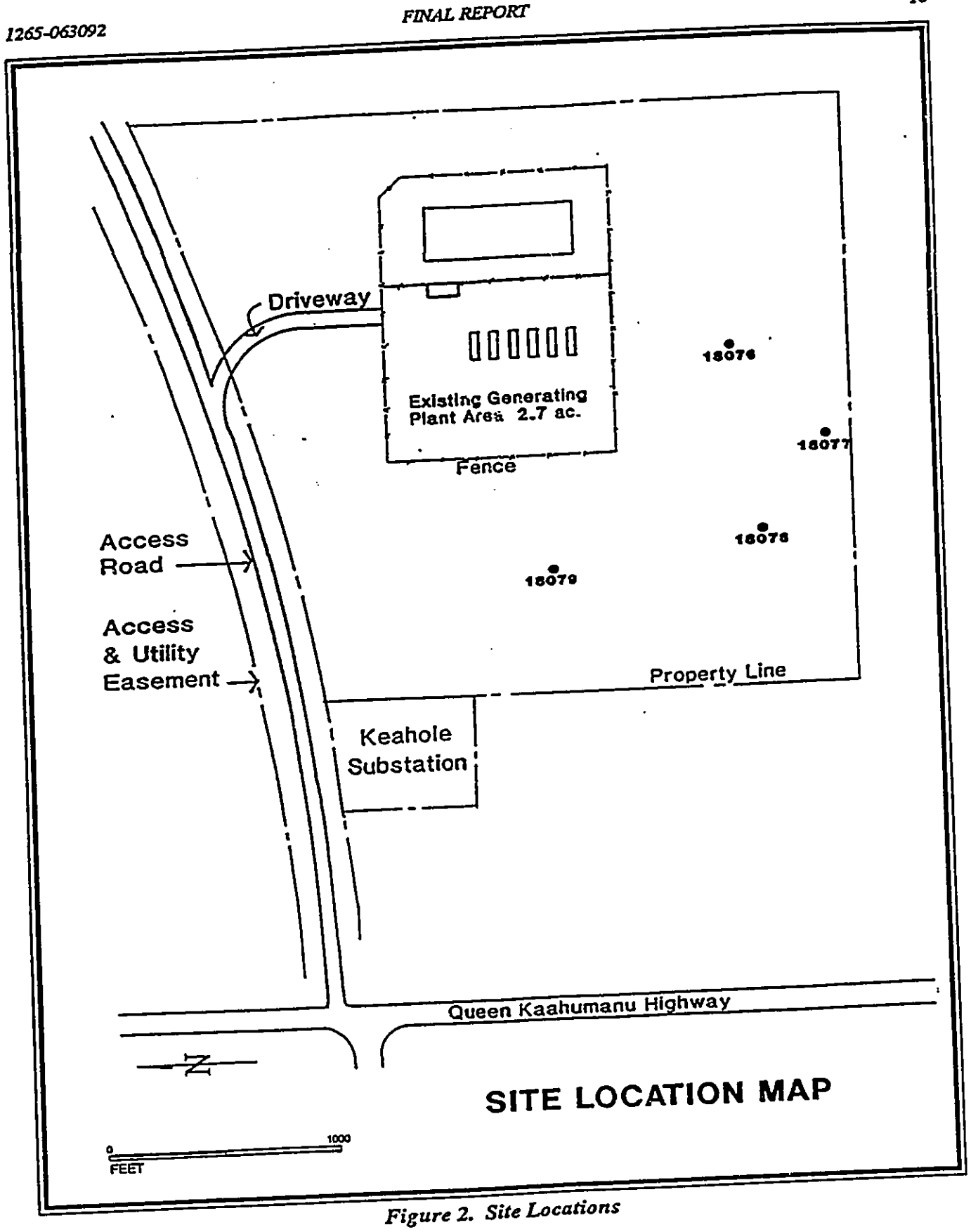

Figure 2. Site Locations

TOPOGRAPHY: Very gently sloping pahoehoe flows. Exposed outcrops are common in the area.
VEGETATION: Fountain grass, *noni*, *koa-haole*, *'ilima*, plumeria, coconut palm, unidentified shrub.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry
DIMENSIONS: 3.50 m by 3.5 m by 0.45 m (approx.)
DESCRIPTION: The site complex consists of two pahoehoe excavations.

FEATURE A: Pahoehoe Excavation
FUNCTION: Quarry
DIMENSIONS: 1.50 m by 1.60 m by 0.19 - 0.45 m
DESCRIPTION: Pahoehoe blocks have been broken out of pahoehoe outcrop to form a small, shallow, oval blister. The excavated blocks (c. 0.20 to 0.45 m diameter each) are lying around the excavation. Feature A is connected to Feature B by a strip of pahoehoe.

FEATURE B: Pahoehoe Excavation
FUNCTION: Quarry
DIMENSIONS: 1.70 m by 1.70 m by 0.21 - 0.44 m
DESCRIPTION: Pahoehoe blocks have been broken out of pahoehoe outcrop to form a small, shallow, circular blister. The excavated blocks (c. 0.15 to 0.35 m diameter each) are lying around the excavation.

SITE NO: State: 18078 PHRI: 1265-3
SITE TYPE: Pahoehoe Excavation
TOPOGRAPHY: Very gently sloping pahoehoe flows. Exposed outcrops are common in the area.
VEGETATION: Fountain grass, *noni*, *koa-haole*, *'ilima*, plumeria, palm, and an unknown shrub.
CONDITION: Poor to fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry
DIMENSIONS: 7.0 m by 2.0 m
DESCRIPTION: Pahoehoe blocks have been broken out of a pahoehoe outcrop to form a long, narrow, shallow blister. The excavated blocks (c. 0.6 to 0.4 m diameter each) are lying around the excavation.

SITE NO: State: 18079 PHRI: 1265-4
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: Very gently sloping pahoehoe flows. Exposed outcrops are common in the area.
VEGETATION: Fountain grass, *noni*, *koa-haole*, *'ilima*, plumeria, coconut palm, and an unknown shrub
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Quarry
DIMENSIONS: 6.2 m by 10.0 m by 0.4 m (approx.)
DESCRIPTION: The site complex consists of three pahoehoe excavations.

FEATURE A: Pahoehoe Excavation
FUNCTION: Quarry
DIMENSIONS: 3.10 m by 1.70 m by 0.45 m
DESCRIPTION: Pahoehoe blocks have been broken out of a pahoehoe outcrop to form an oval, shallow blister. Some of the excavated blocks (c. 0.10 to 0.40 m diameter each) are piled two-courses high along the west and north edge of the excavation, while other blocks are lying around the excavation.

FEATURE B: Pahoehoe Excavation
FUNCTION: Quarry
DIMENSIONS: 1.4 m by 1.0 m by 0.4 m
DESCRIPTION: Pahoehoe blocks have been broken out of a pahoehoe outcrop to form a circular, shallow blister. The excavated blocks (c. 0.1 to 0.3 m diameter each) are lying around the excavation.

FEATURE C: Pahoehoe Excavation
FUNCTION: Quarry
DIMENSIONS: 2.5 m by 2.0 m by 0.3 m
DESCRIPTION: Pahoehoe blocks have been broken out of a pahoehoe outcrop to form an oval, shallow blister. The excavated blocks (c. 0.15 to 0.60 m diameter each) are lying in and around the excavation.

CONCLUSION

DISCUSSION

Four sites, with seven component features, were identified in the project area. Feature types at the sites were limited to pahoehoe excavations, which were interpreted as quarry areas. These site types have not been previously documented in Kalaoa, although they are ubiquitous elsewhere in Kona, e.g., Kealekehe (O'hare, in prep.). How these quarry areas may have functioned is discussed here in the context of the larger settlement pattern.

Rosendahl (1973) has discussed the implications of barren-zone archaeological remains for understanding patterns of aboriginal Hawaiian settlement, particularly in the desolate section of North Kona extending from Kailua to Anaehoomalu. While discussion has concentrated on the nature of barren-zone residential occupation, the relationships between the coastal and upland occupation components are less well defined.

According to Rosendahl, the area of aboriginal Hawaiian occupation can be divided into three principal zones: (a) a very narrow and arid coastal zone associated with the exploitation of marine resources, (b) a sloping, barren intermediate zone of recent volcanics, almost devoid of soil or vegetation, and (c) an upland habitation zone associated with agricultural exploitation. The forest zone further *mauka* was exploited, but rarely inhabited.

The principal forms of occupation within the barren zone included (a) temporary shelter occupation by people traveling between the coast and uplands, and perhaps along the coast, and (b) temporary and extended residential occupation of larger, natural cave features by people engaged in various coastal zone marine exploitation activities. Other possible minor forms of occupation included special purpose temporary occupation, refuge functions, and use of caves as burial features. No direct evidence for other exploitative activities, such as scoria quarries and abrader manufacturing areas (such as those found in South Kohala), was apparent within the North Kona barren zone, according to Rosendahl (1973:66). All evidence encountered was related to activities within the adjacent coastal or upland zones.

Rosendahl also suggests (ibid:66) that while there is no direct archaeological evidence, it is possible that the *nene*, or Hawaiian goose (*Branta sandwichensis*) was hunted in the barren zone. Baldwin's study of the distribution and historic reduction of the *nene* indicates the endemic bird to have been at one time abundant in North Kona, especially in the area between Hualalai and Mauna Loa, and that it moved to the barren lowlands and coastal lava fields of Kekaha during the winter months (Baldwin 1945:28-31).

Much of the ethnohistoric and ethnographic information for North Kona refers to the area between Kailua and Honaunau; the area between Kailua and Anaehoomalu is similar, although here the coastal portion was more barren and had several fishponds, the upland portion was probably less densely populated, and is separated from the coast by a more extensive barren zone with more recent volcanic remains. During the historic period, most travel between Kawaihae and Kailua was by water, and this was apparently the case during the prehistoric period, as well (Rosendahl 1973).

The ethnohistoric and ethnographic sources offer almost no information on the relationship of the coastal and upland occupation components, but it can be assumed that a principal aspect of such relationships would have involved the exchange of marine resources for agricultural resources. This was the usual pattern of aboriginal Hawaiian social and economic interaction and integration (see Rosendahl 1972:7:462-469). This model has been called the *'ili-'ohana* model. A segment of the larger ahupua'a, the *'ili* was a land section extending *mauka* from the coastal waters and strand area through the agricultural lands and into the forest. The *'ohana* was the extended family group which occupied the *'ili* in dispersed, permanent residential units. This socio-economic model emphasized patterns of reciprocal exchange, of both subsistence products and other goods and services, between the *'ohana* members who lived on the coast and those who lived in the uplands. This validity of this model, however, is a matter of debate (Sahlins 1973, Hommon 1976).

Thus, the barren zone may have been used primarily for travel between coastal and upland areas. Temporary shelters and the *mauka-makai* foot trails evidence the movement of people, and presumably goods, between the coast and uplands. The findings in the current project do not support this hypothesis because no trail or temporary habitations were located. This, however, was due to the small size of the project area and to the recent modifications to it.

Evidence from the current project (i.e. the pahoehoe excavations), indicates that the barren zone may also have been the site of quarries that supplied materials such as scoria (which was utilized in the manufacture of abrading tools), and/or extracting basalt and volcanic glass products that were utilized as cutting implements. The excavations may have been used to create depressions for planting or water catchment. Further, the stones removed from the excavation may have been used as building materials. Thus, pahoehoe excavations

may have served a variety of purposes. The pahoehoe excavations in the current project, however, appear to have been prospect pits rather than productive quarries. Perhaps, as Rosendahl suggests (1973:65), the type of lava in this area did not yield scoria or other usable raw materials. This could also account for the lack of pahoehoe excavations in the general vicinity.

It seems likely that the pahoehoe excavations are related to periods of prehistoric occupation, rather than the historic period, based on the presence of habitation and refuge caves in the area just south of the current project. These cave sites provide a temporal range of AD 1480 to 1700 (Hammatt and Folk 1980). It is also possible that during times of conflict, particularly during the late prehistoric, the exchange of materials such as volcanic glass and scoria was restricted, forcing people to seek alternative sources closer to home. Evidence to support this hypothesis has been presented elsewhere (Graves and Goodfellow 1992:74).

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

General significance assessments and recommended general treatments for all identified sites are summarized in Table 4. Significance categories used in the site evaluation process are based on the National Register criteria for evaluation, as outlined in the Code of Federal Regulations (36 CFR Part 60). The Hawaii State Historic Preservation Division uses these criteria for evaluating cultural resources. Sites determined to be potentially significant for information content (Category A, Table 1) fall under Criterion D, which defines significant resources as ones which "have yielded, or may be likely to yield, information important in prehistory or history." Sites potentially significant as representative examples of site types (Category B) are evaluated under Criterion C, which defines significant resources as those "...which embody the distinctive characteristics of a type, period, or method of construction...or that represent a significant and distinguishable entity whose components may lack individual distinction."

Sites with potential cultural significance (Category C) are evaluated under guidelines prepared by the Advisory Council on Historic Preservation (ACHP), entitled Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review (Draft Report, August 1985). The guidelines define cultural value as "...the contribution made by an historic property to an ongoing society or cultural system. A traditional cultural value is a cultural value that has historical depth." The guidelines further specify that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value."

Table 4.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

SIHP Site Number	Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
18076	-	+	-	-	-	+	-	-
18077	-	+	-	-	-	+	-	-
18078	-	+	-	-	-	+	-	-
18079	-	+	-	-	-	+	-	-
Total	0	4	0	0	0	4	0	0

General Significance Categories:
A=Important for information content, further data collection necessary (CRM value mode assessment = scientific research value)
X=Important for information content, no further data collection necessary (CRM value mode assessment = scientific research value)
B=Excellent example of site type at local, regional, island, state, or national level (CRM value mode assessment = interpretive value)
C=Culturally significant (CRM value mode assessment = cultural value)

Recommended General Treatments:
FDC=Further data collection necessary (further survey and testing, and possibly subsequent data recovery/mitigation excavations)
NFW=No further work of any kind necessary, sufficient data collected, archaeological clearance recommended, no preservation potential (possible inclusion into landscaping suggested for consideration)
PID=Preservation with some level of interpretive development recommended (including appropriate related data recovery work) and
PAI=Preservation "as is," with no further work (and possible inclusion into landscaping), or minimal further data collection necessary

Based on the findings of the archaeological survey and test excavation field work, the archaeological remains found within the HELCO Keahole Parcel project area are assessed as significant solely for information content. These four sites have been measured, mapped, described, photographed, and plotted on a topographic map. No further work is recommended for these sites, as the information recovered is considered sufficient.

To assist the client in making decisions regarding the treatment of resources, the general significance of the archaeological sites identified during the current survey was also evaluated in terms of potential research value, interpretive value, and/or cultural value (PHRI Cultural Resource Management [CRM] value modes). *Research value* refers to the potential of archaeological resources for producing information useful in the understanding of cultural history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. *Interpretive value* refers to the potential of archaeological resources for public education and recreation. *Cultural value* refers to the potential of archaeological resources to preserve and promote cultural and ethnic identity and values. All sites identified during the current project were assessed as of low significance for research value, interpretive value and cultural value. CRM assessments for individual sites are presented in Table 3.

The assessments and recommendations presented here are based on the findings of an inventory survey of the project area, and they are subject to the limits of such surveys. There is always the possibility, however remote, that potentially significant, unidentified surface and subsurface cultural remains will be encountered in the course of further archaeological investigations or subsequent development activities. In such situations, archaeological consultation should be sought immediately.

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APPENDIX A

HISTORICAL DOCUMENTARY RESEARCH

by Lehua Kalima, B.A.

Historical information on Kalaoa Ahupua'a, in which the project area is situated, is extremely limited. For this reason, information concerning *ahupua'a* near Kalaoa 4 as well as more general information on the North Kona district are included within this report. The information presented here includes legends, early historic accounts, land use information, and settlement patterns.

Kalaoa Ahupua'a is said to be named for Kalaoa Pu'umoi, sister of Kapalaoa, the mother of the riddling expert Kalapana. The name Kalaoa literally translates as "the choker (as a stick for catching eels)" (Pukui et al. 1974:75).

The entire portion of North Kona which lies between Honokohau (sometimes referred to as Honokahau) and Kapalaoa was once known as Kekaha (Soehren 1963:1). These *ahupua'a* in Kekaha were often treated as a unit. Kekaha (where food does not grow) (ibid.) was a waterless land frequently ravaged by Pele. Hawaiians who lived there gave such epithets as "Kekaha wekawela" (black Kekaha) and "Kekaha wai 'ole" (waterless Kekaha) to these barren lava fields (ibid.).

Hannah Springer, an authority on this area, writes that Kekaha (translated as barren, desolate) was the name given to that section of North Kona from Honokohau, north of Kailua, to Napu'u (the Hills), meaning Pu'uwaa'awa'a and Pu'uanahulu. That section continued along the coast to Anaeho'omalu, the boundary of South Kohala (Springer 1985:2).

Eliza Maguire, a resident of Hu'ehu'e at the turn of the century and a translator of Hawaiian legends, comments on the terrain of this area:

> One readily sees the great lava stretches of country, as one travels along the road. It is no wonder that the simple fisherfolks living along the sea-coast personified the volcano as a dreadful being with supernatural powers whose wrath bore down on them so much destruction, laying waste their gardens, and filling their fish-ponds with rocks, leaving them on a narrow strip of beach, the ocean on one side, and the lava fields on the other (Maguire 1966:5).

Pre-Contact History

Two legends relevant to the project area were found. One legend about the North Kona district concerns the god Lono, who was associated with life-giving resources such as rainfall: "...the story of the origin of the Makahiki rain and harvest festival...was to bring Lono from Kahiki, whither he returns," (Handy and Handy 1972:522-523). Another legend, included in Maguire's *Kona Legends* (1966), concerns a shoreline pool *makai* of the project area. The legend describes how a *kupua* (wizard) named Wawaloli entranced Malumaluiki, a beautiful girl from the uplands, who came to the shore to gather *limu* and shellfish. He taught her a chant, and every day when she came to the shore, Malumaluiki would call out this chant and bring him forth from his hole in the pool. Wawaloli would emerge from the pool and metamorphose from a *loli* (sea slug) into a man. The two would then devote the entire day to lovemaking, and Malumaluiki would neglect to gather food. Her parents wondered why she returned home tired and with no catch to show for her time at the beach. One day her father followed her and witnessed the transformation of Wawaloli and the couple's activities. The next day, carrying his trapping net, he arrived at the pool before Malumaluiki, and he called out the chant to bring forth Wawaloli. As the *loli* emerged from the hole in the pool, the father ensnared it and took it to the *kahuna* Papaapoo at Hoohila. Papaapoo advised the father to heat an *imu* and bake the *loli*. "When the loli is dead, your daughter will live on, and so will all the daughters of the families around here." This was done and Wawaloli perished, but the pool and the hole that he once dwelled in remain.

Information relevant to the present project area was found in a number of archaeological reports. A passage concerning the ancient chief Umi-a-Liloa, found in Schilt (1984), refers to the numerous caves in the general vicinity of the project area and indicates that many of them were used as places of refuge:

> In Kona, 'Umi was said to have established craft and professional separations....This division of labor probably came at a time of rapid population increase and was aimed at increasing production and work efficiency. However, 'Umi's descendants apparently struggled without definitive success to maintain political control over the island. In fact, traditions dating probably from the 1500s to the mid-1700s tell of the stresses and battles between opposing district chiefs of Hawaii island, and Maui and the chiefs of leeward Hawaii. It was probably during this time that many caves in leeward Hawaii Island were extensively modified to become underground places of refuge (Schilt 1984:22).

Cordy (1985) identifies the Kalaoa area as that of the high priest, Kaluolapa, who presided over ceremonies in Haleohiu and Kalaoa. Unfortunately, he does not cite his source for this statement.

One saying about the Kekaha area comments on the life-sustaining qualities of the sea off Kekaha:

Ola Akula ka 'Aina Kaha, Ua Pua ka Lehua i Kai.

Life has come to the *Kaha* lands for the Lehua blooms are seen at sea.

"Kaha Lands" refers to Kekaha, Kona, Hawaii. When the season for deep-sea fishing arrived, the canoes of the expert fishermen were seen going and coming (Pukui 1983:271).

Kekaha was, and is, famous for its offshore fishing grounds. The native historian, Samuel Kamakau, writes about the High Chief Umi-a-liloa fishing for *aku* off the coast of Maka'ula during the 15th century (Kamakau 1961:20). During the later years of his life (c. 1810), Kamehameha frequently enjoyed fishing expeditions along the shores of Kekaha (ibid:203).

John Papa I'i, a Hawaiian historian and member of Kamehameha III's court, notes the abundance of fish and trading done off the coast of Kekaha:

> The next day the ship arrived outside of Kaelehuluhulu, where the fleet for aku fishing had been since the early morning hours. The sustenance of those lands was fish... Soon the fishing canoes from Kawaihai, the Kaha lands, and Ooma drew close to the ship to trade for the *pa'i 'ai* (hard *poi*) carried on board, and shortly a great quantity of *aku* lay silvery-hued on the deck (I'i 1973:109).

Hannah Springer writes about the climate of these Kekaha lands:

> Located on the leeward side of Hawai'i, Kekaha is less affected by the northeast tradewinds, which are distorted, if not blocked by the masses of Mauna Kea, Mauna Loa, and Hualalai, than are the regions of the windward side of the island. The land-sea breezes and other regional winds play an important part in determining the climate of, and affecting activities in Kekaha (Springer 1985:4-5).

Springer also notes that Robert Keakealani of Pu'uanahulu has described the winds of Kekaha as he learned them: The 'Eka wind is the "Waimea wind", the prevailing wind; the Kaumoku is the wind from Kona; the wind from Maui is called Ho'lua (Hoolua); and the Kuhonua is the wind from *mauka.*

The fishpond of Paaiea was a large pond extending from Kaelehululu in Mahaiula to Wawaloli on the southern boundary of Ooma, a distance of about three miles. This pond was not far from Keahole Point, and the fishermen going to Kailua and further south often took a short cut by crossing the pond in their canoes "thus saving time and the hard labor of paddling against the Eka, a strong sea breeze from the south, and also against the strong current from Keahole" (Maguire 1966).

This fishpond was destroyed in 1801 when it was inundated by the Hualalai lava flow.

Three poetic sayings referring to the 'Eka wind, mentioned by Robert Keakealani and Eliza Maguire, are found in Pukui's *'Olelo No'eau*:

Ka Makani kukulu pe'a nui, he 'Eka.

The 'Eka, the wind that sets up the big sails.

When the 'Eka wind blew in Kona, Hawaii, the fishermen sailed out to the fishing grounds (Pukui 1983:159).

Ke 'Eka, makani ho'olale wa'a o na Kona.

The 'Eka breeze of Kona that calls to the canoemen to sally forth to fish.

Refers to Kona, Hawaii (ibid:182).

Makani 'Eka aheahe o Makalawena.

The gentle breeze of Makalawena (ibid:228).

According to tradition, Kekaha was a region "valued by ruling chiefs, inhabited by attendant chiefs, and upon occasion abused by warring chiefs" (Kalakaua 1973:31). It was the object of contention during the late 16th century when Kamalalawalu, ruling chief of Maui, was at war with Lonoikamakahiki, ruling chief of Hawaii (Kamakau 1961:56).

During the early 18th century, when Alapa'inui was at war with Kekaulike of Maui, the latter "abused the country people of Kekaha", cut down "the trees throughout the land of Kona", and "at Kawaihae he cut down all the coconut trees" (ibid:66). These acts of war were of no small consequence, for "to fell trees of such usefulness was considered truly inhuman" (Springer 1985:23).

Early Historical Accounts

The earliest written historical account of this part of the North Kona area is that of Archibald Menzies, who traveled with Captain George Vancouver in 1792. He wrote, "barren and rugged with volcanic dregs and fragments of black lava...in consequence of which the inhabitants were obliged to have recourse to fishing for their sustenance" (1920:99). It is assumed that Menzies never ventured beyond the coastline to the location of the project area.

John Papa I'i described Kalaoa as it appeared when he sailed past, "The gentle Eka sea breeze of the land was blowing when the ship sailed past the lands of the Mahaiulas, Awalua, Haleohiu, Kalaoas, Hoona, on to Oomas, Kohanaiki, Kaloko, Honokohuas, and Kealaheke, then around the cape of Hiialcanoholae, which was two long points of land. At first it seemed that these two were the only jutting points of land, but then more were seen, extending as far as Kapalilua" (1973:110).

William Ellis, during his around-the-island journey in 1823, noted the existing condition of the North Kona area, and also the extensive destruction by Hualalai's 1800-1801 flow. He wrote that the flow had "...inundated several villages, destroyed a number of plantations and extensive fish-ponds, filled up a deep bay twenty miles in length and formed the present coast...Stones walls, trees, and houses, all gave way before it; even large mass or rocks of hard ancient lava, when surrounded by the fiery stream, soon split into small fragments, and falling into the burning mass, appeared to melt again, as borne by it down the mountain's side" (Ellis 1963:30-31).

In 1840, Wilkes, an explorer with the American Expedition, made a few observations about this area:

> ...a considerable trade is kept up between the south and north end of this district. The inhabitants of the barren portion of the latter are principally occupied in fishing and the manufacture of salt, which articles are bartered with those who live in the more fertile regions of the south, for food and clothing (Wilkes 1845:91).

Evidence of this salt manufacture is still seen along the coast in the numerous basalt and concrete salt pans.

An early western description of a journey through the inland area was written by George Bowser in 1880 :

> From Kiholo the road southwards is rough and laborious. Perpetual travelling over lava is very hard upon our horses, and it is impossible to travel faster than the slowest walk. On the road we met with some awful chasms of unknown depth and numberless cracks and fissures in the lava (Bowser 1880:93).

Bowser also recorded the business operations in various areas of the islands. Here he relates his impressions of North Kona and mentions some of the luxuriant foliage he encountered:

> Presently I reached the ridge of the mountain, and had a fine view of the surrounding country. Fronting the sea for many miles in North Kona there is a rich tract of bottom land which might be turned to good account. Large areas of the mountain land might also be cultivated for coffee. It is a shame to see so many hundred square miles of country lying waste for want of enterprise on the part of its owners.
>
> I was astonished to see in this district how bananas, mangoes, oranges, pineapples, in short, all the fruits belonging to these islands grow in profusion and yield splendid crops upon the bare lava. Ferns it is not so surprising to see, for they will grow in all sorts of rocky situations, but the luxuriance of their growth is wonderful. In many places you may see them growing to the height of five-and-twenty feet. The ferns, except the variety which yields the pulu, are only food to look at, for if there is an edible fern here, as in New Zealand, the natives have had too many other more tempting fruits of the soil at hand to think of turning it to account. But the fruits I have just alluded to ought to be worth something if any one would but try to utilize them. They are so fine in quality and grow in such profusion that I feel sure some enterprising person will yet make a fortune by being the first to turn them to account (ibid.).

Land Tenure

During the Great Mahele of 1848 Kalaoa 4 was set aside as Government Land (Board of Commissioners 1929). This land and Kalaoa 1-3 were the lands of King Kamehameha III, who passed it to the government. Most of the land between the 1,000 ft and 2,400 ft elevation was soon sold, and a series of grants was issued in these *ahupua'a* from 1852 to 1864. Typically sold in lots of c. 50 acres, most of them were agricultural parcels (Cordy 1985:6 and Soehren 1982:3).

Agriculture

The introduction of foreign plants and animals has changed cultivation and land use drastically in the Kona area and throughout the Hawaiian chain. Handy tells us that in the Kona area, where the rain for taro planting is seasonal, dry taro was planted in individual holes filled with mulch. Clearing the upland forest for this type of planting was termed *umoki* (Handy 1940:47-48). Kepelino, a native of Kona, gives a detailed account of methods of planting there (ibid:48).

In 1794, Captain Vancouver introduced goats and cattle to the Kona area, and for many years they were the mainstay of industry. The 1850s saw the development of large-scale commercial ranching and agriculture following the Mahele and an 1850 law permitting foreigners to own land. Coffee, grazing land, and sugar cane gradually replaced traditional subsistence crops such as taro and *'uala*. Chinese and Hawaiian labor was used on coffee plantations located in the fertile belt above the 800 ft elevation. At elevations of 500 to 3,000 ft, tobacco was grown commercially until about 1930 (Schilt 1984:24). Tobacco was not grown in the present project area, however, because of a lack of soil. Figure 1 is a map showing the project area vicinity as it appeared in 1888.

Land Settlement Patterns

The Kalaoa area has been described by early visitors as an arid and hot region. As in most of the Kekaha lands, the population of Kalaoa was largely concentrated on the coast, while most fields were in the upland forest. Trails (and associated shelters) connected the two areas (Cordy 1985:5). The 1801 lava flow effectively wiped out the coastal settlements in Kalaoa. According to Schmitt, the population decreased from 300,000 to 145,000 between 1778 and 1819, a reduction of 52% (Schmitt 1977:25).

In his 1985 report, Cordy discusses the conflicting views of Reinecke and Ching concerning the population in the project area vicinity. Reinecke (n.d.) thought there was once a large population, in the hundreds, and the reason for the "scarcity of remains" was that they were destroyed by man, cattle, and storms; were not discernible in sand areas; or were a short distance inland. Ching (1971) agrees, saying that legends suggest "[a] large population for the lands above the study area" (North Kona). He believes the trails in the Kalaoa area suggested inland permanent settlement in Kalaoa. He also argues that fishponds, fishing grounds, and the large number of archaeological sites, refuge caves, and *holua* slides in the North Kona area suggest a land of no little worth (ibid.). Cordy argues that population was always low, that the number of sites is not unusual for 400 years of occupation, and that the area contained only small villages of fishermen in a harsh environment. Counts of permanent house sites and conversion to population estimates (Cordy 1987:244-5) indicate that the combined population of Ooma 1 and 2 and Kalaoa 4 and 5 never consisted of more than 102 people, and was at a maximum between c. 1750-1780. The population in North Kona declined to 1,753 in 1890 and then increased to 3,819 in 1900 (Schmitt 1977:13).

By 1866, most of the land flanking the Mamalahoa Highway had been sold (Soehren 1985). All the early grants had frontage on the "alaloa mauka" or upper belt road, now known as the Mamalahoa Highway, which lies at about the 1,700 ft elevation. Another road at about the 1,100 ft elevation, the Alanui Kauila, served the lower ends of these grants (ibid.). Soehren notes that these arterial roads "connected the upland farm lots of the various *ahupua'a* with one another, with the port and urban center at Kailua and with the rest of the island" (ibid.). Portions of the Alanui Kauila are now part of Kauila Street in Kona Coast View subdivision, while Ahiahi Street in Kona Palisades follows approximately the route of the Alanui Kama, a lower branch of the Alanui Kauila (ibid.).

Communication between different elevations within the *ahupua'a* was provided by *mauka-makai* trails such as the Alanui Kauhini (probably Ka-'uhini, "grasshopper" [ibid.]). One of the trails in Kalaoa mentioned by Ching (1971) could be the Alanui Kauhini. It is a trail that runs *mauka-makai*. In their survey of Kalaoa 4, Telea and Rosendahl (1987) state that the trail once served to transport people and produce between the upland agricultural and the coastal habitation zones.

Shortly after World War II, a jeep trail was bulldozed from Mamalahoa Highway to the shore near Keahole Point (Soehren 1985). The upper portion of this road followed the Alanui Kauhini past private farm lands to the state land below (ibid.). Over the years, the trail was maintained by periodic bulldozing until the Queen Kaahumanu Highway made access to the shore easier (ibid.).

Today the Kalaoa area is well populated in the upper forest zones, since the Kona Palisades Subdivision has developed much of that area. The intermediate zones are slowly becoming developed as part of the industrial and residential areas which have been expanding out of Kailua. No permanent human habitation was ever reestablished on the coast since the 1801 lava flow inundated much of the area. The coastal area is now home to the Keahole Airport and OTEC, the Natural Energy Laboratory of Hawaii.

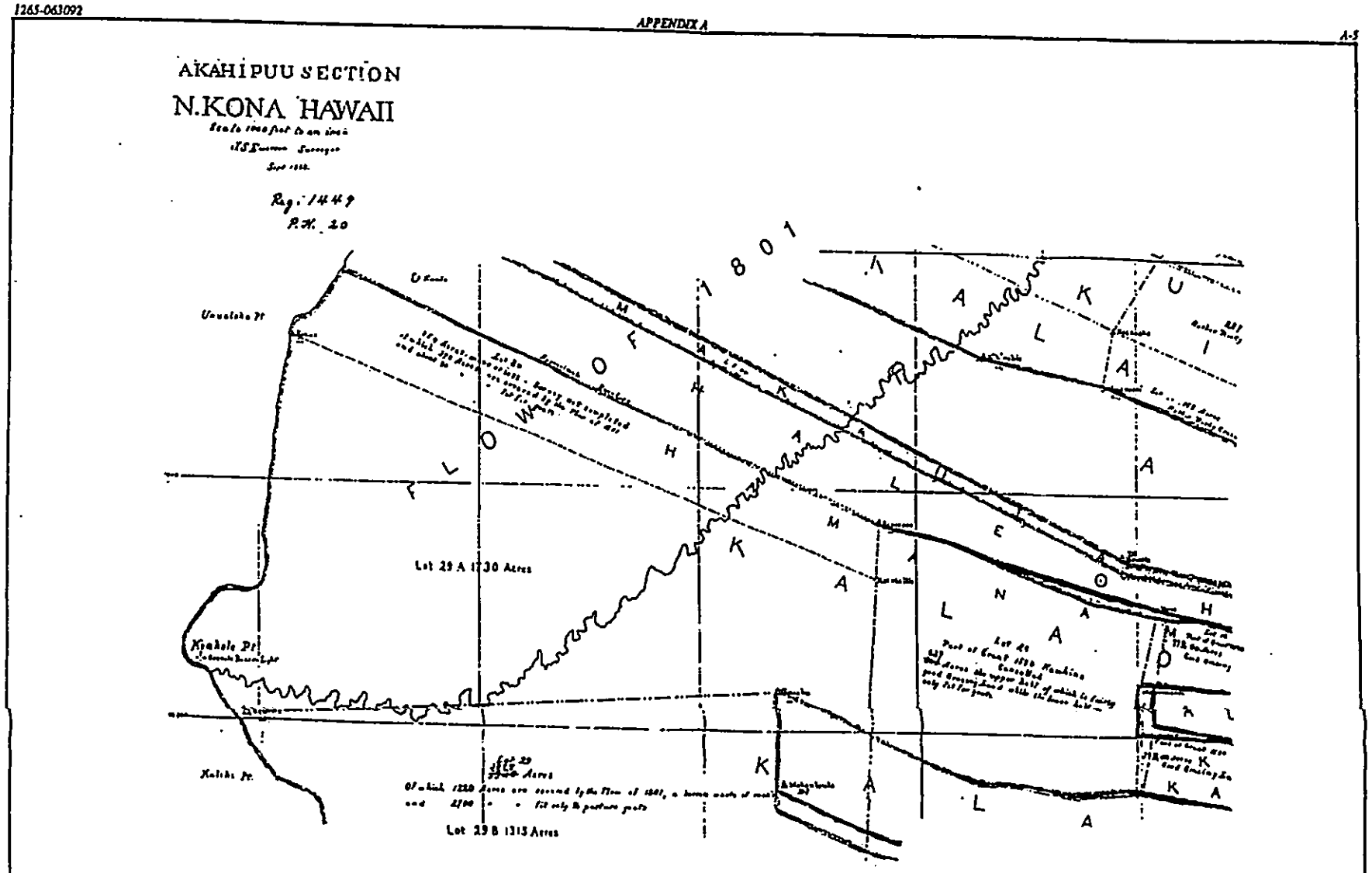

Figure A-1.
Map of Akahipuu Section, North Kona, Hawaii, by J.S. Emerson, Sept. 1888
Taken from State Survey Dept. Reg. Map No. 1449

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APPENDIX B

ILLUSTRATIONS

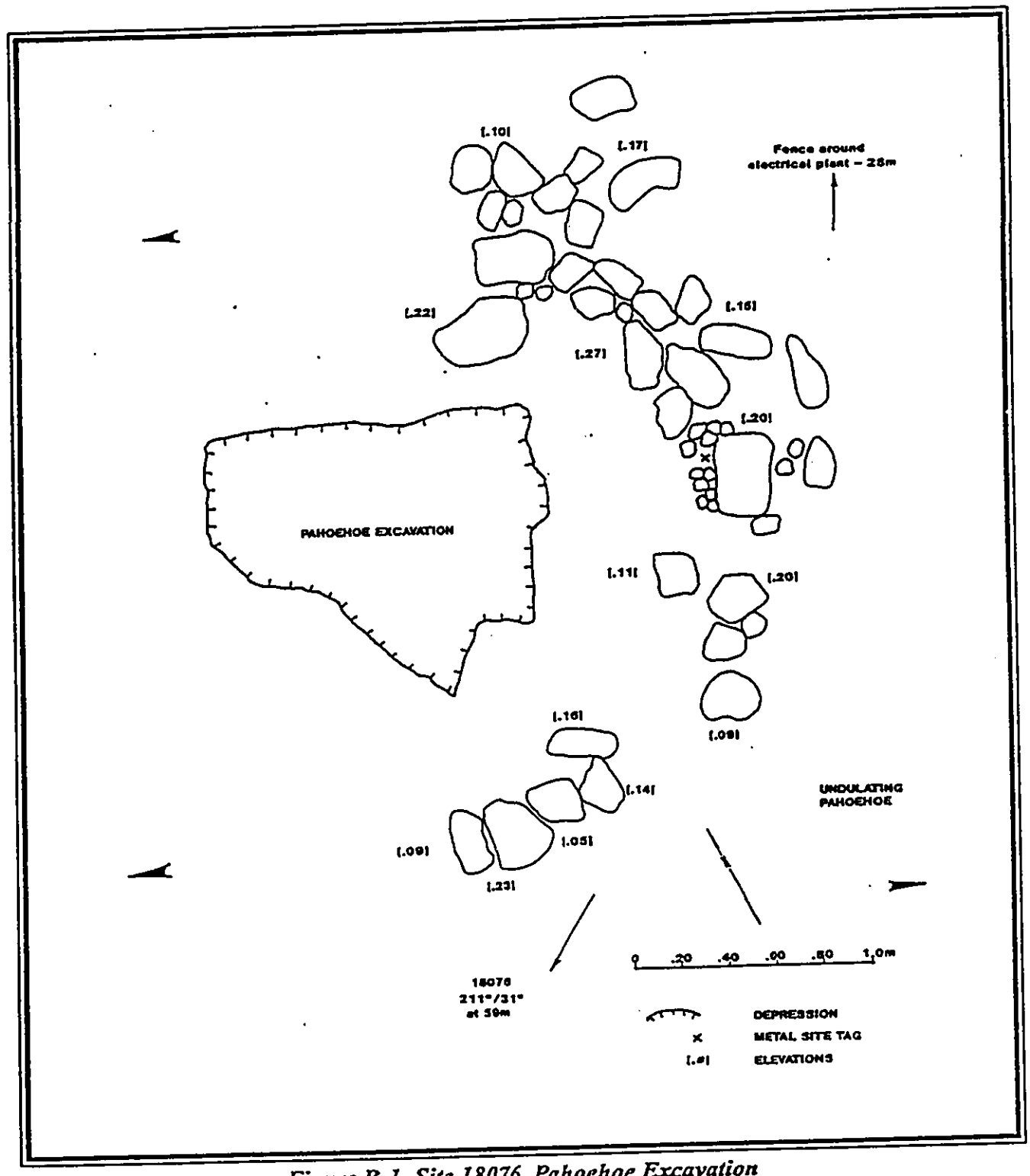

Figure B-1. Site 18076, Pahoehoe Excavation

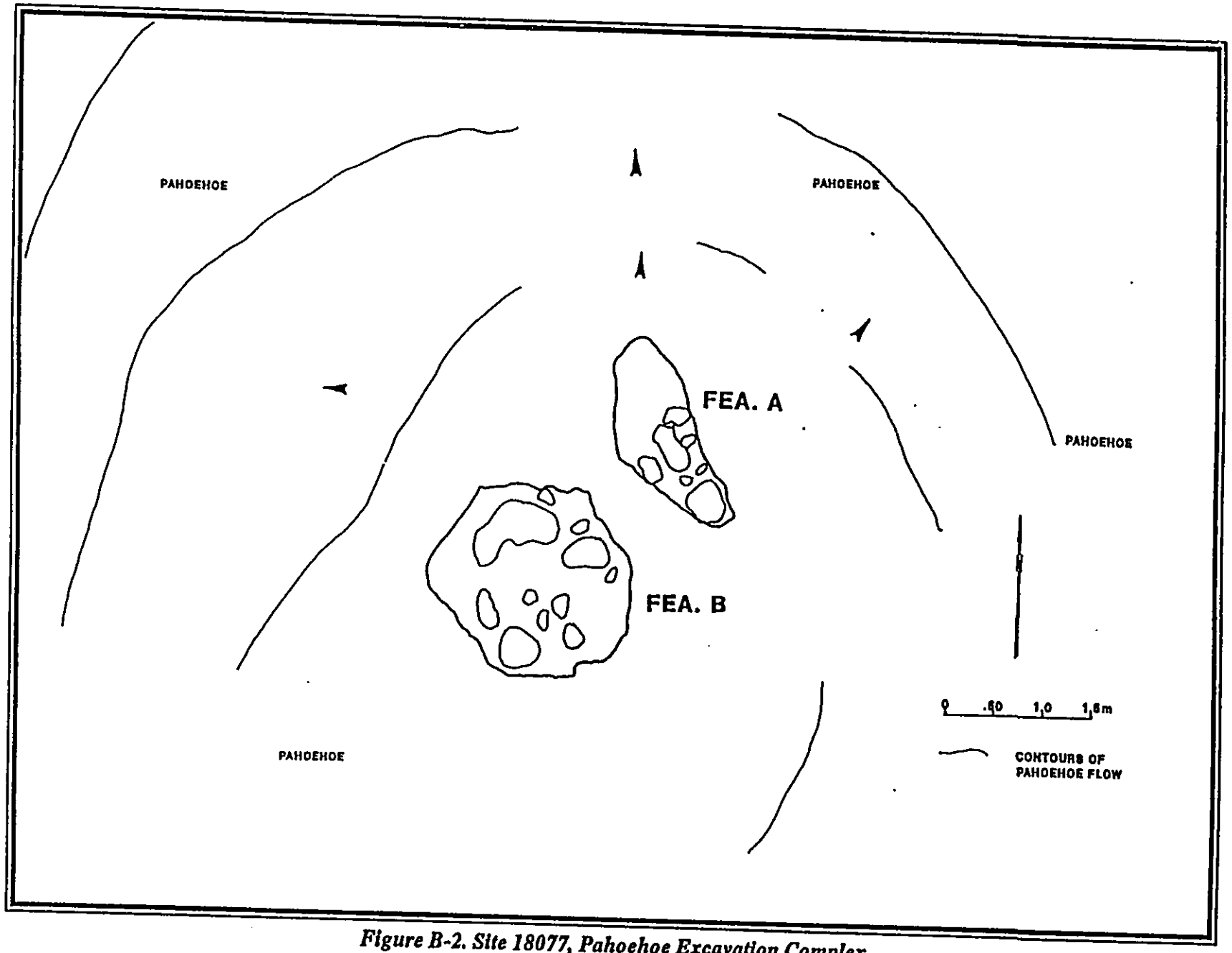

Figure B-2. Site 18077, Pahoehoe Excavation Complex

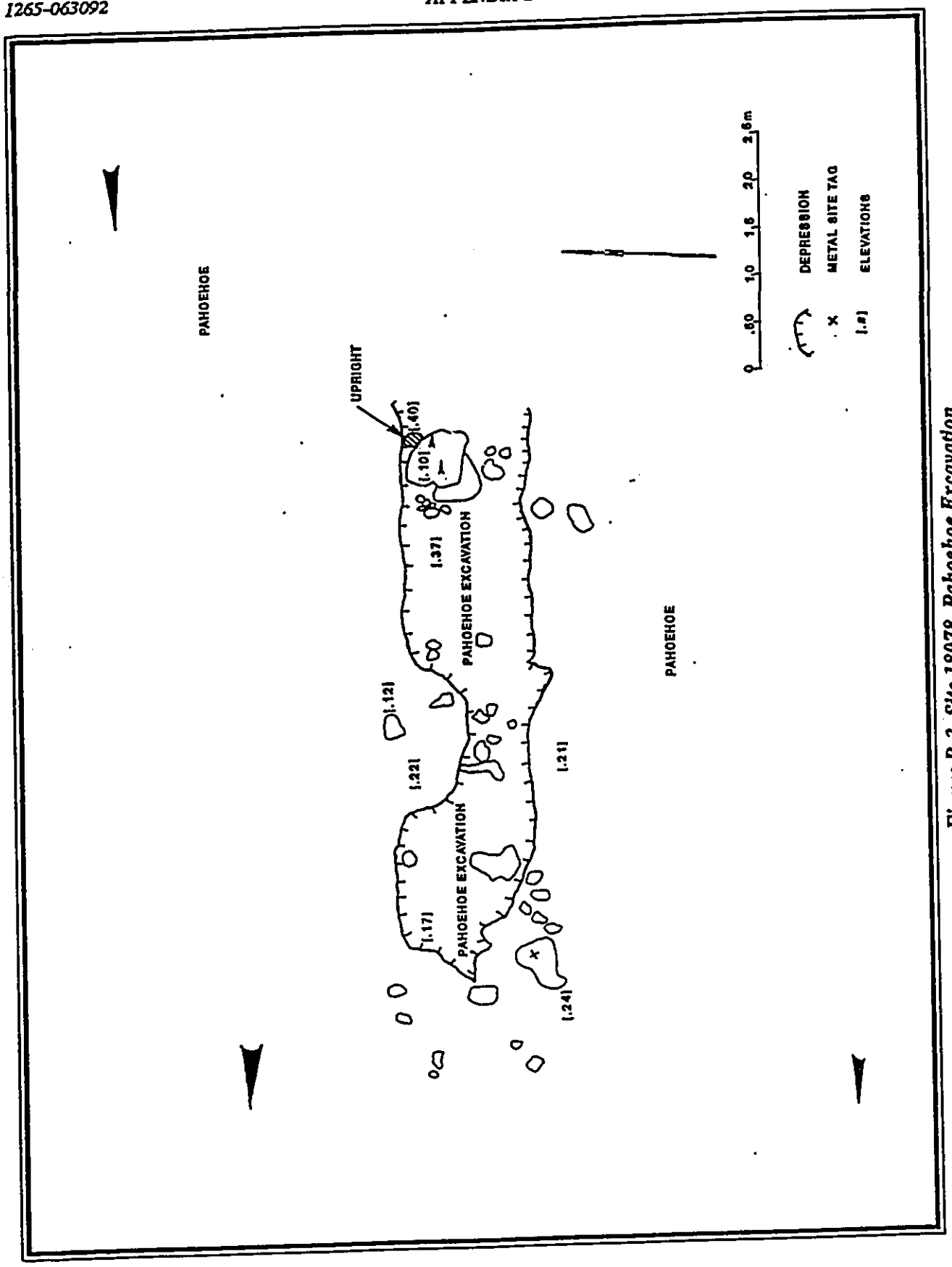

Figure B-3. Site 18078, Pahoehoe Excavation

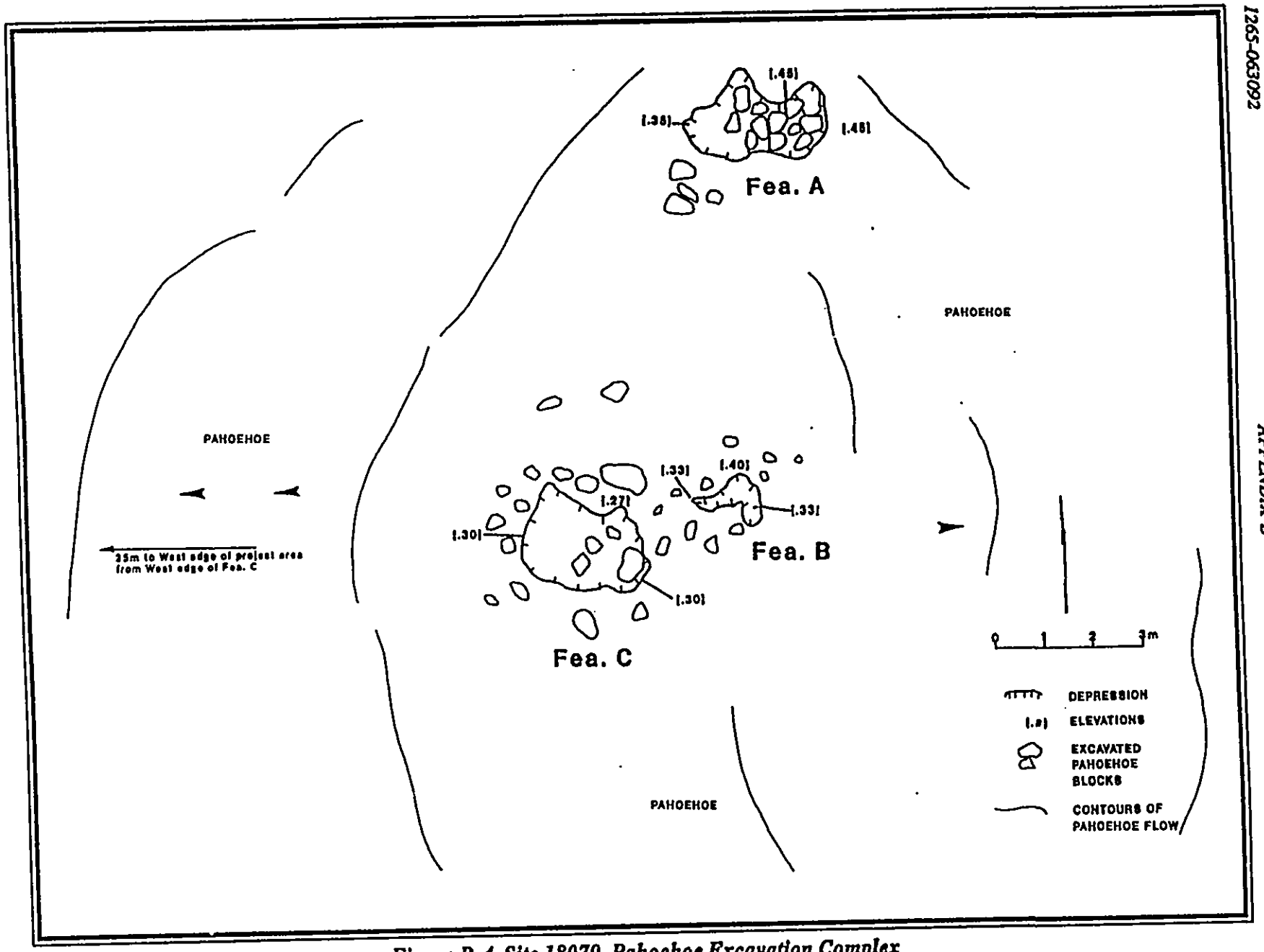

Figure B-4. Site 18079, Pahoehoe Excavation Complex

Appendix E

Lorraine R. Inouye
Mayor

Norman K. Hayashi
Director

Tad Nagasako
Deputy Director

Planning Department

County of Hawaii • 25 Aupuni Street, Room 109 • Hilo, Hawaii 96720 • (808) 961-8288

August 7, 1992

Mr. Mark N. Garrity, Planner
CH2M Hill
1585 Kapiolani Blvd., Suite 1312
Honolulu, HI 96814-4530

Dear Mr. Garrity:

SMA Boundary Inquiry
TMK: 7-3-49:36

Per your request letter dated July 30, 1992, this is to confirm that the subject property is situated outside of the Special Management Area (SMA) boundary.

Should you have any questions, please feel free to contact Alice Kawaha or Rick Warshauer of this office.

Sincerely,

NORMAN K. HAYASHI
Planning Director

AK:lm
6121D

xc: West Hawaii Office