Larry S. Tanimoto
Mayor
Bruce C. McClure
Chief Engineer
Richard H. Nishimura
Deputy Chief Engineer

Department of Public Works

25 Aupuni Street, Rm. 202 • Hilo, Hawaii 96720 • (808) 961-8321 • Fax (808) 969-7138

August 10, 1990

OFFICE OF ENVIRONMENTAL QUALITY CONTROL
465 SOUTH KING STREET ROOM 115
HONOLULU HI 96813

SUBJECT: Amendment to the Revised Environmental Impact Statement for the Kailua-Kona Sewerage System Phase IV (Northern Zone) Kailua-Kona, Hawaii

We are transmitting 60 copies of the Amendment to the Revised Environmental Impact Statement for the Kailua-Kona Sewerage System pursuant to the Rules and Regulations of the Office of Environmental Quality Control. Because the Revised EIS was approved and distributed in July 1981, we are also attaching 60 copies of this document for reference.

The "Facility Plan for the Kailua-Kona Sewerage System, Phase IV (Northern Zone)" was completed in April 1981. The effluent disposal alternatives evaluated were by ocean discharge, land reclamation, and injection wells. The selected effluent disposal method was the ocean outfall with built-in features to divert the effluent to land reclamation projects as they become viable. Recent public concerns dictate that the viability of land reclamation be seriously evaluated and implemented.

The Amendment to the Revised EIS has been prepared to address the impacts of effluent disposal by land irrigation compared to disposal by ocean outfall. We believe we have adequately addressed the existing physical and social conditions at the project site and have attempted to mitigate the environmental impacts that may have resulted since the approval of the Revised EIS.

We have consulted with a number of parties during the preparation of this Amendment to the Revised EIS and believe that their concerns have been addressed.

Please call me if there are any questions.

Bruce C. McClure

BRUCE C. McCLURE, P.E.
Chief Engineer

KTS:ctc
Enclosures

cc: R. M. Towill, Corporation
WWM

Send copy to Rodney Haraguchi, County of Hawaii Planning Dept. Cissy

Larry S. Tanimoto
Mayor
Bruce C. McClure
Chief Engineer
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Deputy Chief Engineer

Department of Public Works

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OFC. OF ENV'L QUALITY CONT.

September 27, 1990

BRUCE S ANDERSON PhD
ACTING DIRECTOR
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
STATE OF HAWAII
ATTENTION CISSY ORNELLAS
465 SOUTH KING STREET ROOM 104
HONOLULU HI 96813

SUBJECT: Amendment to the Revised Environmental Impact Statement for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), Kailua-Kona, Hawaii

The purpose of this letter is to amend our letter of transmittal of August 10, 1990, for the subject EIS amendment. We wish to clarify that the proposed action will have little impact upon the environment and thereby petition for a negative declaration.

Please call me if you have any questions.

Bruce C. McClure

BRUCE C. McCLURE, P.E.
Chief Engineer

cc: WWM, H. Sugiyama
R. M. Towill, Corp. - K. Sakai

AMENDMENT to the

Neg. Dec. (8/23/90)

REVISED ENVIRONMENTAL IMPACT STATEMENT FOR THE KAILUA-KONA SEWERAGE SYSTEM PHASE IV (NORTHERN ZONE) Kailua-Kona, Hawaii

AUGUST 1990

PREPARED FOR:

Department of Public Works
County of Hawaii

RMTC

R. M. Towill Corporation

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

AMENDMENT TO THE
REVISED ENVIRONMENTAL IMPACT STATEMENT
FOR THE
KAILUA-KONA SEWERAGE SYSTEM
PHASE IV (NORTHERN ZONE)

Prepared For:

Department of Public Works
County of Hawaii

JULY 1990

Prepare By:

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

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FIGURES AND TABLES:

APPENDICES

SECTION 1
SUMMARY

This amendment addresses the proposed change in effluent disposal methodology for the Kealakehe Wastewater Treatment Plant. The approved EIS dated July 1981 recommended that a deep ocean outfall be used to dispose effluent. Subsequently, several issues have developed which merit further evaluation of recycling effluent by land reclamation as a viable alternative. These are as follows:

A. A growing demand on the municipal water system as resort and commercial developments increase in Kona. In the last few years, commercial development along Queen Kaahumanu Highway between Kailua-Kona and Keahole Airport has increased significantly. Presently there are plans for several major resort and commercial developments around Keahole Airport and northward to Kohala. The municipal water system presently terminates at the Keahole Airport. The County water system cannot adequately serve these new developments without major (and costly) improvements. All of these proposed resort developments are required to develop their own water sources as a condition for their land use change application. There is some evidence that the municipal water system has already reached its capacity because farmers in the agricultural park above Keahole Airport are experiencing inadequate flow and water pressure. The use of wastewater effluent for irrigation is now economically viable.

B. Proposed resort development in the vicinity of the treatment plant which could possibly use effluent for irrigating golf course, parks, and highway landscaping. The Liliuokalani Trust Children's Center has also expressed their future need for an alternative water supply, i.e., recycled effluent.

C. Growing scientific community concerns about the potential adverse impacts of the deep ocean outfall effluent discharge on the pure ocean requirements

of Natural Energy Laboratory of Hawaii (NELH) and Hawaii Ocean Science Technology Park (HOST).

D. Completion of a soccer, baseball and football complex at the Old Airport. Effluent from the Kailua STP is used for irrigation. An alternate source of water other than the municipal water supply must be found once the Kailua STP is phased out.

E. A growing demand in West Hawaii for a municipal golf course. Presently, all golf courses in West Hawaii are privately owned with expensive green fees. Many of the local residents cannot afford such high fees; thus, there is a need for a municipally owned course with reasonable fees. The use of effluent for irrigation is attractive.

F. Regulations were recently promulgated with strict requirements governing the water quality monitoring of wastewater discharges in the ocean. Water quality monitoring is a costly task which was not included in the Facility Plan cost-effective analysis.

Based on these recent issues, the need to reevaluate effluent disposal by ocean outfall is justified. An attractive effluent disposal alternative to the ocean outfall is to recycle the effluent for irrigation of golf courses, parks, and landscaping. Potable water is not necessary for these uses and this alternative will alleviate some of the demand on the municipal water system.

The treatment plant will use the aerated lagoon process to reduce the sewage pollutants to prescribed Department of Health standards for effluent disposal by land reclamation.

The primary adverse impacts will be related to the short-term construction activity. The long-term adverse impacts forecast are not believed to be significant because the project conforms to and supports the County General Plan.

SECTION 2
PROJECT DESCRIPTION

2.1 General

The following statement is an amendment to the approved Revised Environmental Impact Statement (EIS) for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981.

2.2 Project Location

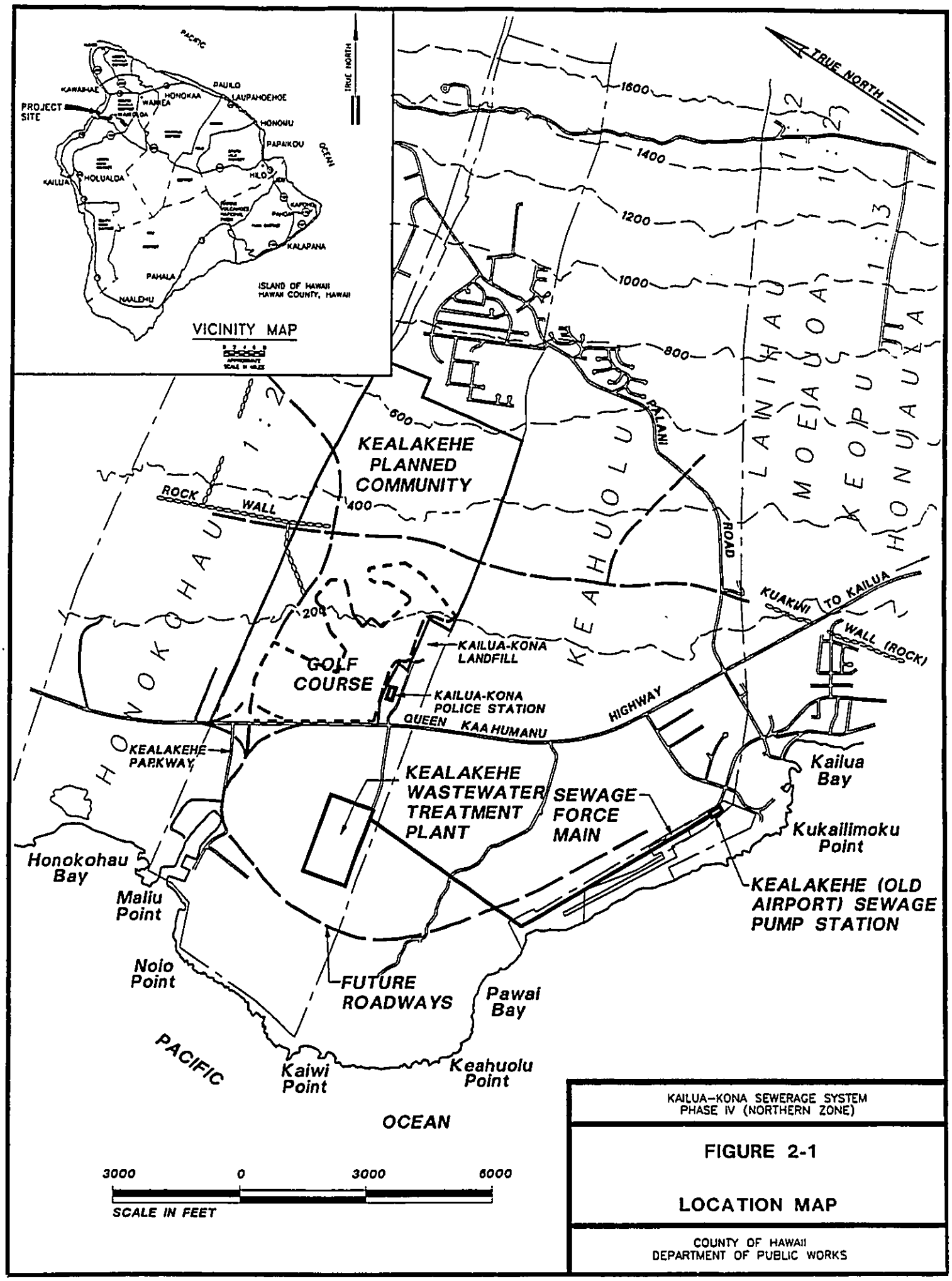
The project area is situated on the west side of the Island of Hawaii (TMK 7-4-8:3 & 17). Effluent disposal by land reclamation will be located on a proposed municipal golf course site. This subject area is delineated in Figure 2-1. This proposed effluent disposal field and golf course will be developed in conjunction with "Kealakehe, A Planned Community," an affordable housing project proposed by the State Housing Finance Development Corporation. A separate EIS for this project is presently being prepared.

2.3 Purpose of Project

The purpose of this supplement is to address the impacts of effluent disposal by land irrigation compared with disposal by ocean outfall.

The "Facility Plan for the Kailua-Kona Sewerage System, Phase IV (Northern Zone)" was completed in April 1981. The effluent disposal alternatives evaluated were by ocean discharge, land reclamation, and injection wells. The selected effluent disposal method was the ocean outfall with built-in features to divert the effluent to land reclamation projects as they become viable. The primary reason effluent disposal by ocean outfall was selected over land reclamation was the limited demand for effluent at the time the Facility Plan was prepared. However, the Facility Plan recognized the potential of land reclamation as reflected by the following excerpt from page 6-59 of the Facility Plan:

> "Reclaiming the effluent for irrigation is an alternative of increasing significance because of the increasing consumer demand for water in Kona."


PACIFIC
OCEAN
TRUE NORTH
PROJECT SITE
KAWAIHAE
HONOKAA
PAAUILO
LAUPAHOEHOE
WAIMEA
HONOMU
PAPAIKOU
HILO
KAILUA
HOLUALOA
KAPOHO
KALAPANA
PAHALA
NAALEHU
ISLAND OF HAWAII
HAWAII COUNTY, HAWAII
VICINITY MAP
1600
1400
1200
1000
800
600
400
200
KEALAKEHE PLANNED COMMUNITY
ROCK WALL
PALANI ROAD
KUAKINI
TO KAILUA
WALL (ROCK)
KAILUA-KONA LANDFILL
GOLF COURSE
KAILUA-KONA POLICE STATION
QUEEN KAAHUMANU HIGHWAY
KEALAKEHE PARKWAY
KEALAKEHE WASTEWATER TREATMENT PLANT
SEWAGE FORCE MAIN
Kailua Bay
Kukailimoku Point
KEALAKEHE (OLD AIRPORT) SEWAGE PUMP STATION
Honokohau Bay
Maliu Point
Nolo Point
FUTURE ROADWAYS
Pawai Bay
Kaiwi Point
Keahuolu Point
3000 0 3000 6000
SCALE IN FEET
KAILUA-KONA SEWERAGE SYSTEM
PHASE IV (NORTHERN ZONE)
FIGURE 2-1
LOCATION MAP
COUNTY OF HAWAII
DEPARTMENT OF PUBLIC WORKS

2.4 General Description of the Action's Characteristics

2.4.1 Features of the Proposed Action

A new treatment plant is presently under construction as shown in Figure 2-1 and effluent will be disposed by land reclamation at the proposed municipal golf course.

2.4.1.1 Overview

After the Facility Plan was completed, several issues have developed which merit further evaluation of recycling effluent by land reclamation as a viable alternative. These are as follows:

A. A growing demand on the municipal water system as resort and commercial developments increase in Kona. In the last few years, commercial development along Queen Kaahumanu Highway between Kailua-Kona and Keahole Airport has increased significantly. Presently there are plans for several major resort and commercial developments around Keahole Airport and northward to Kohala. The municipal water system presently terminates at the Keahole Airport. The County water system cannot adequately serve these new developments without major (and costly) improvements. All of these proposed resort developments are required to develop their own water sources as a condition for their land use change application. There is some evidence that the municipal water system has already reached its capacity because farmers in the agricultural park above Keahole Airport are experiencing inadequate flow and water pressure.

B. Proposed resort development in the vicinity of the treatment plant which could possibly use effluent for irrigating golf course, parks, and highway landscaping. The Liliuokalani Trust Children's Center has also expressed their future need for an alternative water supply, i.e., recycled effluent.

C. Growing scientific community concerns about the potential adverse impacts of the deep ocean outfall effluent discharge on the pure ocean requirements

of Natural Energy Laboratory of Hawaii (NELH) and Hawaii Ocean Science Technology Park (HOST).

D. Completion of a soccer, baseball and football complex at the Old Airport. Effluent from the Kailua STP is used for irrigation. An alternate source of water must be found once the Kailua STP is phased out.

E. A growing demand in West Hawaii for a municipal golf course. Presently, all golf courses in West Hawaii are privately owned with expensive green fees. Many of the local residents cannot afford such high fees; thus, there is a need for a municipally owned course with reasonable fees. The use of effluent for irrigation is attractive.

F. Regulations were promulgated with strict requirements governing the water quality monitoring of wastewater discharges in the ocean. Water quality monitoring is a costly task which was not included in the Facility Plan cost-effective analysis.

Based on these recent issues, the need to reevaluate effluent disposal by ocean outfall is justified. An attractive effluent disposal alternative to the ocean outfall is to recycle the effluent for irrigation of golf courses, parks, and landscaping. Potable water is not necessary for these uses and this alternative will alleviate some of the demand on the municipal water system.

2.4.1.2 Design Considerations

The County of Hawaii has determined that there is a potential need for a municipal golf course at West Hawaii. One feasible location which the County is investigating is the parcel owned by the State of Hawaii at Kealakehe, North Kona. This is the same parcel on which the Kealakehe Wastewater Treatment Plant will be located. The effluent from the plant will be used to irrigate the golf course, County parks, and landscaping. Effluent may also be made available to the Liliuokalani Trust and other interested users.

Under the U.S. Environmental Protection Agency's Construction Grants Program, recycling effluent by land reclamation is an approved disposal method which is eligible for Federal funding. However, only the basic irrigation system for the golf course is grant eligible. The golf course itself, such as the greens, tees, sand traps, clubhouse, landscaping, and other amenities, is not grant eligible and must be funded in its entirety by the County of Hawaii.

Previous land use studies by the State of Hawaii envisioned a golf course on this State parcel makai of the Queen Kaahumanu Highway. A conceptual plan incorporating the aerated lagoon treatment plant within this proposed golf course was developed for the "Master Plan for the Kailua-Kona Sewerage System, Phase IV (Northern Zone)," May 1974.

2.4.1.3 Elements of Land Reclamation

The essential elements of land reclamation include an area large enough to dispose the effluent, an effluent distribution and spraying system, a pumping station, disinfection facilities, and a storage pond.

There are various methods of land treatment: slow rate infiltration, rapid infiltration, and overland flow. Irrigation of a golf course is a form of slow rate infiltration. Therefore, the land reclamation facilities will be designed for slow rate infiltration. In slow rate land treatment, the wastewater is applied to a vegetated land surface and the wastewater receives additional treatment as it percolates through the plant-soil column. A portion of the wastewater percolates to the groundwater and a portion is used by the plants. Studies show that treatment, i.e., removal of viruses and bacteria, is accomplished within the upper 5-foot depth of the plant-soil regime.

Golf courses average about 160 to 200 acres in size. A golf course of approximately 200 acres is required to dispose the 2.8 million gallons of wastewater projected for the year 2010. Assuming no losses to evaporation, wastewater must be sprayed at a rate of one-half inch daily over the 200 acres, to dispose this quantity of wastewater. (Presently, the Keauhou-Kona Resort Golf Course uses about 1/4 inch to 1/2 inch of water a day.)

The land treatment site has no soil cover because it is a recent lava flow. Topsoil must be imported and spread over the lava fields. The soil-plant regime envisioned consists of (1) a grubbed lava subbase where the lava crust is initially zipped and vegetation such as wild grass and shrubbery is mixed with the broken lava, (2) a cinder layer over the broken and graded lava to prevent topsoil from infiltrating into the lava voids, and (3) a topsoil layer planted with a turf grass, such as bermuda.

The effluent wastewater distribution and spraying system consists of disinfection facilities, a pumping station, storage pond, and a piping and sprinkling network. The effluent screens, pumping station and effluent force main and disinfection facilities are presently under construction at the Kealakehe Wastewater Treatment Plant.

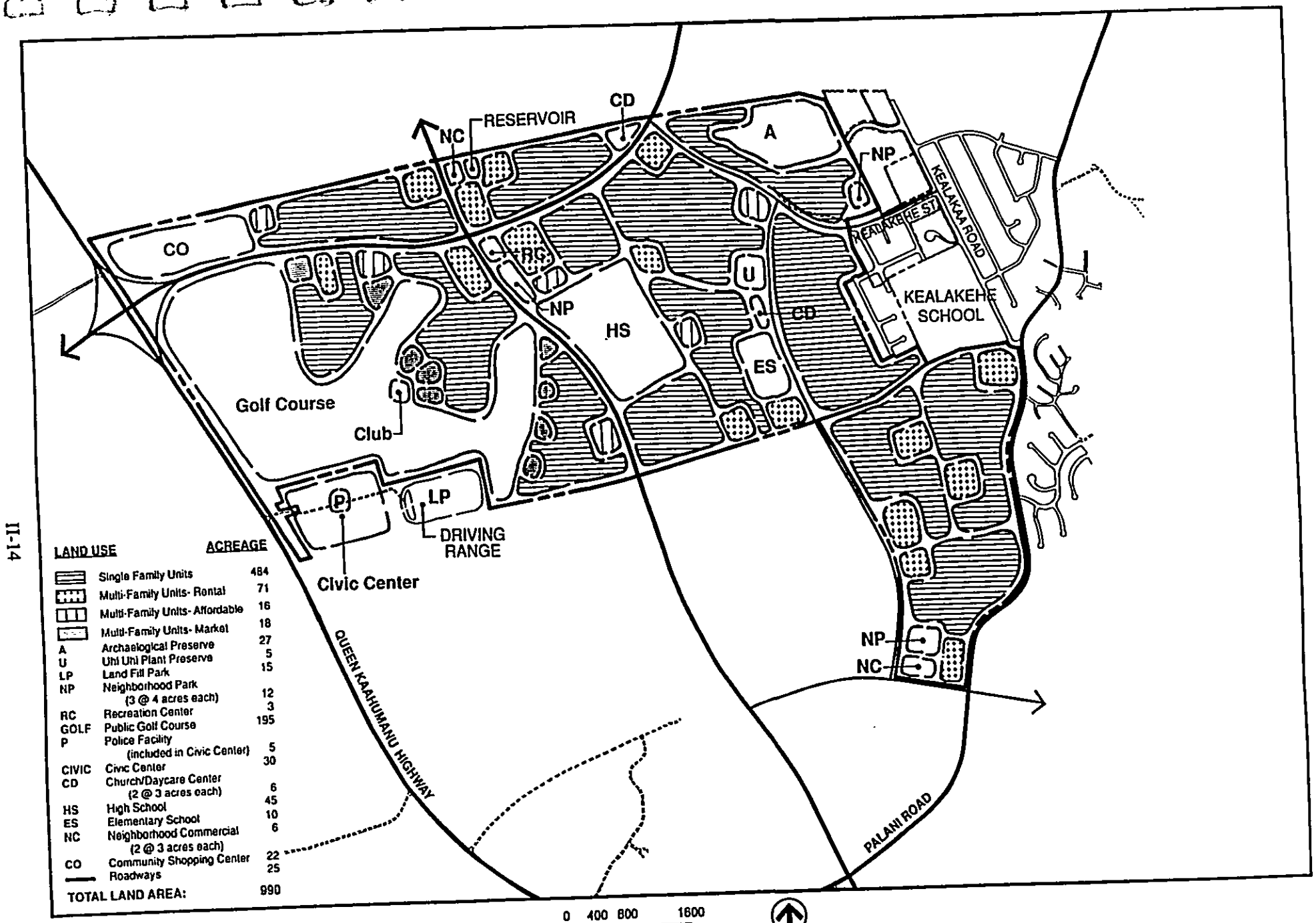
The holding/storage pond will serve the following functions: provide the necessary contact time for the disinfecting agent, such as chlorine, to kill viruses and coliform bacteria; serve as a sump or basin for the land reclamation spraying pumps; and provide emergency storage during the wet season. The size or volume of the holding/storage pond is dictated by the emergency storage requirements. It is estimated that a storage of 7 days of design flow of 2.8 mgd, or 19,600,000 gallons, is required. Assuming an average pond depth of 4 feet, a pond with a water surface area of 15 acres is required. This holding pond may be divided into smaller ponds scattered through the land treatment site. These smaller ponds may then be used as future water hazards for the golf course.

The effluent pumping system at Kealakehe WWTP is sized to deliver the design flow of 2.8 mgd within an 8-hour shift during daylight hours. The effluent pump station capacity was estimated at 7,500 to 8,000 gpm.

The Kealakehe Wastewater Treatment Plant is designed to produce an effluent that meets the effluent quality standards of the State Department of Health for land reclamation applications. The primary effluent disinfection technique incorporated in the design is natural ultraviolet light from sunshine. The wastewater is retained in the aerated lagoon between 15 to 25 days. A very high percentage of the viruses and coliform bacteria will

be killed by this lengthy exposure to sunlight. A standby chlorination system is also provided for use during rainy periods and when the coliform count exceeds the State Department of Health standards.

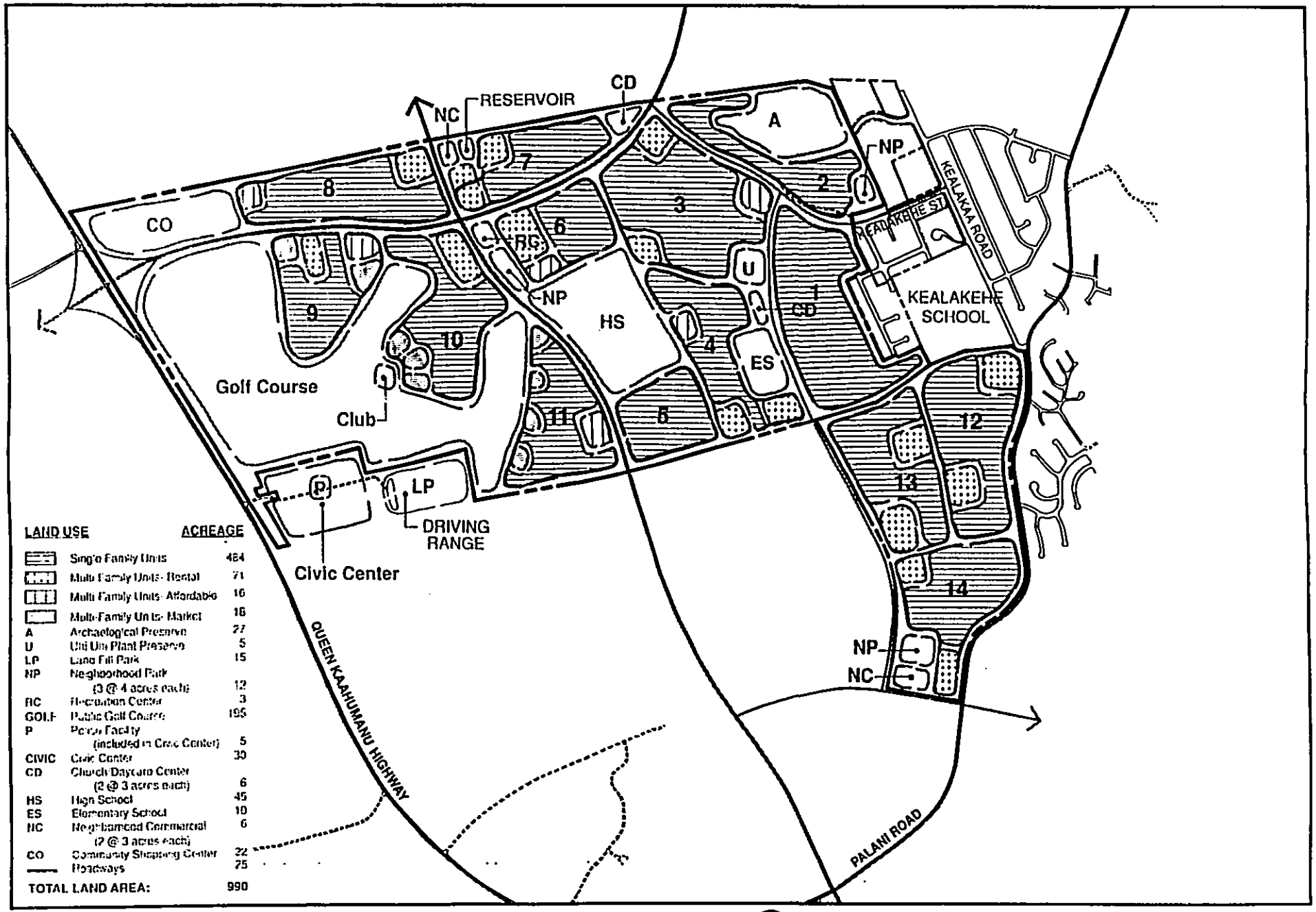
The proposed golf course and the adjacent Kealakehe Planned Community are located in the same TMK parcel and will be constructed to compliment each other. Figures 2-5 to 2-6 and Figures 6-9 to 6-12 from the "Kealakehe Planned Community Environmmental Impact Statement," dated June 1990, prepared by Belt Collins & Associates (extracted and shown in this report), depict concept plans for its land use, the village, the water supply system and the wastewater master plan.



LAND USE		ACREAGE
	Single Family Units	484
	Multi-Family Units- Rental	71
	Multi-Family Units- Affordable	16
	Multi-Family Units- Market	18
A	Archaeological Preserve	27
U	Uhi Uhi Plant Preserve	5
LP	Land Fill Park	15
NP	Neighborhood Park (3 @ 4 acres each)	12
RC	Recreation Center	3
GOLF	Public Golf Course	195
P	Police Facility (included in Civic Center)	5
CIVIC	Civic Center	30
CD	Church/Daycare Center (2 @ 3 acres each)	6
HS	High School	45
ES	Elementary School	10
NC	Neighborhood Commercial (2 @ 3 acres each)	6
CO	Community Shopping Center	22
	Roadways	25
TOTAL LAND AREA:		990

Prepared by: BELT COLLINS & ASSOCIATES
Date: JUNE 1990

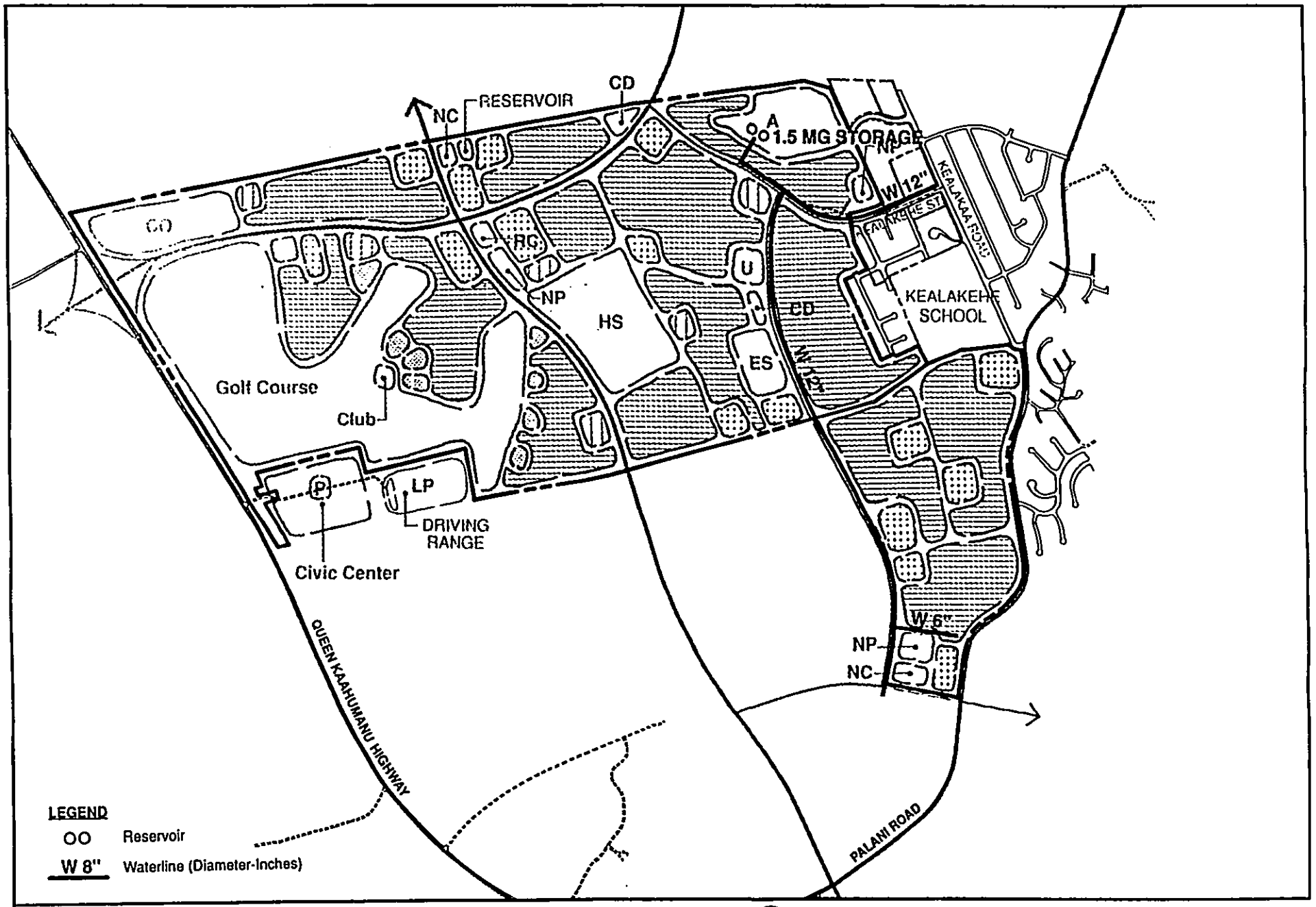
Figure 2-5
LAND USE CONCEPT PLAN



KEALAKEHE PLANNED COMMUNITY
ENVIRONMENTAL IMPACT STATEMENT

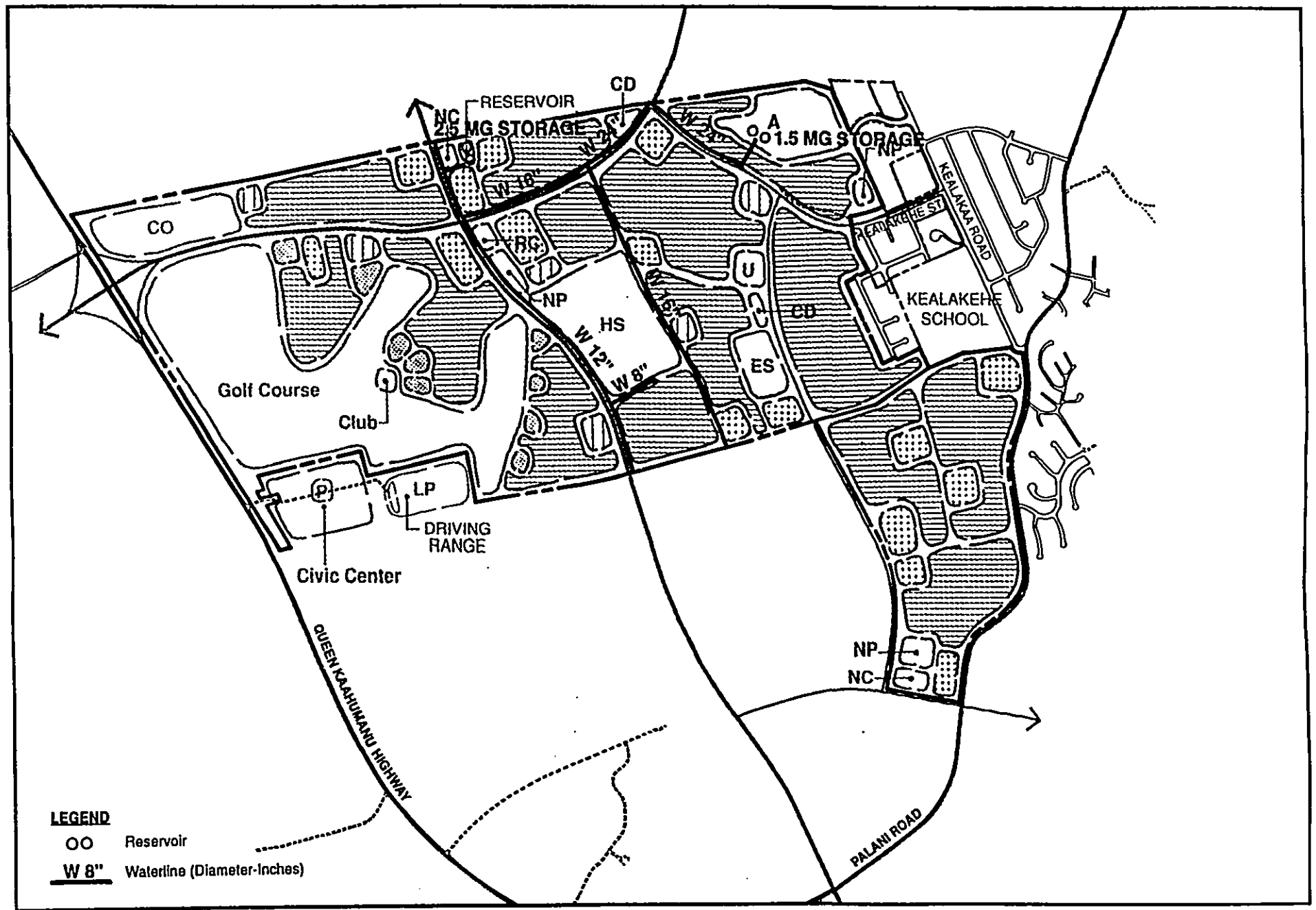
Prepared by: BELT COLLINS & ASSOCIATES
Date: JUNE 1990

Figure 2-6
VILLAGE CONCEPT PLAN



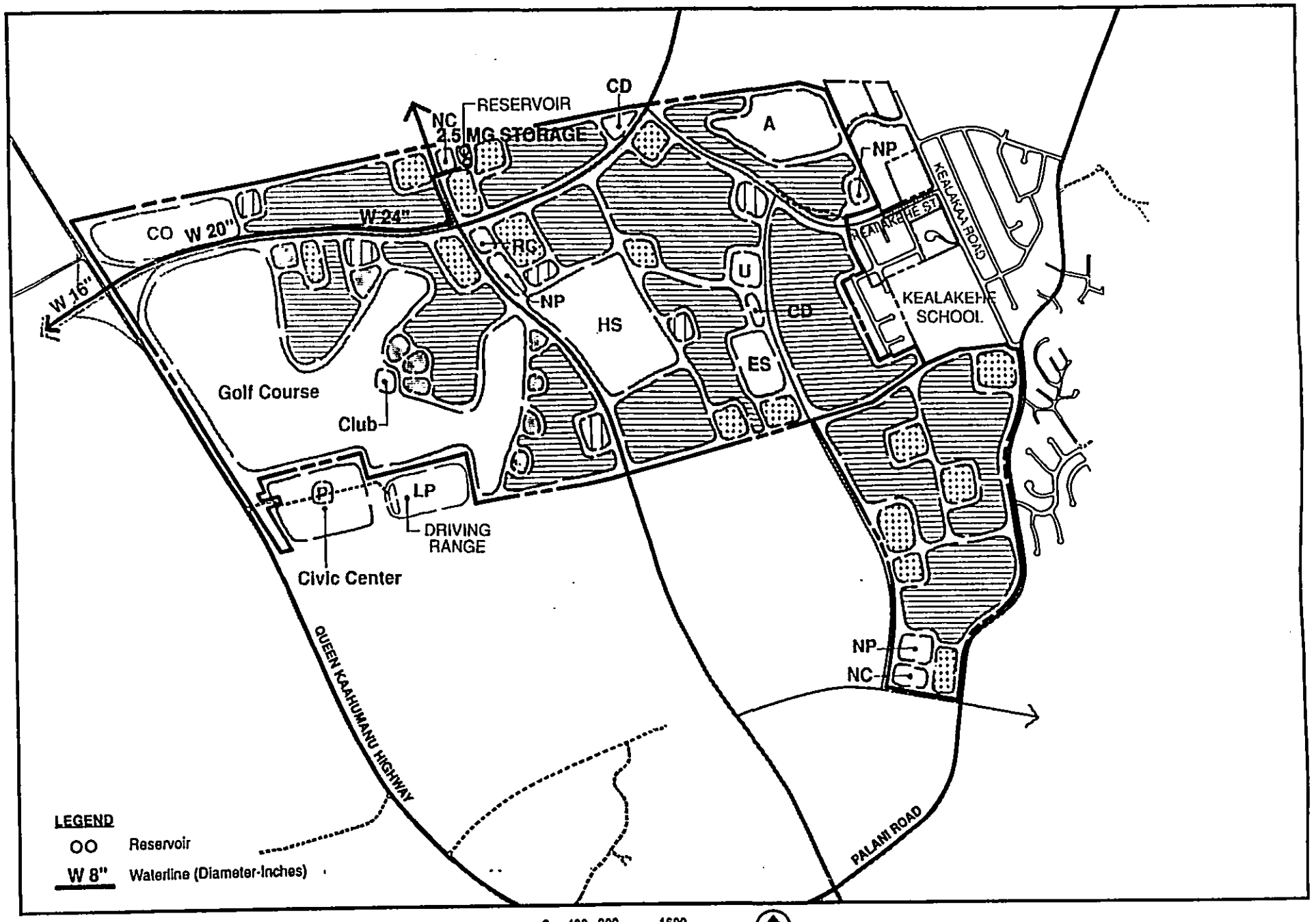
Prepared by: BELT COLLINS & ASSOCIATES
Date: JUNE 1990

Figure 6-9
PROPOSED WATER INFRASTRUCTURE PLAN
935' PRESSURE ZONE WATER SUPPLY SYSTEM



Prepared by: BELT COLLINS & ASSOCIATES
Date: JUNE 1990

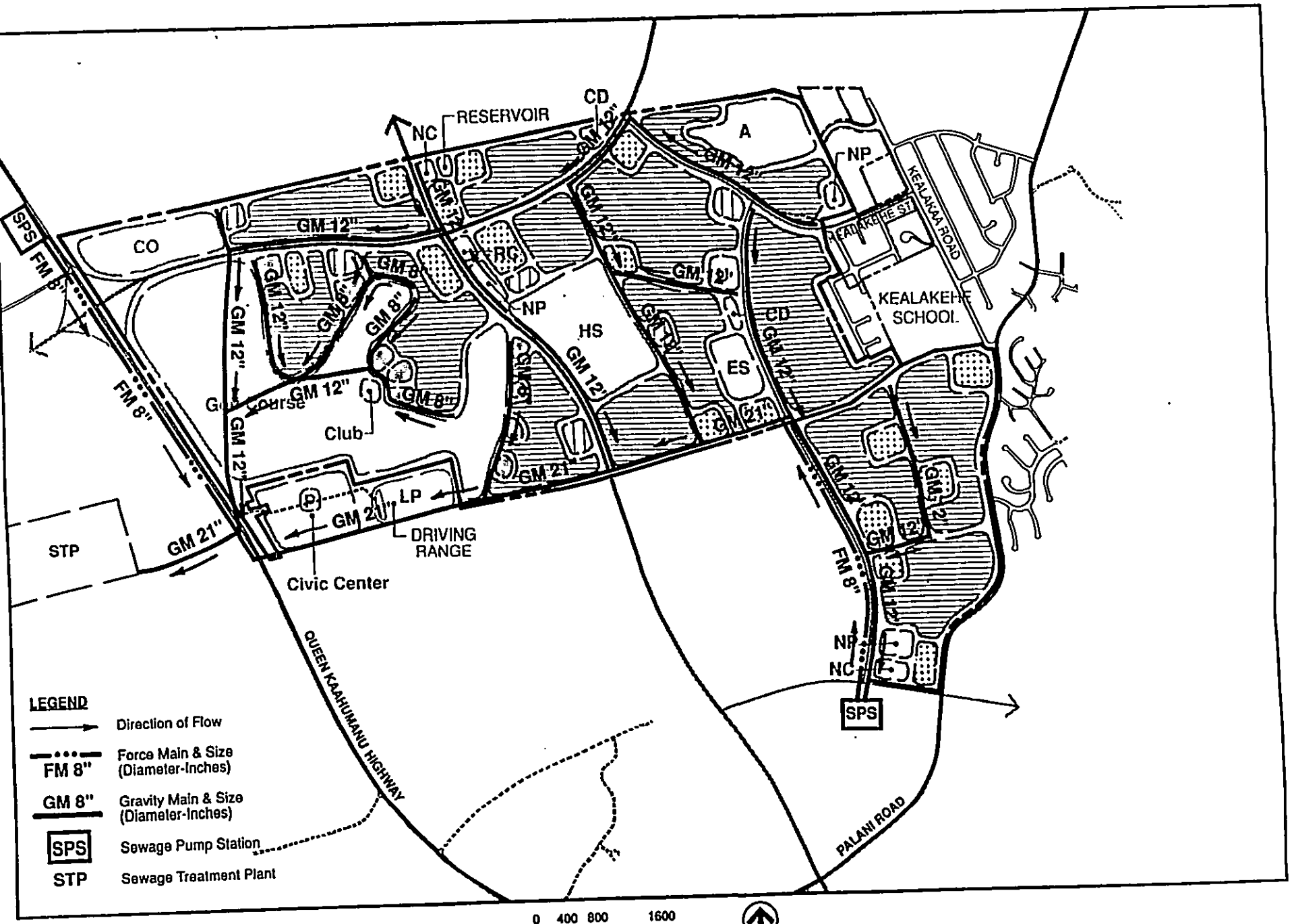
Figure 6-10
PROPOSED WATER INFRASTRUCTURE PLAN
595' PRESSURE ZONE WATER SUPPLY SYSTEM



KEALAKEHE PLANNED COMMUNITY
ENVIRONMENTAL IMPACT STATEMENT

Prepared by: BELT COLLINS & ASSOCIATES
Date: JUNE 1990

Figure 6-11
PROPOSED WATER INFRASTRUCTURE PLAN
325' PRESSURE ZONE WATER SUPPLY SYSTEM



Prepared by: BELT COLLINS & ASSOCIATES
Date: JUNE 1990

Figure 6-12
WASTEWATER MASTER PLAN

SECTION 3
DESCRIPTION OF THE EXISTING ENVIRONMENT

The existing physical, economic and social environments in the planning area are described in this section. These conditions were considered when analyzing the alternatives and determining the impacts of the proposed action on both the Kealakehe Planned Community as well as the proposed golf course.

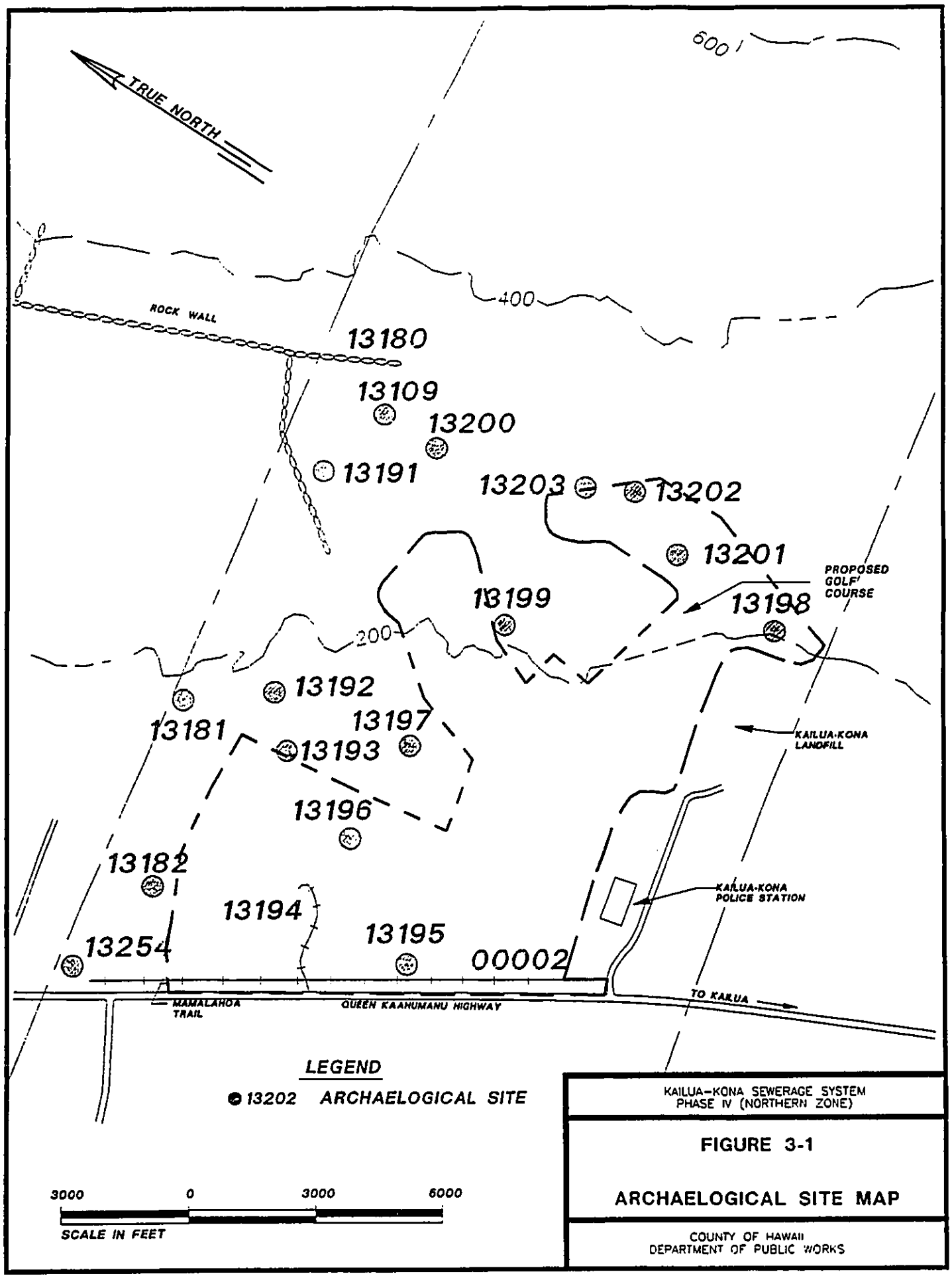
3.1 GENERAL

Archaeological, botanical and fauna surveys of the proposed effluent land irrigation was conducted in October 1989, August 1989 and November 1989, respectively. The primary purpose of the surveys was to provide information for an Environmental Impact Statement (EIS) and Master Plan for the proposed Kealakehe Planned Community project as well as for the County's municipal golf course. Relevant work sites/features which corresponded to the proposed golf course and the planned community were referenced for this portion of the subject report. Refer to Figures 3-1 and 3-2, Table 3-1 and Appendices A, B and C for additional background discussions. Also included in this report as reference are Figures 4-7 and 4-8 from the "Kealakehe Planned Community Environmental Impact Statement," June 1990, by Belt Collins & Associates.

3.1.1 Archaeological Sites

The preservation, protection and restoration of historical and archaeological significance relating to early Hawaiian history is an utmost concern for resident, governmental agencies and private developers.

Figure 3-1 illustrates the findings of the survey. Generally no major archaeological or artifact sites were found. The only features which would probably be of interest within the project site would be Site Nos. 13254, 13194, 13184, 13193, 13197, 13180, 13203, 13202, 13201 and 13190. These items are either historical trails, walls or platform which warrant further surveys. Refer to Table 3-1 and Appendix A for the summary of the assessed inventory of historical sites.


TRUE NORTH
600'
400
200
ROCK WALL
13180
13109
13200
13191
13203
13202
13201
PROPOSED GOLF COURSE
13199
13198
13192
13181
13197
13193
13196
13182
13194
13195
13254
00002
KAILUA-KONA LANDFILL
KAILUA-KONA POLICE STATION
MAMALAHOA TRAIL
QUEEN KAAHUMANU HIGHWAY
TO KAILUA
LEGEND
13202 ARCHAELOGICAL SITE
3000 0 3000 6000
SCALE IN FEET
KAILUA-KONA SEWERAGE SYSTEM
PHASE IV (NORTHERN ZONE)
FIGURE 3-1
ARCHAELOGICAL SITE MAP
COUNTY OF HAWAII
DEPARTMENT OF PUBLIC WORKS

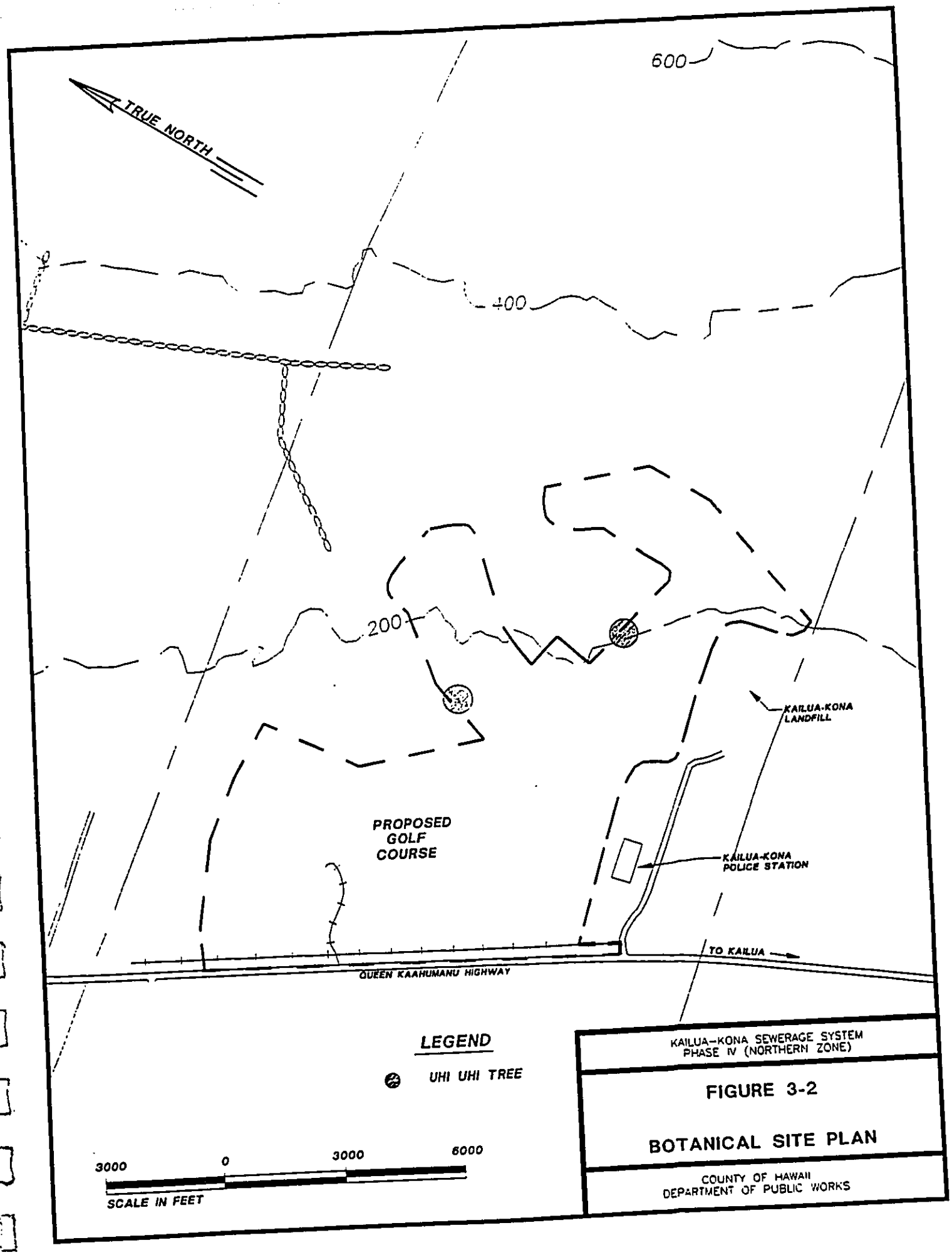

TRUE NORTH
600
400
200
KAILUA-KONA LANDFILL
PROPOSED GOLF COURSE
KAILUA-KONA POLICE STATION
TO KAILUA
QUEEN KAAHUMANU HIGHWAY
LEGEND
UHI UHI TREE
3000
0
3000
6000
SCALE IN FEET
KAILUA-KONA SEWERAGE SYSTEM
PHASE IV (NORTHERN ZONE)
FIGURE 3-2
BOTANICAL SITE PLAN
COUNTY OF HAWAII
DEPARTMENT OF PUBLIC WORKS

TABLE 3-1

ARCHAEOLOGICAL INVENTORY SURVEY
SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS
AND RECOMMENDED GENERAL TREATMENTS

Site No.	Significance Category (A,X,B,C) and Former Site/Feature Type	Recommended General Treatments (FDC, NFW, PID, PAI)
13254	A,B,C - rock mounds, terraces, platforms, walls, cairns, roadbed, mod. outcrop, lava tube cave, "C" shape, stepping stone trail	FDC, PID, PAI
13194	A,B,C - stepping stone trail	FDC, PID
13195	X - cairns	NFW
13196	X - cairns	NFW
13182	X - cairn, Phh. excavation	NFW
13181	A,B,C - platforms	FDC, PID
13192	X - cairn	NFW
13193	A,C - faced mound	FDC, PAI
13197	A - steppingstone trail	FDC
13180	A - wall	FDC
13191	X - cairn	NFW
13199	X - cairn	NFW
13198	X - cairn, Phh. excavation	NFW
13203	A - terrace, pavement	FDC
13202	A - cairns, trail	FDC
13201	A - trail	FDC

Site No.	(A,X,B,C) and Former Formal Site/Feature Type	Significance Category Recommended Treatment (FDC, NFW, PID, PAI)
13190	A - wall, Phh. excavation, mod. outcrop, mounds	FDC
13200	X - rock mounds	NFW

LEGEND:

General Significance Categories:

A = Important for information content, further data collection necessary;
X = Important for information content, no further data collection necessary;
B = Excellent example of site type at local, region, island, State, or National level; and
C = Culturally significant.

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;
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.

NOTE: Information referenced from "Interim Report - Background, Summary of Findings, and General Significance Assessments, and Recommended General Treatments, Archaeological Inventory Survey," by Paul H. Rosendahl, Ph.D, October 1989.

3.1.2 Terrestrial Flora

The Federal Endangered Species Act of 1973 (16 USC 1531-1543), as amended, and the State Threatened and Endangered Wildlife and Plant Law (Chapter 124, Title 13, Subtitle 5, Part 2) provide for protection of an officially endangered species. Efforts should be focused on an environmental plan with the U.S. Fish and Wildlife Service and the State's Department of Land and Natural Resources, Division of Forestry and Wildlife, to help preserve and manage this ecological concern.

Following is a summary of the botanical survey conducted for the Kealakehe Planned Community and includes the proposed golf course. The survey is included in its entirety in Appendices B and C to this environmental impact statement.

3.1.2.1 Existing Conditions

A botanical survey of the subject property was conducted in July 1989 to assess the botanical resources present. The objectives of the survey were to (1) provide a general description of the major vegetation types; (2) inventory the terrestrial, vascular flora; and (3) search for threatened and endangered plants on the project site. A walk-through survey method was employed. Areas most likely to harbor native plant communities or rare species, such as the open, mixed shrubland and rougher a'a lava flows, were more intensively examined. Species identification was made in the field; plants which could not be positively determined were collected for later identification in the herbarium and for comparison with taxonomic literature.

A total of 145 plant species were inventoried on the project site during the field survey. Of these, 110 (76 percent are introduced or alien species, 31 (21 percent) are native, and 4 (3 percent) are of Polynesian origin. Among the 31 species of native plants, 16 species are indigenous (native to the Hawaiian Islands and also elsewhere) while 15 are endemic (native only to the Hawaiian Islands).

Four major vegetation types were identified on the project site. The distribution of the four vegetation types corresponds roughly with substrate type, rainfall, and elevation.

Rainfall varies from 20 inches annually near Queen Kaahumanu Highway to nearly 50 inches annually at the upper boundary of the project area. A'a lava flows run the length of the property, while more weathered pahoehoe flows are found along the peripheries of the property; with one small section of Punalu'u extremely rocky peat overlying pahoehoe bedrock in the northeastern corner of the project site (Sato et al., 1973).

Following is a description of the four vegetation types identified. Figure 4-7 from the "Kealakehe Planned Community Environmental Impact Statement," dated June 1990 by Belt Collins & Associates, presents the distribution of these vegetation types.

OPEN MIXED SHRUBLAND. This vegetation is generally distributed above the 400-foot contour interval on a'a lava. It may extend to lower elevations on some flows with many of the native elements quickly attenuating. The physiognomy is of an open scrub with scattered trees, although in depressions with small gullies shrubs and trees may form dense thickets. Native and introduced shrubs occur in about equal numbers, although among the natives alahe'e (Canthium odoratum) and al'ali'i (Dodonaea viscosa) are locally abundant in places, while among the introduced plants koa-haole (Leucaena leucocephala), klu (Acacia farnesiana), and Christmas berry (Schinus terebinthifolius) are locally abundant. Trees occur as scattered individuals or small, scattered stands. Native shrubs and trees include mamane (Sophora chrysophylla), lama (Diospyros sandwicensis), alahe'e, maiapilo (Capparis sandwichiana), a'ali'i, Bidens micrantha ssp. ctenophylla, kalamona, (Senna gaudichaudii), naio (Myoporum sandwicense), uhi uhi (Caesalpinia kavaiensis), wiliwili (Erythrina sandwicensis), and 'ohe (Reynoldsia sandwicensis). The more commonly occurring introduced shrubs include koa 'haole, Christmas berry, klu, lantana (Lantana camara), guava (Psidium guajava), senna (Senna septemtrionalis), and pluchea (Pluchea symphytifolia). Introduced trees include kukui (Aleurites moluccana), jacaranda (Jacaranda mimosifolia), silk oak (Grevillea robusta), and monkeypod (Samanea saman).

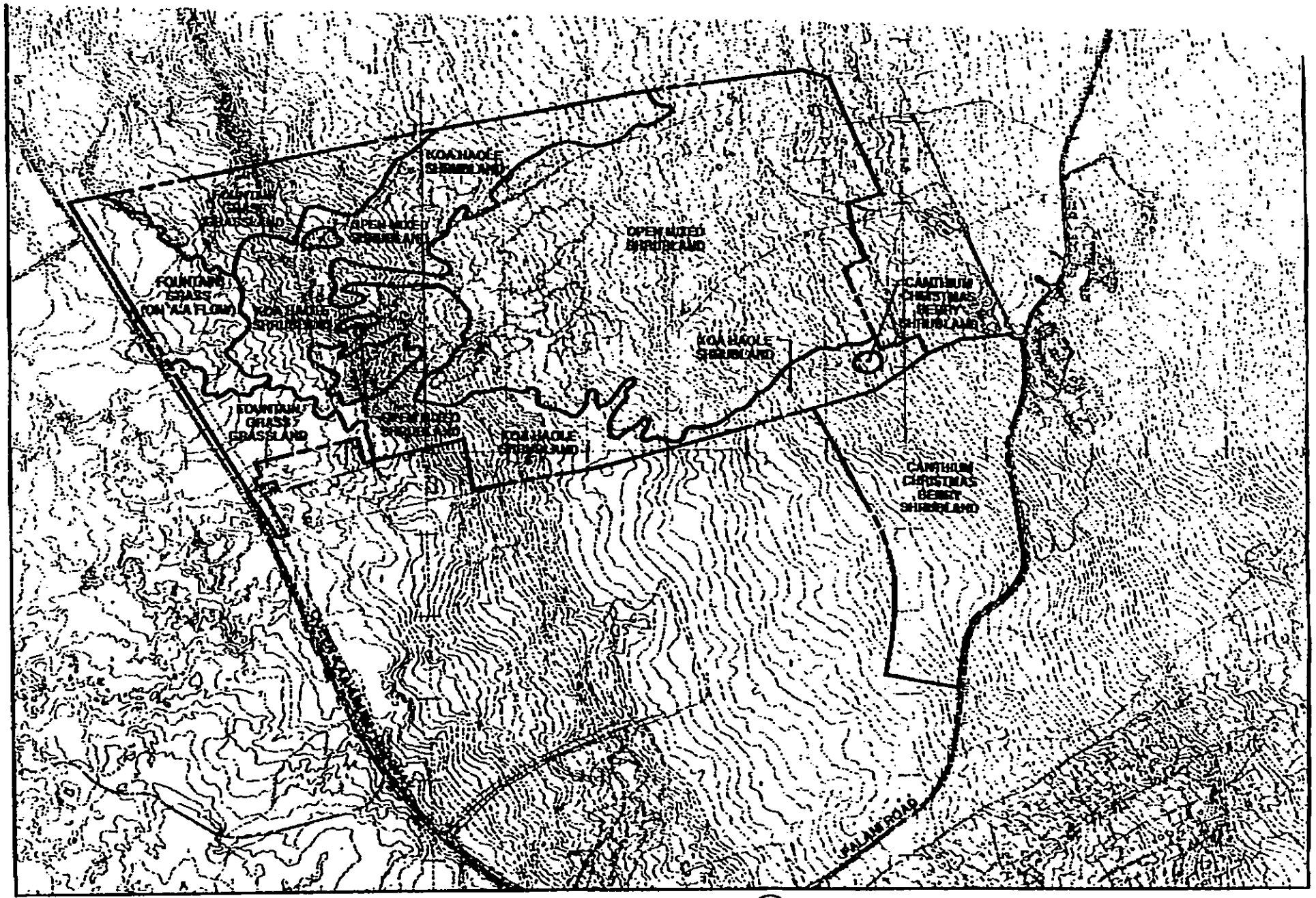


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FIGURE 4-7
VEGETATION

Ground cover is usually a mixture of grasses, smaller shrubs or subshrubs, and young koa-haole plants less than a foot high. These include Natal redtop (Rhynchelytrum repens), fountain grass (Pennisetum setaceum), Guinea grass (Panicum maximum), love grass (Eragrostis tenella), molassesgrass (Melinis minutiflora), Bermuda grass (Cynodon dactylon), 'uhaloa (Waltheria indica), 'ilima (Sida fallax), coffee senna (Senna occidentalis), false mallow (Malvastrum coromandelianum), nettle-leaved vervain (Stachytarpheta urticifolia), indigo (Indigofera suffruticosa), bur bush (Triumfetta rhomboidea), and air plant (Kalanchoe pinnata).

Cattle grazing on this part of the property tends to keep most of the open mixed shrubland low and there are numerous cattle paths through the shrubland. Where cattle congregate, usually under trees and where there is some soil, plants or acute-leaved sida (Sida acuta), bur bush, hairy honohono (Commelina benghalensis), false mallow, amaranth (Amaranthus viridus), and coffee senna are more numerous.

There are minor variants of this shrubland. For example, along the upper boundary, adjacent to the residential area and public housing, the property has been more disturbed as evidenced by the large piles of boulders, a number of dozer walks, and piles of rubbish. In this area, weedy species such as Spanish needle (Bidens pilosa), Florida beggarweed (Desmodium tortuosum), hyptis (Hyptis suaveolens), etc., are abundant, and California grass (Brachiara mutica) forms extensive mats. Where the substrate is weathered pahoehoe, fountain grass becomes more numerous.

CANTHIUM/CHRISTMAS BERRY SHRUBLAND. This vegetation type occurs on the 150-acre parcel which is included in the proposed community. The Canthium/Christmas berry shrubland continues across the slope and extends onto the adjacent Queen Liliuokalani Trust Keahuolu lands where a recent flora survey was conducted (Char, 1989).

The substrata is a'a with blocky chunks generally 4 to 6 inches in diameter. Both alahe'e (Canthium odoratum) and Christmas berry occur in almost equal numbers, though one or the other may be more abundant in places. The shrubs form dense thickets, 10 to 15 feet tall. Scattered through the shrubland are clusters of mamane, 18 to 20 feet tall; other native shrubs and trees including wiliwili, a'ali'i 'ohe, Bidens micrantha ssp. ctenophylla, lama, and 'ohi'a (Metrosideros polymorpha). Introduced trees and shrubs, which also generally occur as scattered individuals, include jacaranda, silk oak, autograph tree (Clusia rosea), guava, kukui, and monkeypod. Koa-haole forms small clumps in places but is not abundant. Near the school boundary, large plants of sisal (Agave sisalana) are found.

Ground cover varies from 40 to 50 percent and is composed of seedlings of the tree and shrub species mentioned above plus a mixture of grasses and weedy herbs, though litter and barren a'a predominate. Low-lying, open areas are often filled with Natal redtop, molassesgrass, lantana, fountain grass, 'ilima, and air plant, Locally abundant, twining and sprawling over shrubs, are vines of huehue (Cocculus triloba).

KOA-HAOLE SHRUBLAND. This vegetation type is generally found associated with pahoehoe substrate, Dense to open koa-haole shrublands are found adjacent to the Kealakehe residential area, the County landfill, and above the quarry and cement batching plant. The koa-haole plants vary in height from 8 to 12 feet tall, although, in places, they may be somewhat taller. Scattered trees of kiawe (Prosopis pallida) and 'opiuma (Pithecellobium dulce) are usually found associated with this shrubland. Other trees and shrubs occasionally found here include alahe'e, Christmas berry, monkeypod, lantana, maiapilo, and naio. Locally abundant are 'ilima and 'uhaloa.

Lower elevation koa-haole shrubland usually supports a dense ground cover of fountain grass, while upper elevation shrubland has a ground cover composed of Natal redtop, fountain grass, and various weedy species as nettle-leaved vervain

(Stachytarpheta urticifolia), beggar's tick (Bidens pilosa, Bidens Cynapifolia), hairy abutilon (Abutilon grandifolium), and air plant.

Where this vegetation type occurs on a'a substrate, there is very little ground cover and the koa-haole shrubs tend to occur in scattered patches usually in shallow depressions.

FOUNTAIN GRASS GRASSLAND. Along the northern boundary of the subject property, where it abuts Palani Ranch, fountain grass forms a rather extensive and dense grassland. Koa-haole shrubs occur as scattered individuals, although, in low-lying areas they may sometimes form small-sized thickets. Other shrubs and subshrubs occasionally found in the grassland include 'ilima, indigo (Indigofera suffruticosa), alahe'e, 'uhaloa, and maiapilo. A few trees of kiawe and 'ohe can be observed scattered through the grassland; one rather large tree of maua (Xylosma hawaiiense), about 20 feet tall, is found on a rocky knoll near the jeep trail that begins behind the quarry.

On the a'a flow adjacent to Queen Kaahumanu Highway, fountain grass occurs in scattered clumps. In these areas, 'uhaloa and 'ilima are abundant.

In general, these grasslands tend to be species poor as the aggressive fountain grass forms a dense cover which crowds out other plants. Fountain grass is considered a serious pest in dry areas of the Big Island as it outcompetes most native species for establishment. It is also a fire-adapted species. The grass burns swiftly and hot causing extensive damage to native dry forest. After fires it is able to quickly reestablish itself (Wagner, et al., in press).

3.1.2.2 Threatened and Endangered Plants

One officially listed endangered species, the uhi uhi (Caesalpinia kavaiensis; formerly known as Mezoneuron kavaiense), and one candidate endangered species, Bidens micrantha subspecies (ssp.) ctenophylla (no common name), occur on the Kealakehe site.

An officially listed endangered species is protected by the Federal Endangered Species Act of 1973 (16 USC 1531-1543), as amended, and by the State's threatened and endangered wildlife and plants law (Chapter 124, Hawaii Revised Statutes, Title 13, Subtitle 5, Part 2). Bidens micrantha ssp. ctenophylla is considered a Category 1 candidate endangered species by the United States Fish and Wildlife Service (1985). Plants considered Category 1 material should be regarded as candidates for addition to the Endangered and Threatened Species List and, as such, consideration should be given them in environmental planning.

The uhi uhi is a large shrub to medium sized tree (up to 30 feet tall) with thick, rough, dark gray bark and very dark blackish-brown heartwood. The leaves are twice divided into smaller leaflets with 4 to 8 pairs of pale green leaflets per pinnae. The flowers are borne in clusters at branch tips and are pinkish-purple to brick red. The seed pods are flat and thin; bluish-glaucous when young, pale pinkish-tan to gray when older. The Hawaiians used the strong, dark, heavy wood for spears and fishing implements called la'au melomelo or la'au makalei (Rock 1913, 1920).

Uhi uhi was first described from the Island of Kauai in 1867. Later specimens were collected on Oahu and Maui. Uhi uhi plants were discovered in the North Kona area in 1909. Today the population has been greatly reduced. Only a single tree is known from the Kauai plantation, a few plants occur in the Waianae Mountains on Oahu, and about two dozen plants have been recorded on the slopes of Hualalai in the Puuwaawaa-Kaupulehu ahupua'a on the Island of Hawaii. Cattle, goats, and other feral herbivores were probably responsible for most of the population decline, but in recent years exotic plants, such as fountain grass, have become so abundant as to inhibit regeneration and to increase the chances of wildfire (Lamoureux 1982).

Nineteen uhi uhi plants were located on the Kealakehe project site. This represents a significant increase in the number of known plants and also extends the range of distribution of the species from Puuwaawaa-Kaupulehu across to the Kailua-Kona area. On the project site, the majority of the plants are found between the 500 and 550-foot elevation contours in open mixed shrubland. A few plants occur in koa-haole shrubland

on a'a flows. The location of the 19 plants is presented in Figure 4-8 extracted from the "Kealakehe Planned Community Environmental Impact Statement," dated June 1990 by Belt Collins & Associates. The plants vary in height from 8 feet to about 25 feet tall, with the majority of them from 12 to 15 feet tall. Most are multi-branched and, at the time of the field survey, had flowers and many seed pods. Although an intensive search around the plants was made, no seedlings or saplings of uhi uhi were located.

Bidens micrantha ssp, ctenophylla occurs in shrubland and dry forests on the leeward slopes of Hualalai. In addition to being a candidate endangered species, it is also considered vulnerable or threatened by extensive habitat destruction or modification or by other environmental disturbances (Wagner et al. in press). It is an attractive plant with dense clusters of yellow, daisy-like flowers. The dense inflorescences may contain 15 to 75 or more flower per cluster. Bidens is an erect, much branched, perennial herb from 2 to 5 feet tall. Under optimum growing conditions, it may reach 7 to 8 feet in height.

On the Kealakehe project site, Bidens is found scattered throughout the open mixed shrubland and Canthium/Christmas berry shrubland in fairly large numbers.

Because they are a federally designated endangered species, the 19 uhi uhi plants (including the two within the golf course) identified on the Kealakehe site must be preserved. As part of the analysis of environmental impacts conducted for the proposed project, an opinion was sought from the State Attorney General concerning the ability to move or relocate uhi uhi plants from areas designated for development. The Department of the Attorney General responded, in part, "...because it does not seem the uhi uhi trees can be successfully transplanted, and because it cannot be said that destruction of any of the species would help propagate the species as a whole, under existing statutes the uhi uhi trees must be preserved in place." (letter to William W. Paty, Chairman of the Board of Land and Natural Resources, December 20, 1989). Therefore, while impact upon the habitat of the uhi uhi plants may be significant due to grading and site preparation, there will be no significant impact upon the uhi uhi plants because they will be preserved.

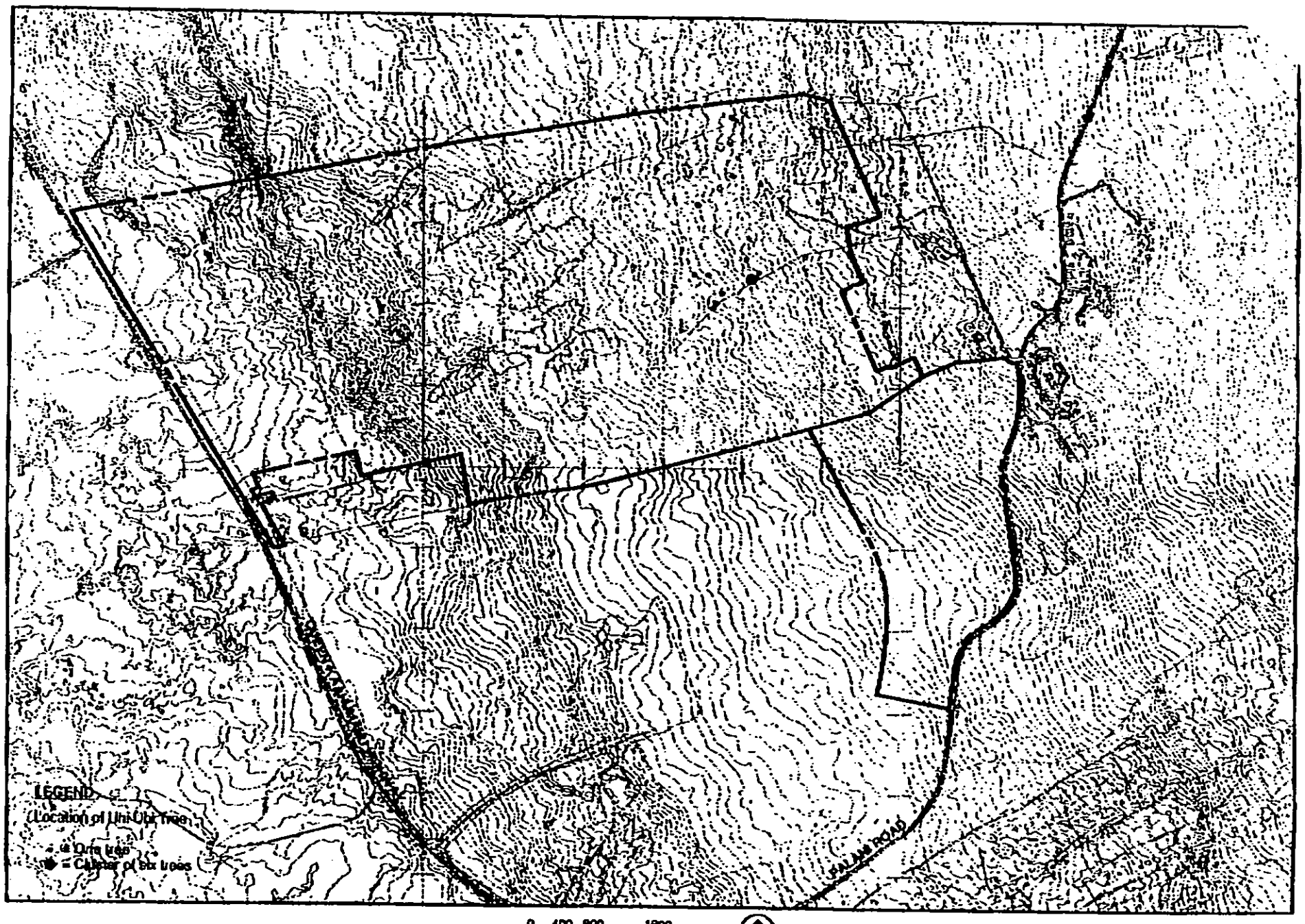

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FIGURE 4-8
ENDANGERED FLORA SPECIES LOCATION

Impacts upon the Bidens, a candidate endangered species, may be significant because of the need for removal of existing vegetation in the course of site preparation.

SECTION 4

RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE

Comprehensive discussions of the above section is presented in the Revised EIS for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981. Therefore, no additional information is required to update this section of this amendment.

SECTION 5

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATIVE MEASURES TO MINIMIZE ADVERSE IMPACTS

The impacts of the proposed action on the environment may be classified in two categories: primary and secondary. Primary or direct impacts associated directly with the construction activity of the project, i.e., dust, noise, and traffic disruption are generally a short term nature. Primary long-term impacts may occur after completion of the construction. Secondary or indirect impacts may result indirectly from the provision of a public facility such as a sewerage system. Uncontrolled population growth, urban sprawl, induced land use changes, and pollution from urban runoff are some examples of secondary impacts. Secondary impacts are generally long term in nature but short-term secondary impacts may occur during construction.

5.1 Impacts of the Proposed Wastewater System

The environmental impacts of the proposed wastewater management project are both primary and secondary. The primary impacts are generally short-term and associated with the construction of the facilities. The secondary impacts are generally long-term and related to the operation of the facilities.

5.1.1 Primary Impacts

The proposed wastewater project consists of the following system: the collection and transmission system, the treatment facility, and the disposal system. The short-term and long-term impacts associated with the construction of these facilities are discussed below.

5.1.1.1 Wastewater Disposal System

The network piping and sprinklers will be buried under the proposed golf course. Construction of the piping and sprinkling system will be along a recent lava flow ending at the proposed site. Impacts on the construction conditions include particulate matter in the air, foreseeable blasting due to the apparent basaltic subterrain, noise, traffic congestion and vehicular emission. Governmental regulator agencies will oversee and control these construction related efforts.

Archaeological, flora and fauna impacts were discussed earlier and measures to preserve these features will be incorporated in the design and construction of the effluent disposal by land reclamation.

5.1.1.2 Archaeological/Terrestrial Flora

A. Archaeological: Generally no major archaeological or artifact sites were found. The only features on which the construction of the wastewater disposal system would have a probable impact on would be historical trails, walls or platforms. These items warrant further survey of the sites.

B. Terrestrial Flora: Impacts to the existing flora would result from preparation of the project site for the development. Grading cut and fill work, and similar construction activities will destroy existing plant cover. Impacts would also occur from the introduction of alien or exotic plant species which might outcompete existing species. The significance of potential impact has been evaluated on the basis of the extent of loss of existing vegetation, the potential for introduction of competitive exotic species, and the potential for loss of endangered or threatened species.

The impact to existing vegetation is considered to be significant due to the need for extensive grading and clearing associated with site preparation. However the loss of existing vegetation will be offset, to some degree, by the introduction of extensive landscaping and turf grass for the golf course.

5.1.2 Secondary Impacts

The short-term and long-term secondary impacts associated with the development of the new facilities are discussed below.

A. Wastewater Disposal System: The disposal by land reclamation will be discharged onto the proposed golf course. No secondary impacts are anticipated because the treated effluent would be disinfected at the Kealakehe WWTP to State Department of Health standards.

B. Economics: The short term costs of disposal by land reclamation will, as with the ocean outfall, be shared by the Federal, State and County governments which are funded by the general public.

5.1.3 Mitigation Measures

To offset the loss of native plants, the use of native plant material for landscaping is recommended. Native plants adapted to the low rainfall and lava substrates of the Kealakehe site are recommended for inclusion into the overall landscaping of the golf course. While the golf course fairways and greens must be recultivated using exotic grasses, much of the area designated as rough can be left undisturbed or recultivated with native plants. Many of the native plants are attractive and of ornamental value; these include the uhi uhi, wiliwili, 'ohe, naio, alahe'e, mamane, kalomona, and Bidens micrantha ssp. ctenophylla.

In order to mitigate the potential impact of the proposed project upon the habitat of the uhi uhi plants and upon the Bidens, it is proposed that a five-acre endangered plant preserve be established around a cluster of eight uhi uhi trees located in the upper portion of the Kealakehe site outside of the golf course. This preserve would also help to preserve a number of other native species in the area including the candidate Bidens species. Propagation material from other native plants not found within the 5-acre preserve, such as maua, wiliwili, halapepe (Pleomele hawaiiensis), olopua (Nestegis sandwicensis), and pua-kala (Argemone glauca) as well as from the separate uhi uhi plants, should be collected for inclusion onto the site. The preserve should be an actively used nature study park with trails, jogging paths, picnic shelters, etc. Descriptive signs should be provided for the plants. Pamphlets for a self-guided tour could be provided and would highlight the native species, describe how the Hawaiians used the plants, and present ways these plants could be used in landscaping to conserve water. In addition to the five-acre preserve, it is recommended that a one-half acre preserve should be established around each of the remaining eleven uhi uhi plants. Long-term management of these separate one-half acre lots and the five-acre preserve would include an active management program for the eradication of introduced plants, especially fountain grass, koa-haole, and Christmas berry.

Additional mitigation measures will include the following: 1) the preparation of a mitigation plan for the uhi uhi plants in the Kealakehe area, which will include a plan for the propagation of the uhi uhi plants and Bidens plants with seeds and cuttings from the mature trees and plants on site; 2) the initiation of State legislation to bring Hawaii State law into conformance with Federal law concerning the relocation of endangered plant species; and 3) the establishment of an escrow fund for the long-term preservation of endangered and candidate endangered species with startup funds not to exceed $100,000. Conducted in tandem, these three mitigation measures will provide the means to cultivate seedlings and cutting from the existing plants in a funded preserve, monitor the impacts of development upon the endangered and candidate endangered species, and eventually relocate the endangered plants to a more secure area once their genetic line is secured through the cultivation of seeds and cuttings from each adult plant.

Finally, the United States Fish and Wildlife Service has been contacted and advised of the existence of the endangered plants. Because two of the uhi uhi plants are located within the golf course area (to be transferred by Executive Order of the Governor to the County of Hawaii) which is to serve as the effluent disposal area for the Kealakehe Sewage Treatment Plant, the County of Hawaii's Public Works Department has formally requested a "biology opinion" from the FWS. While the biology opinion, which amounts to a recommendation, will not be completed before publication of this environmental impact statement, it is expected to provide additional guidelines and recommendations for mitigation measures applicable to both the HFDC and County of Hawaii.

SECTION 6

PROBABLE ADVERSE ENVIRONMENTAL IMPACTS WHICH CANNOT BE AVOIDED

Comprehensive discussions of the above section is presented in the Revised EIS for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981. Therefore, no additional information is required to update this section of the amendment.

SECTION 7
ALTERNATIVES TO THE PROPOSED ACTION

7.1 General

Discussion of these alternatives are detailed in the Revised EIS for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981.

Each alternative must be evaluated from an environmental, social, and monetary view point. The environmental and social concerns were previously addressed in the Facility Plan. An environmental concern which was not addressed in the approved EIS is the potential adverse impact of the wastewater discharge on the purity of the cold ocean water requirements of the Natural Energy Laboratory of Hawaii and the Hawaii Ocean Science Technology Park, both located at Keahole. The ocean data and studies prepared for the ocean outfall indicate that contamination is very remote or non-existent. However, this hypothesis is very difficult to prove or disprove, and therefore shall remain as an issue. By proper design and attentive operations and maintenance, both alternatives are acceptable from an environmental and social point of view.

SECTION 8

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

Comprehensive discussions of the above section is presented in the Revised EIS for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981. Therefore, no additional information is required to update this section of the amendment.

SECTION 9

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Comprehensive discussions of the above section is presented in the Revised EIS for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981. Therefore, no additional information is required to update this section of the amendment.

SECTION 10

AN INDICATION OF WHAT OTHER INTERESTS AND CONSIDERATIONS OF GOVERNMENTAL POLICIES ARE THOUGH TO OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

Comprehensive discussions of the above sections are presented in the Revised EIS for the Kailua-Kona Sewerage System, Phase IV (Northern Zone), July 1981. Therefore, no additional information is required to update this section of the amendment.

APPENDIX A

Archaeological Inventory Survey
Kealakehe Planned Community Project Area

Report 652-101689

Interim Report: Background, Summary of Findings, and General Significance Assessments, and Recommended General Treatments

Archaeological Inventory Survey
Kealakehe Planned Community Project Area

Lands of Kealakehe and Keahuolu,
North Kona District, Island of Hawaii
(TMK:7-04-08:17,Por.12)

by

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Prepared for

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October 1989

PHRI

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BACKGROUND

At the request of Mr. Lee Sichter of Belt, Collins & Associates, on behalf of their client, State of Hawaii - Housing Finance and Development Corporation (HFDC), Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological inventory survey of the c. 950-acre proposed Kealakehe Planned Community project area, located in the Lands of Kealakehe and Keahuolu, North Kona District, Island of Hawaii (TMK:7-04-08:17,Por.12). The overall objective of the survey was to provide information appropriate to and sufficient for the preparation of an Environmental Impact Statement (EIS) and Master Plan being developed for the project.

The survey field work was conducted September 5-October 13, 1989. Prior to carrying out the work, a general scope and specific field tasks for the project were discussed with Dr. Ross H. Cordy, chief archaeologist in the Hawaii Department of Land and Natural Resources-Historic Sites Section/State Historic Preservation Office (DLNR-HSS/SHPO).

Based on a preliminary review of available background literature and records, and on discussions with Mr. Sichter and the appropriate DLNR-HSS/SHPO personnel, the following specific tasks were determined to constitute an adequate scope of work for the present survey:

1. Conduct archaeological background and historical documentary research involving review and evaluation of readily available archaeological and historical literature, historic documents and records, and cartographic sources relevant to the immediate project area;

2. Conduct a 100%-coverage, low-level (30-50 ft altitude) aerial survey (helicopter) of the entire project area, with special emphasis on (a) following out any foot trails present and plotting them on aerial photographs and/or maps, (b) identifying all sites observed, and (c) identifying areas devoid of sites (e.g., relatively recent lava flows and mechanically altered lands);

3. Conduct variable coverage (partial to 100%), variable intensity (30-90 ft intervals) ground survey of the project area, with the actual extent and intensity of coverage determined on the basis of the aerial survey;

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

5. Analyze background research data and field data, and prepare appropriate reports.

The present survey area consists of the undeveloped portion of the Land of Kealakehe east (mauka) of Queen Kaahumanu Highway and west (makai) of Palani Road (c. 800 acres), and a 150-acre parcel in the Land of Keahuolu bounded by Palani Road on the east and the Kealakehe/Keahuolu boundary on the north (Figure 1). Terrain in the area consists of gently sloping pahoehoe and aa flows that are covered with moderately to very dense scrub vegetation. Vegetation consists predominantly of the tree species kiawe (Prosopis pallida [Humb. and Bonp. ex Willd.] HBK), koa-haole (Leucaena leucocephala [Lam.] de Wit), and Christmas-berry (Schinus terebinthifolius Raddi.). Understory plants consist predominantly of lantana (Lantana camara L.), klu (Acasia farnesiana [L.] Willd.), fountain grass (Pennisetum setaceum [Forsk.] Chiov.), California grass (Brachiaria mutica [Forsk.] Stapf, Jamaica vervain (Stachytarpheta jamaicensis [L.] Vahl), and airplant (Bryophyllum pinnatum).

Aerial reconnaissance of the project area indicated that cultural features were present on all lava types, and that much of the surface was covered with heavy vegetation. During the pedestrian survey, therefore, intervals between sweeping crew members were maintained at a high-intensity level of about 30-ft over the entire project area. The survey crew consisted of four to five individuals, who oriented their parallel sweeps north-south across the project area. In order to ensure complete coverage, survey transects were flagged.

As sites/features were identified they were tagged and plotted on a 1":200 ft scale aerial photograph. Subsequently, a crew of four to eight tagged the sites with metal tags, photographed the sites, measured and described the sites, and in most cases, cleared and mapped them. Hand-excavated test units (1.0 by 1.0 m) were excavated at one site (13188 *). All excavated soil was screened through 1/8-inch mesh and all shell, lithic, botanical and faunal materials were collected. Analysis of midden, artifacts and stratigraphic data is pending.

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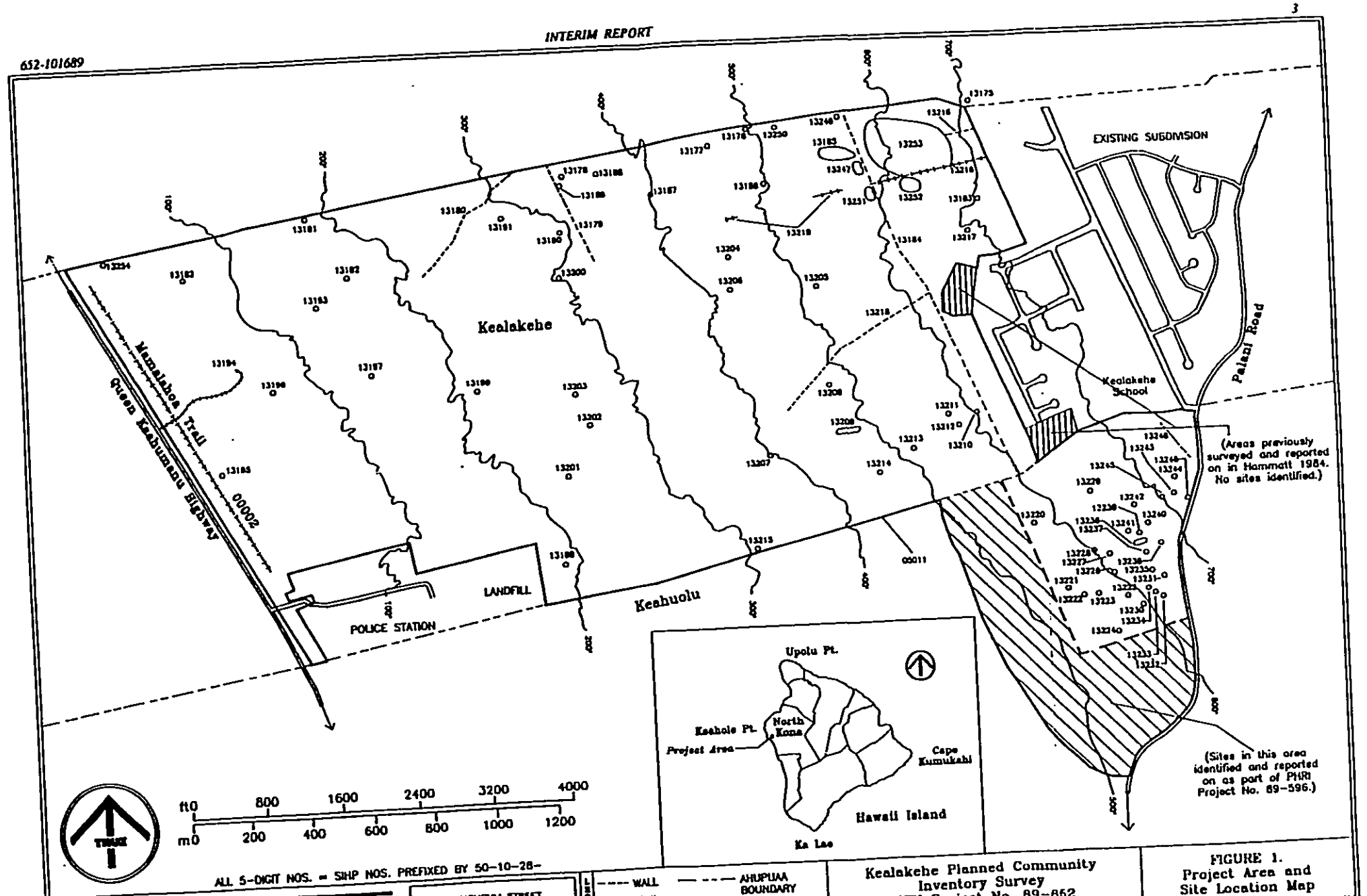
* State Inventory of Historic Places (SIHP) site designation system: all four-digit site numbers prefixed by 50-10-25 or -27 (50=State of Hawaii, 10=Island of Hawaii, 25 or 27=USGS 7.5' series quad map ["Kailua" or "Keahole, Hawaii"]).

INTERIM REPORT

652-101689



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Kealakehe Planned Community
Inventory Survey
PHRI Project No. 89-662

FIGURE 1.
Project Area and
Site Location Map

SUMMARY OF FINDINGS

Eighty-one sites consisting of a minimum of 766 component features were identified/reidentified within the project area. The sites are summarized in Table 1 (at end). Correlation of newly identified and previously recorded sites is still pending, however, it appears that one (13183) of the newly identified sites has been previously recorded by Hammatt, Shideler, and Borthwick as Site 12 (1987). Previously recorded Mamalahoa Trail (King's Trail) is within the project area; this site was not given a PHRI temporary number.

Among the identified sites, 27 (33.8%) consist of single components and the rest consist of two to 120 components. Tentative functional interpretations were determined for individual features within complexes and for single component sites; functional interpretations were based on feature morphology, physical setting, and associated features or artifacts. Eight general functional categories were identified (Table 2)—agriculture (664 features, 86.6%), habitation (21 features, 2.7%), transportation (19, 2.5%), markers (30, 3.9%), agricultural/ habitation (11, 1.4%), land division (9, 1.2%), possible burial (8, 1.0%), and possible ceremonial (4, 5.2%).

The distribution and density of features within the project area indicate that the area was used principally for relatively intense dryland agriculture. Agricultural complexes are most numerous in the upper portions of the area, at elevations of 500 ft and greater. As indicated in Table 2, the most common agricultural features are pahoehoe excavations and rock mounds. These two formal types comprise 66% of all agricultural features, and 57.4% of all identified features. It is highly likely that additional pahoehoe excavations and mounds are present within the project area.

Roughly half (10 of 21) of the habitation features identified to date appear to reflect temporary habitation. These include four cave shelters with minimal amounts of midden and minimal internal modification, two C-shapes, two hearths that are relatively recent, a wall, and a midden scatter. Seven platforms, an enclosure, a pavement, and a terrace have been tentatively assigned habitation functions.

Features identified as habitation/agriculture are questionable as to exact function. Morphological characteristics of these features are reflective of habitation structures; the features may, however, also comprise more formalized agricultural structures. Similarly, the four possible ceremonial and eight possible burial features may also comprise habitation or more formalized agricultural features.

Four of the eight possible burial platforms are present at one site (13181) located well below (160 ft elevation) the intensive agriculture zone. This is the only site identified that may correlate with a burial site previously described by Soehren (1975) at the northern end of Kealakehe.

The transportation category includes ten steppingstone trail segments, five sections of kerbstone trail, and two sections of historic roadbed. It is likely that at least four of the steppingstone trail sections were once connected to form two trails. Other steppingstone trails are short, and appear to have connected various agricultural complexes. At least one of the kerbstone trails (13219) has been associated with an early historic inland-seaward "3 ft road" that connected the upper government road with the Mamalahoa Trail (Emerson survey map). Major portions of this trail have been destroyed by bulldozing and land clearing activities associated with ranching.

Among the nine land division walls identified, one is definitely associated with ranching (13215). Four of the walls have modifications such as cattle gates and fencing; however, it has not been determined if the walls predate the modifications. Four walls appear to comprise Pre-Contact land boundary walls. A wall at Site 13248 defines the Kealakehe/Keahuolu ahupua'a boundary.

Table 2.

FREQUENCY OF FORMAL FEATURE TYPES BY FUNCTIONAL CATEGORIES

Features	Count	% of Category	% of Total
Agricultural Features			
Enclosures	14	2.1	
Faced mounds	6	.9	
Linear rock mounds/walls	101	15.2	
Modified outcrops	45	6.8	
Pahoehoe excavations	228	34.3	
Rock mounds	212	31.9	
Stepped terraces	2	.3	
Terraces	49	7.4	
Walled terrace	1	.1	
Walls	6	.9	
Subtotal:	**664**	**99.9**	**86.7**
Habitation Features			
Caves	4	19.0	
C-shapes	2	9.5	
Enclosure	1	4.8	
Hearths	2	9.5	
Midden scatter	1	4.8	
Pavements	2	9.5	
Platforms	7	33.3	
Terrace	1	4.8	
Wall	1	4.8	
Subtotal:	**21**	**100.0**	**2.7**
Indeterminate Markers			
Cairns	30		3.9

Features	Count	% of Category	% of Total
Transportation Features			
Steppingstone trails	10	52.6	
Kerbstone trails	5	26.3	
Footpaths	2	10.5	
Roadbeds	2	10.5	
Subtotal:	**19**	**99.9**	**2.5**
Possible Ceremonial Features			
Enclosures	2	50.0	
Platform	1	25.0	
Stepped Terrace	1	25.0	
Subtotal:	**4**	**100.0**	**0.5**
Habitation or Agriculture Features			
Enclosures	2	18.2	
Pavements	2	18.2	
Platforms	2	18.2	
Terraces	3	27.3	
Walled pavement	1	9.1	
Subtotal:	**11**	**100.0**	**1.4**
Land Division/Ranching Features			
Walls	9		1.2
Possible Burial Features			
Platforms	8		1.0
Total Number of Features:	**766**		**99.9**

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

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). Sites determined to be potentially significant for information content (Category A, Table 3) are assessed 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 excellent examples of a unique site or site type (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 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 historic 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 a traditional cultural value."

Among the 81 sites identified within the project area, 65 are assessed as significant solely for information content (Table 3). No further work is recommended for 21 of the 65 sites. These 21 sites have limited information value at the level of local analysis—they consist principally of cairns (six sites) that could not be associated with trails or other features, recent mango tree enclosures (two sites), isolated agricultural features (two sites), ranching features (three sites), and a recent campsite. The sites have been adequately documented; they have been mapped, described, photographed, and their locations have been plotted.

Forty-four of the 65 sites are recommended for further data collection if the sites or portions of them are to be affected by development. These sites potentially contain information pivotal to understanding prehistoric and early historic settlement and agricultural land use patterns in leeward Hawaii. Over half of the sites are agricultural complexes (25 sites, 55% of category); six sites are habitation or possible habitation sites, four sites consist of walls, and and seven sites consist of short trail sections.

Seven of the remaining 16 sites are multifunctional complexes tentatively assessed as having significant information content, as providing excellent examples of feature types or complex types, and as provisionally having cultural value. Present at these sites are shrines, ceremonial features, or human interments. Further data collection and interpretive development are recommended for portions of these complexes, and preservation as is is provisionally recommended for any identified burial features. Five of the sites in this category are agricultural complexes that also contain habitation features and possible shrines or burials (13176, 13183, 13185, 13209, and 13254). The remaining sites include a possible burial complex (13281) and a relatively well-preserved enclosure that is possibly a ceremonial structure (13228).

Four of the remaining 16 sites have been identified as potentially containing human interments. These sites are assessed as having provisional cultural value, in addition to the information value present, regardless of whether or not burials are present. Recommended treatment for these sites is further data collection and preservation as is if human skeletal remains are encountered. Included in this category are Sites 13178, 13193, 3205 and 13223. These sites are either single feature sites or small complexes of less than three features. If burials are not identified at the sites, and data collection is completed, no further treatments would be recommended

Five sites are tentatively assessed as having information value at the local and regional level, as being excellent examples of a site type, and as having cultural value as relatively important transportation routes. Further data recovery is recommended for these sites, and preservation with interpretive development of undisturbed sections is recommended. Two of the sites (13234 and 13244) are very likely sections of the same kerbstone trail. Site 13219 represents the major inland-seaward route, and the Mamalahoa Trail is of the regional thoroughfare which connected Kealakehe with other lands and places. Also included in this category is a well-preserved, relatively lengthy section of a steppingstone foot trail (Site 13294).

Table 3.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
13175	-	+	-	-	-	+	-	-
13177	-	+	-	-	-	+	-	-
13182	-	+	-	-	-	+	-	-
13191	-	+	-	-	-	+	-	-
13192	-	+	-	-	-	+	-	-
13195	-	+	-	-	-	+	-	-
13196	-	+	-	-	-	+	-	-
13198	-	+	-	-	-	+	-	-
13199	-	+	-	-	-	+	-	-
13200	-	+	-	-	-	+	-	-
13208	-	+	-	-	-	+	-	-
13215	-	+	-	-	-	+	-	-
13216	-	+	-	-	-	+	-	-
13217	-	+	-	-	-	+	-	-
13237	-	+	-	-	-	+	-	-
13243	-	+	-	-	-	+	-	-
13245	-	+	-	-	-	+	-	-
13249	-	+	-	-	-	+	-	-
13250	-	+	-	-	-	+	-	-
13251	-	+	-	-	-	+	-	-
13253	-	+	-	-	-	+	-	-
Subtotal:	**0**	**21**	**0**	**0**	**0**	**21**	**0**	**0**

General Significance Categories:

A = Important for information content, further data collection necessary (PHRI CRM value mode=research value);
X = Important for information content, no further data collection necessary (PHRI CRM value mode=research value, SHPO=not significant)
B = Excellent example of site type at local, region, island, State, or National level (PHRI CRM value mode=interpretive value); and
C = Culturally significant (PHRI CRM value mode=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;
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

Table 3 (cont.)

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
13179	+	-	-	-	+	-	-	-
13180	+	-	-	-	+	-	-	-
13184	+	-	-	-	+	-	-	-
13186	+	-	-	-	+	-	-	-
13187	+	-	-	-	+	-	-	-
13188	+	-	-	-	+	-	-	-
13189	+	-	-	-	+	-	-	-
13190	+	-	-	-	+	-	-	-
13197	+	-	-	-	+	-	-	-
13201	+	-	-	-	+	-	-	-
13202	+	-	-	-	+	-	-	-
13203	+	-	-	-	+	-	-	-
13204	+	-	-	-	+	-	-	-
13206	+	-	-	-	+	-	-	-
13207	+	-	-	-	+	-	-	-
13210	+	-	-	-	+	-	-	-
13211	+	-	-	-	+	-	-	-
13212	+	-	-	-	+	-	-	-
13213	+	-	-	-	+	-	-	-
13214	+	-	-	-	+	-	-	-
13218	+	-	-	-	+	-	-	-
13220	+	-	-	-	+	-	-	-
13221	+	-	-	-	+	-	-	-
13222	+	-	-	-	+	-	-	-
13224	+	-	-	-	+	-	-	-
13225	+	-	-	-	+	-	-	-
13226	+	-	-	-	+	-	-	-
13227	+	-	-	-	+	-	-	-
13229	+	-	-	-	+	-	-	-
13230	+	-	-	-	+	-	-	-
13231	+	-	-	-	+	-	-	-
13232	+	-	-	-	+	-	-	-
13233	+	-	-	-	+	-	-	-
13235	+	-	-	-	+	-	-	-
13236	+	-	-	-	+	-	-	-
13238	+	-	-	-	+	-	-	-
13239	+	-	-	-	+	-	-	-
13240	+	-	-	-	+	-	-	-
13241	+	-	-	-	+	-	-	-
13244	+	-	-	-	+	-	-	-
13246	+	-	-	-	+	-	-	-
13247	+	-	-	-	+	-	-	-
13248	+	-	-	-	+	-	-	-
13252	+	-	-	-	+	-	-	-
Subtotal:	**44**	**0**	**0**	**0**	**44**	**0**	**0**	**0**

Table 3 (cont.)

Site Number	Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
13194	+	-	+	+	+	-	+	-
13219	+	-	+	+	+	-	+	-
13234	+	-	+	+	+	-	+	-
13242	+	-	+	+	+	-	+	-
00002	+	-	+	+	+	-	+	-
Subtotal:	**5**	**0**	**5**	**5**	**5**	**0**	**5**	**0**
13178	+	-	-	*	+	-	-	*
13193	+	-	-	*	+	-	-	*
13205	+	-	-	*	+	-	-	*
13223	+	-	-	*	+	-	-	*
Subtotal:	**4**	**0**	**0**	**4**	**4**	**0**	**0**	**4**
13176	+	-	+	*	+	-	+	*
13181	+	-	+	*	+	-	+	*
13183	+	-	+	*	+	-	+	*
13185	+	-	+	*	+	-	+	*
13209	+	-	+	*	+	-	+	*
13228	+	-	+	*	+	-	+	*
13254	+	-	+	*	+	-	+	*
Subtotal:	**7**	**0**	**7**	**7**	**7**	**0**	**7**	**7**
Total:	**60**	**21**	**12**	**16**	**60**	**21**	**12**	**11**

* Provisional assessment; definite assessment pending further data collection (i.e., testing features for presence/absence of skeletal remains)

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Table 1.

SUMMARY OF IDENTIFIED SITES

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	*CRM Value Mode Assess. R	I	C	+Field Work Tasks DR	SC	EX
13175	Complex (8)#	Agriculture	L	L	L	-	-	-
A-I	Enclosures							
13176	Complex (4)	Agriculture/ Possible shrine	M	M	M/H	+	-	+
A	Stepped terrace							
B	Terrace							
C	Modified outcrop							
D	Stepping stone trail							
13177	Cairns (2)	Indet. markers	L	L	L	-	-	-
13178	Complex (3)	Agriculture/ Possible Burial	M/H	L	L/H	+	-	+
A	Platform							
B	Phh. excavations (2)							
13179	Wall	Land division/ Ranching	M	L	L/M	+	-	-
13180	Wall	Land division/ Ranching	M	L	L/M	+	-	-
13181	Complex (4)	Possible burial	M/H	M	M/H	+	-	+
A	Platforms (2)							
B	Platform							
C	Platform							
13182	Complex (2)	Indet. marker	L	L	L	-	-	-
A	Cairn							
B	Phh. Excavation							

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

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

Number of component features within complex.

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13183	Complex (5)	Habitation/ Agricultural/ Possible Burial	H	M	L/H	+	+	+
A	Lava tube cave							
B	Pavement							
C	Enclosure							
D	Platform							
E	Enclosure							
13184	Walls (2)	Land division	M	M/L	M	+	-	-
13185	Complex (40)	Agriculture/ Possible Burial/ Possible Habitation	H	M/H	M/H	+	-	+
	13 Faced terraces							
	12 Modified outcrops							
	12 Rock mounds							
	2+ Phh. excavations							
	1 Cairn							
13186	Complex (2)	Transportation/ Agriculture	M	M	M	+	+	+
A	Steppingstone trail							
B	Enclosure							
13187	Phh. Excavations (3)	Agriculture	M	L	L	+	-	-
13188	Cave	Habitation	M	L	L	+	+	+
13189	Complex (2)	Agriculture	M	L	L	+	-	+
A	Terrace							
B	Terrace							
13190	Complex (20+)	Agriculture	M/H	L	L	+	-	+
A	Wall							
B	Phh. excavations (2)							
C	Modified outcrop							
D	Phh. excavations (6)							
	Plus ten rock mounds and additional Phh. excavations							

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13191	Cairn	Indet. marker	L	L	L	-	-	-
13192	Cairn	Indet. marker	L	L	L	-	-	-
13193	Faced Mound	Agriculture (?)	L/M	L	L/H	+	-	+
13194	Steppingstone Trail	Transportation	M/H	M	M/H	+	-	-
13195	Cairns (2)	Historic markers	L	L	L	-	-	-
13196	Cairns (2)	Indet. markers	L	L	L	-	-	-
13197	Steppingstone Trail	Transportation	M/H	L	M/H	+	-	-
13198	Complex (2)	Indet. marker	L	L	L	-	-	-
A	Cairn							
B	Phh. excavation							
13199	Cairn	Recent marker	L	L	L	-	-	-
13200	Rock mounds (2)	Agriculture	M	L	L	-	-	-
13201	Trail	Transportation	M	L	M	+	-	-
13202	Complex (3)	Transportation	M	L	M	+	-	-
A	Cairns (2)							
B	Trail							
13203	Complex (2)	Agriculture/ Possible Habitation	M/H	L	L	+	-	+
A	Terrace							
B	Pavement							
13204	Steppingstone Trail	Transportation	M	M	M	+	-	-

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13205	Complex (2)	Habitation/ Possible Ceremonial	H	M	M/H	+	-	+
A	Platform							
B	Enclosure							
13206	Steppingstone Trail	Transportation	M	M	M/H	+	-	-
13207	Complex (5)	Transportation/ Agricultural/ Possible habitation	M/H	M	M	+	+	+
A	Steppingstone trail							
B	Terraces (3)							
C	Terrace							
13208	Complex (4)	Agricultural/ Indet. markers	L	L	L	-	-	-
A	Modified outcrop							
Plus 3 collapsed cairns								
13209	Complex (52+)	Habitation/ Agricultural/ Possible burial	H	M	M/H	+	+	+
A	Steppingstone trail							
B	Cairn							
C	Stepped terrace							
D	Terrace with platform and rock mound							
E	Platform							
F	Terrace							
I	Cairn							
J	Cairn							
K	Modified outcrops (3)							
L	Cairn							
M	Midden deposit							
Plus 40+ Phh. excavations								
13210	Complex (3)	Habitation/ Agriculture	H	L	L	+	-	+
A	Platform							
B	Terrace							
C	Terrace							

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13211	Complex (2)	Agriculture	M	L	L	+	-	-
A	Rock mound							
B	Terrace w/walls							
13212	Complex (8)	Agriculture/ Transportation	M	L	M	+	-	-
A	Phh./aa excavation							
B	Terraces (6)							
C	Kerbstone trail							
13213	Enclosure	Agriculture/ Possible habitation	M	L	L	+	-	+
13214	Complex (2)	Agriculture/ Possible Habitation	M	L	L	+	-	+
A	Enclosure							
B	Platform							
13215	Wall	Ranching	L	L	L	-	-	-
13216	Wall	Land division/ Ranching (?)	M	L	L/M	-	-	-
13217	Enclosure	Agriculture (recent)	L	L	L	-	-	-
13218	Wall	Land division/ Ranching (?)	M/L	M/L	M/L	+	-	-
13219	Kerbstone Trail	Transportation	M/H	M	M/H	+	-	-

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13220	Complex (3)	Agriculture	M	L	L	+	-	-
	A Linear rock mound							
	B Phh. excavation							
	C Circular rock mound							
13221	Complex (80)	Agriculture	M/H	L	M	+	-	+
	55 Linear rock mounds							
	25 Phh. excavations							
13222	Complex (19)	Agriculture	M/H	L	M	+	-	-
	A Phh. excavation							
	B Linear rock mound							
	Plus 14 circular rock mounds and 3 phh. excavations							
13223	Complex (4)	Agriculture/ Habitation/ Possible burial	H	M	L/H	+	-	+
	A Enclosure							
	B Platform							
	C Terrace w/6 cleared depressions							
	D Platform							
13224	Complex (28+)	Agriculture	M	L	L	+	-	-
	A Terrace							
	Plus 19 phh. excavations and 8 rock mounds							
13225	Complex (7)	Agriculture	M	L	L	+	-	-
	A Phh. excavations (3)							
	B Linear rock mound							
	Plus 3 circular rock mounds							

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13220	Complex (3)	Agriculture	M	L	L	+	-	-
A	Linear rock mound							
B	Phh. excavation							
C	Circular rock mound							
13221	Complex (80)	Agriculture	M/H	L	M	+	-	+
	55 Linear rock mounds							
	25 Phh. excavations							
13222	Complex (19)	Agriculture	M/H	L	M	+	-	-
A	Phh. excavation							
B	Linear rock mound							
Plus 14 circular rock mounds and 3 phh. excavations								
13223	Complex (4)	Agriculture/ Habitation/ Possible burial	H	M	L/H	+	-	+
A	Enclosure							
B	Platform							
C	Terrace w/6 cleared depressions							
D	Platform							
13224	Complex (28+)	Agriculture	M	L	L	+	-	-
A	Terrace							
Plus 19 phh. excavations and 8 rock mounds								
13225	Complex (7)	Agriculture	M	L	L	+	-	-
A	Phh. excavations (3)							
B	Linear rock mound							
Plus 3 circular rock mounds								

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13226	Complex (12)	Agriculture	M	L	L	+	-	-
	A L-shaped rock mound/wall Plus 7 Phh. excavations and 4 rock mounds							
13227	Complex (120)	Agriculture	H	M	M	+	-	+
	59 Circular rock mounds 48 Pahoehoe excavations 13 Linear rock mounds							
13228	Enclosure	Indet./Possible ceremonial	M/H	M	M/H	+	-	+
13229	Complex (10+)	Agriculture	M	L	L	+	-	-
	A Cairn w/3 enclosed Phh. excavations B Modified Phh. excavation Plus 5+ rock mounds							
13230	Walled cave	Habitation	H	L	L	+	+	+
13231	Complex (8+)	Agriculture	M	L	L	+	-	-
	Rock mounds (8)							
13232	Complex (10)	Agriculture	M	L	L	+	-	-
	Phh. excavations (10)							
13233	Complex (6+)	Agriculture	M	L	L	+	-	-
	Rock mounds (6+)							
13234	Kerbstone Trail	Transportation	M/H	M	M/H	+	-	-
13235	Complex (33+)	Agriculture	M/H	L	L	+	-	-
	13+ Linear rock mounds 10+ Circular rock mounds 10+ Phh. excavations							

Table 1. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13236	Complex (6)	Agriculture	M	L	L	+	-	-
	Rock mounds (6)							
13237	Enclosure	Agriculture (recent)	L	L	L	-	-	-
13238	Complex (20)	Agriculture	M	L	L	+	-	-
	10 Phh. excavations 10 Rock mounds							
13239	Complex (23)	Agriculture	M/H	M	L	+	-	-
A	Wall							
B	Cairn							
C	Terrace							
Plus 20 Phh. excavations								
13240	Complex (33)	Agriculture	M	L	L	+	-	-
	20 Rock mounds 10 Phh. excavations 3 Faced mounds							
13241	Complex (49)	Agriculture/ Possible habitation	M	M	L	+	-	+
A	Terrace							
B	Cupboard							
C	L-shaped rock mound							
D	Terrace							
Plus 24 modified outcrops and 21 rock mounds								
13242	Steppingstone Trail	Transportation	M	M	M/H	+	-	-
13243	Complex (4)	Habitation (recent)	L	L	L	-	-	-
A	C-shape							
B	Hearths							
C	Hearths							
D	Wall							

Table 1. (Cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13244	Kerbstone Trail	Transportation	M	M/L	M	+	-	-
13245	Complex (3)	Indet. markers/ Agriculture	L	L	L	-	-	-
A	Cairns (2)							
B	Rock mound							
13246	Complex (6+)	Agriculture/ Transportation	M	L	L	+	-	-
A	Roadbed							
B	Linear mound							
C	Linear mound							
D	Depression w/2 alignments							
E	Phh. excavation w/alignment							
F	Linear mound							
Plus additional Phh. excavations								
13247	Complex (4)	Agriculture	M	L	L	+	-	-
A	Linear mounds (2)							
B	Cleared depression							
C	Stepped terrace							
13248	Wall	Land division	M/H	M	M/H	+	-	-
13249	Complex (5)	Agriculture	M	L	L	-	-	-
A	Terrace							
B	Terrace							
C	Terrace							
D	Terrace							
E	Rock mound							
13250	Terraced rock mound	Agriculture	M	L	L	-	-	-

Table 1. (Cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13251	Enclosure	Agriculture/ Ranching	M	L	L	-	-	-
13252	Complex (14)	Agriculture/ Possible habitation	H	M	L/M	+	-	+
A	Faced mound							
B	Faced mound							
C	Enclosure							
D	Faced mound							
E	Walled pavement w/2 cairns and a rock mound							
F	Terrace w/central depression							
G	Terrace							
H	L-shaped wall							
I	Pavement							
J	Pavement							
K	Rock mound							
13253	Wall	Land division	M	M	M/H	-	-	-
13254	Complex (50+)	Habitation/ Agriculture	H	M	M/H	+	-	+
13	Circular rock mounds							
10	Linear rock mounds							
10	Terraces							
5	Platforms							
3	Walls							
2	Cairns							
2	Faced mounds							
1	Roadbed							
1	Modified outcrop							
1	Lava tube cave							
1	C-shape							
1	Steppingstone trail							
00002	Kerbstone Trail (Mamalahoa Trail)	Transportation	M/H	H	M	+	-	-

APPENDIX B

Botanical Survey

BOTANICAL SURVEY

KEALAKEHE PLANNED COMMUNITY

NORTH KONA, HAWAI'I

by

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Prepared for: BELT COLLINS & ASSOCIATES

November 1989

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BOTANICAL SURVEY

KEALAKEHE PLANNED COMMUNITY

NORTH KONA, HAWAI'I

The proposed planned community is being undertaken by the State of Hawaii through its Housing Finance and Development Corporation (HFDC) in participation with the County of Hawaii through its Office of Housing and Community Development (OHCD). The primary goal of the project is to provide affordable housing opportunities for the anticipated growth in the West Hawaii area.

The Kealakehe project site consists of approximately 840 acres of land located mauka of the Queen Ka'ahumanu Highway; additionally about 150 acres on the adjacent Queen Lili'uokalani Trust property will also be included within the proposed planned community. The 840-acre parcel extends from about 50 ft. elevation along the Queen Ka'ahumanu Highway to 700 ft. elevation at its upper boundary. Properties near the upper boundary include the Kealakehe Elementary and Intermediate Schools, Public Housing Projects, and single family residences. Adjoining existing land uses near the lower boundary include the County's Kealakehe Landfill, police substation, County Animal Shelter, and power substation. The smaller 150-acre parcel extends from about 500 ft. elevation to roughly 770 ft. elevation; Palani Road runs along its eastern boundary.

Field studies were conducted over a three-day period, 14-16 July 1989, to assess the botanical resources present on the subject property. A total of three botanists were used to gather the technical data contained in this report. The objectives of the survey were to (1) provide a general description of the major

vegetation types; (2) inventory the terrestrial, vascular flora; and (3) search for threatened and endangered plants on the project site.

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. Recent aerial photographs and topographic maps were examined to determine vegetation cover patterns, terrain characteristics, access, boundaries and reference points.

Access along the lower boundary of the 840-acre parcel was from the Queen Ka'ahumanu Highway and from a jeep trail behind the quarry and cement batching plant. Along the upper boundary, a number of streets in the residential area dead end adjacent to the property. A number of fencelines, rock walls, dozer walks, and waterline can be found on the property; these were used as reference points during the field studies. The 150-acre parcel was accessed from Palani Road and from the adjacent school property.

A walk-through survey method was employed. Areas most likely to harbor native plant communities or rare species, as the open, mixed shrubland and rougher 'a'a lava flows, were more intensively examined. Notes were made on plant associations and distribution, substrate types, topography, exposure, etc. Species identification was made in the field; plants which could not be positively determined were collected for later identification in the herbarium and for comparison with the 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 taxa.

VEGETATION DESCRIPTION

Four major vegetation types are recognized on the project site and are described in detail below. All those vascular plants inventoried during the field studies are presented in the species checklist at the end of the report. One officially listed endangered species, the uhiuhi (Caesalpinia kavaiensis), and one candidate endangered species, Bidens micrantha ssp. ctenophylla, occur on the site. A more detailed discussion on their status is found under the "Threatened and Endangered Plants" section of this report.

The distribution of the four vegetation types corresponds roughly with substrate type, rainfall, and elevation. As one moves upslope, annual rainfall increases from about 20 inches near the Queen Ka'ahumanu Highway to almost 50 inches at the upper boundary. 'A'a lava flows run the length of the property, while more weathered pahoehoe flows are found along the peripheries of the property; one small section along the upper boundary contains Punalu'u extremely rocky peat overlying pahoehoe bedrock (Sato et al. 1973).

1. Open Mixed Shrubland

This vegetation type generally is distributed above the 400 ft. contour interval on 'a'a lava. It may extend to lower elevations on some flows with many of the native elements quickly attenuating.

The physiognomy is of an open scrub with scattered trees,

although in depressions and small gullies shrubs and trees may form dense thickets. Native and introduced shrubs occur in about equal numbers, although among the natives alahe'e (Canthium odoratum) and a'ali'i (Dodonaea viscosa) are locally abundant in places, while among the introduced plants koa-haole (Leucaena leucocephala), klu (Acacia farnesiana), and Christmas berry (Schinus terebinthifolius) are locally abundant. Trees occur as scattered individuals or small, scattered stands. Native shrubs and trees include mamane (Sophora chrysophylla), lama (Diospyros sandwicensis), alahe'e, maiapilo (Capparis sandwichiana), a'ali'i, Bidens micrantha ssp. ctenophylla, kalamona (Senna gaudichaudii), naio (Myoporum sandwicense), uhiuhi (Caesalpinia kavaiensis), wiliwili (Erythrina sandwicensis), and 'ohe (Reynoldsia sandwicensis). The more commonly occurring introduced shrubs include koa-haole, Christmas berry, klu, lantana (Lantana camara), guava (Psidium guajava), senna (Senna septemtrionalis), and pluchea (Pluchea symphytifolia). Introduced trees include kukui (Aleurites moluccana), jacaranda (Jacaranda mimosifolia), silk oak (Grevillea robusta), and monkeypod (Samanea saman).

Ground cover is usually a mixture of grasses, smaller shrubs or subshrubs, and young koa-haole plants less than a foot high. These include Natal redtop (Rhynchelytrum repens), fountain grass (Pennisetum setaceum), Guinea grass (Panicum maximum), love grass (Eragrostis tenella), molassesgrass (Melinis minutiflora), Bermuda grass (Cynodon dactylon), 'uhaloa (Waltheria indica), 'ilima (Sida fallax), coffee senna (Senna occidentalis), false mallow (Malvastrum coromandelianum), nettle-leaved vervain (Stachytarpheta urticifolia), indigo (Indigofera suffruticosa), bur bush (Triumfetta rhomboidea), and air plant (Kalanchoe pinnata).

Cattle grazing on this part of the property tend to keep most of the open mixed shrubland low and there are numerous cattle paths through the shrubland. Where the cattle congregate, usually under

trees and where there is some soil, plants of acute-leaved sida (Sida acuta), bur bush, hairy honohono (Commelina benghalensis), false mallow, amaranth (Amaranthus viridus), and coffee senna are more numerous.

There are minor variants of this shrubland. For example, along the upper boundary, adjacent to the residential area and public housing, the property has been more disturbed as evidenced by the large piles of boulders, a number of dozer walks, and piles of rubbish. In this area, weedy species such as Spanish needle (Bidens pilosa), Florida beggarweed (Desmodium tortuosum), hyptis (Hyptis suaveolens), etc., are abundant, and, California grass (Brachiaria mutica) forms extensive mats. Where the substrate is weathered pahoehoe, fountain grass becomes more numerous.

2. Canthium/Christmas Berry Shrubland

This vegetation type occurs on the ±150-acre parcel which is included in the proposed planned community. The Canthium/Christmas berry shrubland continues across the slope and extends onto the adjacent Queen Lili'uokalani Trust Keahuolu lands where a recent flora survey was conducted (Char 1989).

The substrate is 'a'a with blocky chunks generally 4 to 6 inches in diameter. Both alahe'e (Canthium odoratum) and Christmas berry occur in almost equal numbers, though one or the other may be more abundant in places. The shrubs form dense thickets, 10 to 15 ft. tall. Scattered through the shrubland are clusters of mamane, 18 to 20 ft. tall; other native shrubs and trees include wiliwili, a'ali'i, 'ohe, Bidens micrantha ssp. ctenophylla, lama, and 'ohi'a (Metrosideros polymorpha). Introduced trees and shrubs, which also generally occur as scattered individuals, include jacaranda, silk oak, autograph tree (Clusia rosea), guava, kukui, and monkeypod. Koa-haole forms small clumps in places but is not abundant. Near the school boundary, large plants of sisal (Agave sisalana) are found.

Ground cover varies from 40 to 50% and is composed of seedlings of the tree and shrub species mentioned above plus a mixture of grasses and weedy herbs, though litter and barren 'a'a predominate. Low-lying, open areas are often filled with Natal redtop, molassesgrass, lantana, fountain grass, 'ilima, and air plant. Locally abundant, twining and sprawling over shrubs, are vines of huehue (Cocculus triloba).

3. Koa-haole Shrubland

This vegetation type is generally found associated with pahoehoe substrate. Dense to open koa-haole shrublands are found adjacent to the Kealakehe residential area, the County landfill, and above the quarry and cement batching plant. The koa-haole plants vary in height from 8 to 12 ft. tall, although, in places, they may be somewhat taller. Scattered trees of kiawe (Prosopis pallida) and 'opiuma (Pithecellobium dulce) are usually found associated with this shrubland. Other trees and shrubs occasionally found here include alahe'e, Christmas berry, monkeypod, lantana, maiapilo, and naio. Locally abundant are 'ilima and 'uhaloa.

Lower elevation koa-haole shrubland usually supports a dense ground cover of fountain grass, while upper elevation shrubland has a ground cover composed of Natal redtop, fountain grass, and various weedy species as nettle-leaved vervain (Stachytarpheta urticifolia), beggar's tick (Bidens pilosa, Bidens cynapifolia), hairy abutilon (Abutilon grandifolium), and air plant.

Where this vegetation type occurs on 'a'a substrate, there is very little ground cover and the koa-haole shrubs tend to occur in scattered patches usually in shallow depressions.

4. Fountain Grass Grassland

Along the northern boundary of the subject property, where it abuts Palani Ranch, fountain grass forms a rather extensive and dense grassland. Koa-haole shrubs occur as scattered individuals, although, in low-lying areas they may sometimes form small-sized thickets. Other shrubs and subshrubs occasionally found in the grassland include 'ilima, indigo (Indigofera suffruticosa), alahe'e, 'uhaloa, and maiapilo. A few trees of kiawe and 'ohe can be observed scattered through the grassland; one rather large tree of maua (Xylosma hawaiiense), about 20 ft. tall, is found on a rocky knoll near the jeep trail that begins behind the quarry.

On the 'a'a flow adjacent to Queen Ka'ahumanu Highway, fountain grass occurs in scattered clumps. In these areas, 'uhaloa and 'ilima are abundant.

In general, these grasslands tend to be species poor as the aggressive fountain grass forms a dense cover which crowds out other plants. Fountain grass is considered a serious pest in dry areas of the big island as it outcompetes most native species for establishment. It is also a fire-adapted species. The grass burns swiftly and hot causing extensive damage to native dry forest species. After fires it is able to quickly reestablish itself (Wagner et al. in press).

THREATENED AND ENDANGERED PLANTS

One officially listed endangered species, the uhiuhi (Caesalpinia kavaiensis; formerly known as Mezoneuron kavaiense), and one candidate endangered species, Bidens micrantha subspecies (ssp.) ctenophylla (no common name), occur on the Kealakehe site. An officially listed endangered species is protected by the Federal Endangered Species Act of 1973 (16USC 1531-1543), as amended, and by the State's threatened and endangered wildlife and plants law

(Chapter 124, Title 13, Subtitle 5, Part 2). Bidens micrantha ssp. ctenophylla is considered a Category 1 candidate endangered species by the U. S. Fish and Wildlife Service (1985). Plants considered Category 1 material should be regarded as candidates for addition to the Endangered and Threatened Species List and, as such, consideration should be given them in environmental planning.

The uhiuhi is a large shrub to medium-sized tree (up to 30 ft. tall) with thick, rough, dark gray bark and very dark blackish-brown heartwood. The leaves are twice divided into smaller leaflets with 4 to 8 pairs of pale green leaflets per pinnae. The flowers are borne in clusters at branch tips and are pinkish-purple to brick red. The seed pods are flat and thin; bluish-glaucous when young, pale pinkish-tan to gray when older. From 1 to 4 pale brown, flat seeds are found in each pod. The Hawaiians used the strong, dark, heavy wood for spears and fishing implements called la'au melomelo or la'au makalei (Rock 1913, 1920).

Uhiuhi was first described from the island of Kaua'i in 1867; later specimens were collected on O'ahu and Maui. J. F. Rock, a botanist, discovered uhiuhi plants in the North Kona area in 1909. Today the populations have been greatly reduced. Only a single tree is known from the Kaua'i population, a few plants occur in the Wai'anae Mountains on O'ahu, and about two dozen plants have been recorded on the slopes of Hualalai in the Pu'u-waawaa - Ka'upulehu ahupua'as on the island of Hawai'i. Cattle, goats, and other feral herbivores were probably reponsible for most of the population decline, but in recent years exotic plants, such as fountain grass, have become so abundant as to inhibit regeneration and to increase the chances of wildfire (Lamoureux 1982).

Nineteen uhiuhi plants were located on the Kealakehe project site during our field studies. This find represents a significant increase in the number of known plants and also extends the range

of distribution of the species from Pu'uwaawaa-Ka'upulehu across to the Kailua-Kona area. On the project site, the majority of the plants are found between the 500 and 550 ft. elevation contours in open mixed shrubland. A few plants occur in koa-haole shrubland on 'a'a flows. The plants vary in height from 8 ft. to about 25 ft. tall, with the majority of them 12 to 15 ft. tall. Most are multi-branched and, at the time of the survey, had flowers and many seed pods. Although we made an intensive around the plants, we did not find any seedlings or saplings of uhiuhi.

Bidens micrantha ssp. ctenophylla occurs in shrubland and dry forests on the leeward slopes of Hualalai, Hawai'i. In addition to being a candidate endangered species, it is also considered vulnerable (Wagner et al in press), that is, it is threatened by extensive habitat destruction or modification or by other environmental disturbances.

It is a rather attractive plant with its dense clusters of yellow, daisy-like flowers. Bidens is an erect, much-branched, perennial herb from 2 to 5 ft. tall. Under optimum growing conditions, it may reach 7 to 8 ft. in height. The dense inflorescences may contain 15 to 75 or more flowers per cluster.

On the Kealakehe project site, Bidens is found scattered throughout the open mixed shrubland and Canthium/Christmas berry shrubland in fairly large numbers.

DISCUSSION AND RECOMMENDATIONS

A total of 145 plant species were inventoried on the project site during the course of the field studies. Of these, 110 (76%) are introduced or alien species, 31 (21%) are native, and 4 (3%) are originally of Polynesian origin. Among the natives, 16 are indigenous (native to the Hawaiian islands and also elsewhere)

while 15 are endemic (native only to the islands). Native species are the dominant components in two of the four major vegetation types recognized on the project site; these are the open mixed shrubland and the Canthium/Christmas berry shrubland. One officially listed endangered species, the uhiuhi, and one candidate endangered species, Bidens micrantha ssp. ctenophylla, occur on the site. The uhiuhi is protected by both Federal and State endangered species laws.

It is recommended that efforts be focused on preserving and managing a portion of the open mixed shrubland for the conservation of the native vegetation and endangered species. A 25 to 30-acre preserve sited around the largest concentration of uhiuhi trees should be set up as a botanical interpretive park. This should be an actively used park with trails, jogging paths, picnic shelters, etc. Descriptive signs should be provided for the plants. Pamphlets for a self-guided tour could be provided at a kiosk; the pamphlets could highlight the native species, describe how the Hawaiians used the plants, landscaping uses, etc.

While the area proposed for the nature park also contains a good representative sample of native species (Bidens, 'ohe, mamane, naio, kalomona, lama, alahe'e, maiapilo), propagation material from other natives not found within the proposed nature park area, such as maua, wiliwili, halapepe (Pleomele hawaiiensis), olupua (Nestegis sandwicensis), and pua-kala (Argemone glauca), should be collected for inclusion onto the site. Seedlings started from seeds collected from uhiuhi plants outside the park should also be planted, thus preserving the gene pool, even if the original plants were lost. An active, long-term management plan for eradicating introduced plants, especially fountain grass, koa-haole, and Christmas berry, on the site should be set-up.

All mitigating actions should be undertaken in cooperation with

and reviewed by the U. S. Fish and Wildlife Service and the State's Department of Land and Natural Resources -- Division of Forestry and Wildlife. These are the agencies which oversee the protection of endangered species.

The use of native plant material for landscaping should also be considered. Recently, attention has been focused on using native species already adapted to the local climatic and soil conditions of a site. The Honolulu Board of Water Supply has installed a "xeriscape" garden -- a garden with plants which use less water -- on its property in the Halawa Industrial Park. A number of native, dryland species are incorporated into their landscaping design. Native plants adapted to the low rainfall and lava substrates on the Kealakehe site would require less water, maintenance, and almost no soil if used for landscaping. The plants could be propagated and used for landscaping common areas such as schoolgrounds, parks, golf courses, entrance ways, etc. In addition, homeowners may also be interested in planting natives if these were made available to them. Many of the natives are attractive and of ornamental value; these include uhiuhi, wiliwili, 'ohe, naio, maiaplio, alahe'e, mamane, kalomona, and Bidens micrantha ssp. ctenophylla.

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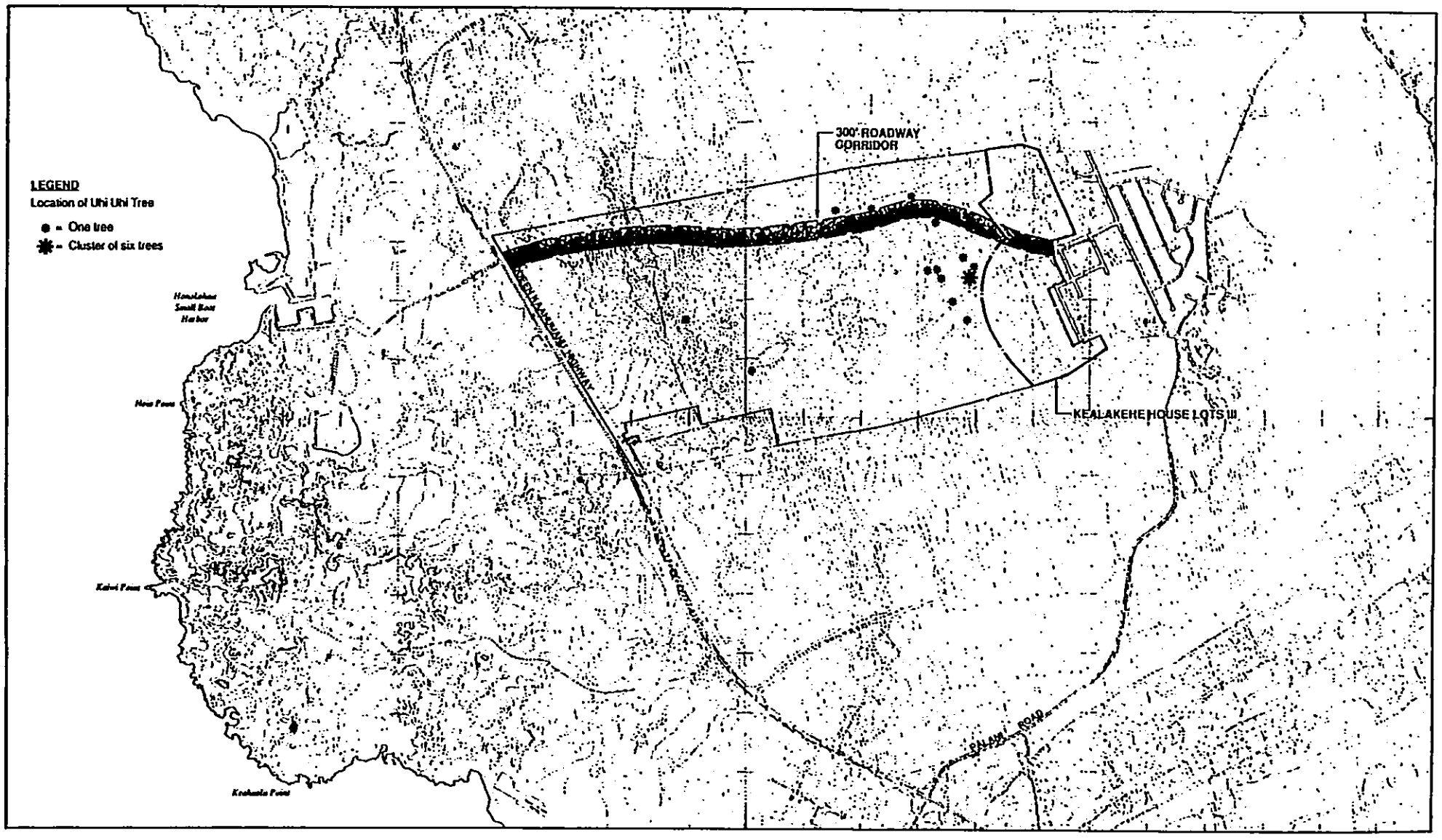

KEALAKEHE HOUSE LOTS III

Figure 10
ENDANGERED FLORA
SPECIES LOCATION

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
FERNS AND FERN ALLIES						
NEPHROLEPIDACEAE (Sword Fern Family)						
Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern, kupukupu	X	+	+	+	+
POLYPODIACEAE (Common Fern Family)						
Phlebodium aureum (L.) J. Sm.	laua'e-haole	X	+	+	-	-
Phymatosorus scolopendria (Burm.) Pic-Ser.	laua'e, lauwa'e	X	+	+	-	-
PSILOTACEAE (Psilotum Family)						
Psilotum nudum (L.) Beauv.	moa	I	-	+	-	+
SINOPTERIDACEAE (Cliffbrake Fern Family)						
Doryopteris decora Brack.	kumu niu, 'iwa 'iwa	E	-	-	+	-
MONOCOTS						
AGAVACEAE (Agave Family)						
Agave sisalana Perrine	sisal	X	-	+	-	-
Pleomele hawaiiensis Degener & I. Degener	halapepe	E	+	-	-	-
COMMELINACEAE (Spiderwort Family)						
Commelina benghalensis L.	hairy honohono	X	+	-	+	-
Rhoeo spathacea (Sw.) Stern	tradescantia	X	-	+	-	-
CYPERACEAE (Sedge Family)						
Cyperus compressus L.	cyperus	X	+	-	-	-
DIOSCOREACEAE (Yam Family)						
Dioscorea bulbifera L.	bitter yam, pi'oi	P	+	+	-	-

Scientific Name	Common Name	Status	Vegetation Type o	m	k	f
POACEAE (Grass Family)						
Brachiaria mutica (Forssk.) Stapf	California grass	X	+	–	–	–
Cenchrus echinatus L.	common sandbur, 'ume 'alu	X	–	–	+	–
Chloris barbata (L.) Sw.	swollen finger grass, mau'ulei	X	+	+	+	+
Cynodon dactylon (L.) Pers.	Bermuda grass, manienie	X	+	–	–	–
Dactyloctenium aegyptium (L.) Willd.	beach wiregrass	X	+	–	–	–
Digitaria ciliaris (Retz.) Koeler	crabgrass	X	+	–	–	–
Digitaria radicosa (Presl) Miq.		X	–	+	–	–
Eleusine indica (L.) Gaertn.	wiregrass	X	+	+	–	–
Eragrostis tenella (L.) P. Beauv. ex Roem. & Schult.	lovegrass	X	+	+	+	+
Melinis minutiflora P. Beauv.	molassesgrass	X	+	+	+	–
Panicum maximum Jacq.	Guinea grass	X	+	+	–	–
Pennisetum setaceum (Forssk.) Chiov.	fountain grass	X	+	+	+	+
Rhynchelytrum repens (Willd.) Hubb.	Natal redtop	X	+	–	–	–
Setaria gracilis Kunth	yellow foxtail, mau'u Kaleponi	X	+	–	–	–
DICOTS						
ACANTHACEAE (Acanthus Family)						
Barleria cristata L.	barleria	X	–	+	+	–
Justicia betonica L.	white shrimp plant	X	–	+	–	–
AMARANTHACEAE (Amaranth Family)						
Amaranthus spinosus L.	spiny amaranth, pakai kuku	X	+	–	–	–
Amaranthus viridus L.	amaranth, pakai	X	+	–	–	–
ANACARDIACEAE (Mango Family)						
Mangifera indica L.	mango	X	+	–	+	–
Schinus terebinthifolius Raddi	Christmas berry, wilelaiki	X	+	+	+	+

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
APOCYNACEAE (Dogbane Family)						
Catharanthus roseus (L.) G. Don	Madagascar periwinkle	X	+	+	+	+
ARALIACEAE (Ginseng Family)						
Reynoldsia sandwicensis A. Gray	'ohe	E	+	+	+	+
Schefflera actinophylla (Endl.) Harms	octopus tree	X	-	+	+	-
ARISTOLOCHIACEAE (Birthwort Family)						
Aristolochia littoralis Parodi	Dutchman's pipe	X	+	-	-	-
ASTERACEAE (Sunflower Family)						
Ageratum conyzoides L.	maile hohono	X	+	-	-	-
Bidens cynapiifolia Kunth	West Indian beggar's tick	X	+	+	+	-
Bidens micrantha ssp. ctenophylla (Sherff) Nagata and Ganders		E	+	+	-	-
Bidens pilosa L.	Spanish needle, beggar's tick	X	+	+	+	+
Crassocephalum crepidioides (Benth.) S. Moore	crassocephalum	X	+	+	-	-
Emilia coccinea (Sims) G. Don	Flora's paintbrush	X	+	-	-	-
Emilia fosbergii Nicolson	pualele	X	+	+	-	-
Pluchea symphytifolia (Mill.) Gillis	pluchea, sourbush	X	+	+	+	+
Sonchus oleraceus L.	sow thistle	X	+	+	+	-
Tridax procumbens L.	coat buttons	X	+	+	+	+
Vernonia cinerea var. parviflora (Reinw.) DC	little ironweed	X	+	-	-	-
BIGNONIACEAE (Bignonia Family)						
Jacaranda mimosifolia D. Don	jacaranda	X	+	+	-	-
Spathodea campanulata P. Beauv.	African tulip	X	+	+	-	-
BRASSICACEAE (Mustard Family)						
Lepidium virginicum L.	wild peppergrass	X	+	-	-	-

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
BUDDLEJACEAE (Butterfly Bush Family)						
Buddleia asiatica Lour.	dog tail, huelo 'ilio	X	+	+	-	+
CACTACEAE (Cactus Family)						
Opuntia ficus-indica (L.) Mill.	panini, papipi	X	+	-	-	+
CAPPARACEAE (Caper Family)						
Capparis sandwichiana DC	maiapilo, pilo	E	+	+	+	+
Cleome gynandra L.	wild spider flower	X	+	-	-	-
CARICACEAE (Papaya Family)						
Carica papaya L.	papaya, mikana	X	+	+	-	-
CLUSIACEAE (Mangosteen Family)						
Clusia rosea Jacq.	autograph tree, copey	X	-	+	-	-
CONVOLVULACEAE (Morning-glory Family)						
Ipomoea indica (J. Burm.) Merr.	koali-'awania	I	+	+	+	+
Ipomoea obscura (L.) Ker-Gawl.	field bindweed	X	-	+	-	-
Ipomoea triloba L.	little bell, pink bindweed	X	+	+	-	-
CRASSULACEAE (Orpine Family)						
Kalanchoë pinnata (Lam.) Poir.	air plant	X	+	+	+	-
CUCURBITACEAE (Gourd Family)						
Coccinia grandis (L.) Voigt	scarlet-fruited gourd, coccinia	X	+	-	+	-
Cucumis dipsaceus Ehrenb. ex Spach	wild cucumber	X	+	-	-	+
Cucurbita pepo L.	pumpkin	X	-	-	+	-
Momordica charantia L.	wild bittermelon	X	+	+	+	+
CUSCUTACEAE (Dodder Family)						
Cuscuta sandwichiana Choisy	kauna'oa	E	-	+	-	-
EBENACEAE (Ebony Family)						
Diospyros sandwicensis (A. DC) Fosb.	lama	E	+	+	+	-

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
EUPHORBIACEAE (Spurge Family)						
Aleurites moluccana (L.) Willd.	kukui, tutui	P	+	+	+	–
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	+	+	+	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	+	–	+	+
Chamaesyce hyssopifolia (L.) Sm.	spurge	X	–	–	+	–
Chamaesyce prostrata (Aiton) Sm.	prostrate spurge	X	–	–	–	+
Euphorbia heterophylla L.	fire plant	X	+	–	–	–
Phyllanthus debilis Klein ex Willd.	phyllanthus weed	X	+	+	+	–
Ricinus communis L.	castor bean	X	+	+	–	+
FABACEAE (Pea Family)						
Abrus precatorius L.	rosary pea	X	–	+	–	–
Acacia farnesiana (L.) Willd.	klu	X	+	+	+	+
Albizia lebbeck (L.) Benth.	Siris tree	X	–	+	–	–
Caesalpinia bonduc (L.) Roxb.	kakalaioa, hihikolo	I	+	+	–	–
Caesalpinia kavaiensis H. Mann.	uhiuhi	E	+	–	+	–
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	X	+	+	+	–
Crotalaria incana L.	fuzzy rattlepod	X	+	+	–	–
Crotalaria pallida Aiton	rattlepod	X	+	+	–	–
Desmodium incanum DC	Spanish clover, ka'imi	X	+	+	–	–
Desmodium tortuosum (Sw.) DC	Florida beggarweed	X	+	+	–	+
Erythrina sandwicensis Degener	wiliwili	E	+	+	–	–
Erythrina variegata Stckm.	haole wiliwili	X	–	+	–	–
Indigofera suffruticosa Mill.	indigo, iniko	X	+	+	+	+
Leucaena leucocephala (Lam.) de Wit	koa-haole	X	+	+	+	+
Macroptilium lathyroides (L.) Urb.	wild bean, cow pea	X	+	–	–	–
Medicago lupulina L.	black medic	X	+	–	–	–
Pithecellobium dulce (Roxb.) Benth.	'opiuma	X	+	+	+	+
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	X	+	+	+	+
Samanea saman (Jacq.) Merr.	monkeypod	X	+	+	+	–

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
Senna gaudichaudii (Hook. & Arnott) H. Irwin & Barneby	kalamona, uhuiuhi	I	+	+	+	-
Senna occidentalis (L.) Link	coffee senna, 'auko'i	X	+	+	-	+
Senna septemtrionalis (Viv.) H. Irwin & Barneby	senna, kolomona	X	+	+	-	-
Sophora chrysophylla (Salisb.) Seem.	mamane	E	+	+	-	-
Tephrosia purpurea (L.) Pers.	'ahuhu, 'auhuhu	P	+	-	-	-
FLACOURTIACEAE (Flacourtia Family)						
Xylosma hawaiiense Seem.	maua, a'e	E	-	-	-	+
GOODENIACEAE (Goodenia Family)						
Scaevola sericea Vahl	naupaka kahakai	I	+	-	-	-
LAMIACEAE (Mint Family)						
Hyptis suaveolens (L.) Poit.	hyptis	X	+	-	-	-
Plectranthus parviflorus Willd.	spurflower	I	+	+	-	-
Salvia coccinea Juss. ex J. A. Murray	scarlet sage	X	+	+	-	-
Salvia occidentalis Sw.	West Indian sage	X	-	-	-	+
MALVACEAE (Mallow Family)						
Abutilon grandifolium (Willd.) Sweet	abutilon, mao	X	+	+	+	+
Malvastrum coromandelianum (L.) Garcke	false mallow, hauuoi	X	+	+	+	+
Sida acuta ssp. carpinifolia (L. f.) Borssum Waalkes	acute-leaved sida	X	+	-	-	-
Sida fallax Walp.	'ilima	I	+	+	+	+
Sida rhombifolia L.	Cuba jute	X	+	-	-	-
Sida spinosa L.	prickly sida	X	+	-	+	-
MENISPERMACEAE (Moonseed Family)						
Cocculus trilobus (Thunb.) DC	huehue	I	+	+	+	-

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
MYOPORACEAE (Myoporum Family)						
Myoporum sandwicense A. Gray	naio	I	+	-	+	-
MYRTACEAE (Myrtle Family)						
Metrosideros polymorpha Gaud.	'ohi'a, 'ohi'a-lehua	E	-	+	-	-
Psidium cattleianum Sabine	strawberry guava, waiawi 'ula'ula	X	+	+	-	-
Psidium guajava L.	guava, kuawa	X	+	+	-	-
NYCTAGINACEAE (Four-o'clock Family)						
Boerhavia coccinea Mill.	red-flowered boerhavia	X	+	-	+	+
OLEACEAE (Olive Family)						
Nestegis sandwicensis (A. Gray) Degener, I. Degener, & L. Johnson	olopua, pua	E	+	-	-	-
OXALIDACEAE (Wood Sorrel Family)						
Oxalis corymbosa DC	pink wood sorrel, 'ihi pehu	X	+	-	-	-
PAPAVERACEAE (Poppy Family)						
Argemone glauca (Nutt. ex Prain) Pope	native poppy, pua-kala	E	+	-	-	-
PASSIFLORACEAE (Passion Flower Family)						
Passiflora edulis Sims	passion fruit, liliko'i	X	+	-	-	-
Passiflora foetida L.	pohapoha	X	+	+	+	+
PHYTOLACCACEAE (Pokeweed Family)						
Rivinia humilis L.	rouge plant	X	+	+	-	-
PIPERACEAE (Pepper Family)						
Peperomia leptostachya Hook. & Arnott	'ala'ala-wai-nui	I	+	+	+	-
PLANTAGINACEAE (Plantain Family)						
Plantago lanceolata L.	narrow-leaved plantain	X	+	+	-	-

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
PLUMBAGINACEAE (Leadwort Family)						
Plumbago zeylanica L.	'ilie'e, hilie'e	I	+	+	+	-
PORTULACACEAE (Purslane Family)						
Portulaca oleracea L.	pigweed, portulaca	X	+	+	+	+
Portulaca pilosa L.	'ihi	X	+	+	-	+
Talinum triangulare (Jacq.) Willd.	talinum	X	+	+	+	-
PROTEACEAE (Protea Family)						
Grevillea robusta A. Cunn. ex R. Br.	silk oak, 'oka kalika	X	+	+	-	-
ROSACEAE (Rose Family)						
Osteomeles anthyllidifolia (Sm.) Lindl.	'ulei	I	+	+	-	-
RUBIACEAE (Coffee Family)						
Canthium odoratum (G. Forster) Seem.	alahe'e, walahe'e	I	+	+	+	+
Morinda citrifolia L.	noni	P	+	+	+	+
SANTALACEAE (Sandalwood Family)						
Santalum paniculatum Hook. & Arnott	'iliahi	E	+	-	+	-
SAPINDACEAE (Soapberry Family)						
Dodonaea viscosa Jacq.	a'ali'i	I	+	+	+	+
SCROPHULARIACEAE (Figwort Family)						
Lophospermum erubescens D. Don	larger roving sailor, creeping gloxinia	X	+	-	-	-
SOLANACEAE (Nightshade Family)						
Lycopersicon esculentum Mill.	cherry tomato, ohi'a lomi	X	+	-	-	-
Lycopersicon pimpinellifolium (Jusl.) Mill.	currant tomato, wild tomato	X	+	-	-	+

Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
Solanum americanum Mill.	popolo	I?	+	-	-	-
Solanum aff. elaeagnifolium Cav.		X	+	-	-	-
STERCULIACEAE (Cacao Family)						
Waltheria indica L.	'uhaloa, hi'aloa	I?	+	+	+	+
TILIACEAE (Linden Family)						
Triumfetta rhomboidea Jacq.	bur bush	X	+	-	-	-
VERBENACEAE (Verbena Family)						
Lantana camara L.	lantana, lakana	X	+	+	+	+
Stachytarpheta dichotoma (Ruiz & Pav.) Vahl	vervain	X	+	+	-	-
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain, oi, owi	X	-	+	-	-
Stachytarpheta urticifolia (Salisb.) Sims	nettle-leaved vervain	X	+	+	+	-
Verbena litoralis Kunth	verbena, oi, owi	X	+	-	-	-

APPENDIX C

Survey of the Avifauna and Feral Mammals at Kealakehe Property

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

Prepared for

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7 August 1989

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

INTRODUCTION

The purpose of this report is to summarize the findings of a four day (1-4 August 1989) bird and mammal field survey of Kealakehe Property, North Kona, Hawaii (see Fig.1). Also included are references to pertinent literature as well as unpublished reports.

The objectives of the field survey were to:

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

2- Provide some baseline data on the relative abundance of each species as well as general habitat preferences.

3- Determine the presence or likely occurrence of any native fauna particularly any that are considered "Endangered" or "Threatened". If such occur or may likely be found on the property identify what features of the habitat may be essential for these species and suggest how those resources may best be protected.

4- Determine if the property contains any special habitats that if lost or altered by development might result in a significant impact on the fauna in this region of the island.

GENERAL SITE DESCRIPTION

The project site is located on approximately 840 acres at Kealakehe, North Kona, Hawaii (see Fig.1). The makai section is parkland habitat with scattered low trees, Kiawe (Prosopis pallida) Koa Haoli (Leucaena latisiliqua) and Fountain Grass (Pennisetum setaceum) are the common plants in this area. The mauka portions of the property are covered by a dense second growth forest of Christmas Berry (Schinus terebinthifolius) Kukui (Aleurites moluccana) and a host of other exotic trees. Some native trees are also scattered throughout the area.

Weather during the field survey was variable with clear mornings and cloudy afternoons. All days of the survey had light easterly winds.

STUDY METHODS

Field observations were made with the aid of binoculars and by listening for vocalizations. These observations were concentrated during the peak bird activity periods of early morning and late afternoon. Attention was also paid to the presence of tracks and

scats as indicators of bird and mammal activity.

A trail was cut and marked in the dense upper section of the property. At various locations along this trail as well as in all types of habitat elsewhere on the property (see Fig. 1) eight minute counts were made of all birds seen or heard. Between these count stations observations of birds seen or heard were also noted. These data provide the basis for the relative abundance estimates given in this report. Published and unpublished reports of birds known from similar habitat on lands adjacent to this site and elsewhere in West Hawaii were also consulted in order to acquire a more complete picture of the possible species that might occur in the area (Bruner 1979, 1980, 1984a, 1984b, 1984c, 1985a, 1985b, 1985c, 1988a, 1988b, 1989a, 1989b; Pratt et al. 1987).

Observations of feral mammals were limited to visual sightings and evidence in the form of skeletal remains, scats and tracks. No attempts were made to trap mammals in order to obtain data on their relative abundance and distribution. Three evenings were devoted to searching for the presence of owls and the Hawaiian Hoary Bat (Lasiurus cinerus semotus).

Scientific names used herein follow those given in the most recent American Ornithologist's Union Checklist (A.O.U. 1983), Hawaii's Birds (Hawaii Audubon Society 1984), A Field Guide to the Birds of Hawaii and the Tropical Pacific (Pratt et al. 1987), Mammal Species of the World (Honacki et al. 1982), Hawaiian Coastal Plants and Hawaiian Forest Plants (Merlin 1977a, 1977b).

RESULTS AND DISCUSSION

Resident Endemic (Native) Land and Water Birds:

No endemic species were recorded during the course of the field survey. The Short-eared Owl or Pueo (Asio flammeus sandwichensis) is the only species which might occur at this site. This species is relatively common on Hawaii particularly at higher elevations (Berger 1972, Hawaii Audubon Society 1984, Pratt et al. 1987). No other endemic birds would be expected at this site given the elevation and location of the site and the nature of the habitats available to the birds.

Migratory Indigenous (Native) Birds:

Migratory shorebirds winter in Hawaii between the months of August through May. Some juveniles will stay through the summer months as well (Johnson and Johnson 1983). Of all the shorebirds species which winter in Hawaii the Pacific Golden Plover (Pluvialis fulva) is the most abundant. Plover prefer open areas such as mud flats, lawns, pastures and plowed fields. They arrive in Hawaii in early August and depart to their arctic breeding grounds during the last week of April (Johnson et al. 1981). Bruner (1983) and Johnson et al. (1989) have also shown plover are extremely site-faithful on their wintering grounds and many establish foraging territories which they defend vigorously. Such behavior makes it possible to acquire a fairly good estimate of the abundance of plover in any one area. These populations likewise remain relatively stable over many years (Johnson et al. 1989). No plover were recorded during this field survey. This result was

not unexpected due to the time of year of the survey and the type of habitats present on the site. It is likely that during the time of year when plover are in Hawaii that very few if any actually utilize this property. In its present state this property is unsuitable for migrating shorebirds.

Resident Indigenous (Native) Birds:

No indigenous species were recorded nor would any be expected at this site.

Resident Indigenous (Native) Seabirds:

No seabirds were observed on the property. Some seabirds nest and roost on barren lava flows in Hawaii but at much higher elevation (Pratt et al. 1987).

Exotic (Introduced) Birds:

A total of 18 species of exotic birds were recorded during the field survey. Table One shows the relative abundance of each species as well as general habitat preferences. The list of exotic species found on the adjacent Queen Liliuokalani property was similar. The most abundant species at Kealakehe were Japanese White-eye (Zosterops japonicus), Common Myna (Acridotheres tristis), House Finch (Carpodacus mexicanus) and Zebra Dove (Geopelia striata). Given the range of habitats found on the property as well as data from surveys elsewhere in West Hawaii (Bruner 1979, 1980, 1984a, 1984b, 1984c, 1985a, 1985b, 1985, 1988a, 1988b, 1989a, 1989b) and information provided in Berger (1972),

Hawaii Audubon Society (1984) and Pratt et al. (1987) the following exotic bird species might also be expected to occur on or near the property: Erckel's Francolin (Francolinus erkelii), California Quail (Callipepla californica), and Japanese Quail (Coturnix japonica). The most unexpected sightings were: Lavender Waxbill (Estrilda caerulescens), Yellow-fronted Canary (Serinus mozambicus), and Saffron Finch (Sicalis flaveola). These popular cage birds have become increasingly more common in this region over the past few years. The Yellow-billed Cardinal (Paroaria capitata) has likewise expanded its range along the Kona Coast. This species does not at present occur elsewhere in the State. A close relative the Red-crested Cardinal (Paroaria coronata) is common on Oahu. Like its relative the Yellow-billed Cardinal prefers coastal habitat and does not range into dense middle or upper elevation forests.

Feral Mammals:

A total of 7 Small Indian Mongoose (Herpestes auropunctatus) were seen or heard during the survey. Three feral cats were observed as well as the skeletal remains of pigs and cows. Cattle were also heard along the north boundary of the property. Evidence of rats and mice were also found in the area of the sanitary landfill (County of Hawaii Kealakehe Rubbish Dump). No trapping was done in order to assess the relative abundance of mammals on this property. The presence of the sanitary

landfill provides a concentrated food resource for birds as well as rats, mice, mongooses and cats.

Records of the endemic and endangered Hawaiian Hoary Bat (Lasiurus cinerus semotus) are sketchy but the species has been reported from Hawaii (Tomich 1986). None were observed on this field survey despite three nights of observations. This species roosts solitarily in trees. Much remains to be known about the natural history of this bat and its ecological requirements here in Hawaii. Bruner (1984d) found bats on the Sheraton Waikoloa Beach Resort property located to the NW of this site.

CONCLUSION

A brief field survey can at best provide only a limited perspective of the wildlife present in any given area. Not all species will necessarily be observed and information on their use of the site must be sketched together from brief observations and the available literature. The number of species and the relative abundance of each species may vary throughout the year due to available resources and reproductive success. Species which are migratory will quite obviously be a part of the faunal picture 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). Thus only long term studies can provide a comprehensive view of the

bird and mammal populations in a particular area. However, when brief field studies are coupled with data gathered from other similar habitats the value of the conclusions drawn are significantly increased.

The following are some general conclusions related to bird and mammal activity on the property.

1- The dense tangle of vegetation in the upper portions of the site make access on foot extremely difficult. A trail was cut through this area and thus provided a means of censusing the fauna. All representative types of habitat found on the property were censused. The dense forested mauka section contained many more species of birds than the open habitat located on the lower slope.

2- The present habitats provide a limited range of living spaces which are utilized by the typical array of exotic species of birds one would expect at this elevation and in this type of environment in Hawaii. However, some species typically found in this habitat were not recorded. This could have been due to the fact that the survey was too brief or that their numbers are so low that they went undetected or a combination of these and other factors. No endemic birds or seabirds were recorded nor would they be expected to occur on this property. The creation of open habitat, as a result of development, will increase the usuable space for birds like Pacific Golden Plover.

3- The proposed development will create an urban environment. Some species are presently concentrated around the sanitary landfill these include: Common Myna (Acridotheres tristis) and the ubiquitous House Sparrow (Passer domesticus). Census data taken on three separate occasions at the sanitary landfill site found approximately 1000 Common Myna as well as large numbers of House Sparrows ! These large concentrations are typical of urban birds where concentrated food resources are available. Following development these two species will likely be more widespread on the property. Other species such as Japanese White-eye (Zosterops japonicus), House Finch (Carpodacus mexicanus) and game birds like Black Francolin (Francolinus francolinus) will decline in abundance once the forested area is eliminated.

4- In order to obtain more definitive data on mammals, a trapping program would be required. No endangered species were observed. The sanitary landfill provides an unatural concentration of food resources for mammals as well as birds. Census data obtained by trapping would likely show a greater than normal numbers of rats, mice, mongooses and cats than would be expected without this resource.

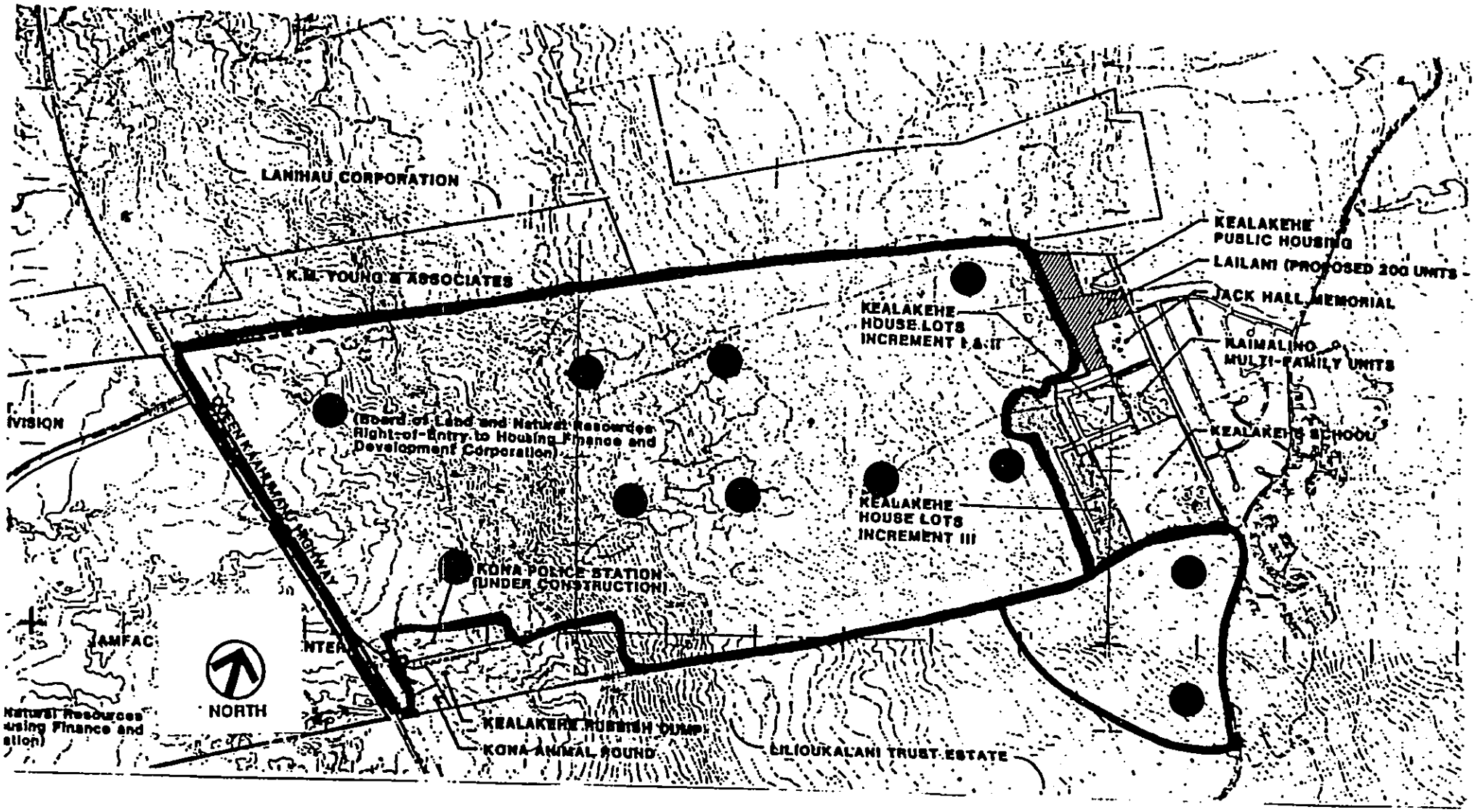

Fig. 1. Kealakehe property with eight minute count stations marked by a ●.

TABLE 1

Exotic species of birds recorded on Kealakehe Property, North Kona, Hawaii

COMMON NAME	SCIENTIFIC NAME	RELATIVE ABUNDANCE*	HABITAT PREFERENCES*
Ring-necked Pheasant	Phasianus colchicus	R = 1	G,E
Black Francolin	Francolinus francolinus	U = 2	G,E
Gray Francolin	Francolinus pondicerianus	R = 9	E,T
Spotted Dove	Streptopelia chinensis	U = 3	E
Zebra Dove	Geopelia striata	A = 16	E
Common Barn Owl	Tyto alba	R = 1	G,E
Northern Mockingbird	Mimus polyglottos	R = 3	E,U
Common Myna	Acridotheres tristis	A = 12	U,E
Yellow-billed Cardinal	Paroaria capitata	U = 3	T
Northern Cardinal	Cardinalis cardinalis	C = 6	T
Japanese White-eye	Zosterops japonicus	A = 21	T,E
Nutmeg Mannikin	Lonchura punctulata	U = 9	G,E
Warbling Silverbill	Lonchura malabarica	U = 5	E,G
Lavender Waxbill	Estrilda caerulescens	R = 10	E,G
House Finch	Carpodacus mexicanus	A = 13	T,E
House Sparrow	Passer domesticus	C = 10	U
Saffron Finch	Sicalis flaveola	R = 4	G,E
Yellow-fronted Canary	Serinus mozambicus	C = 6	E

* (see page 12 fro 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+) Number which follows is average of data from all survey days

C = common (ave. 5-10) Number which follows is average of data from all survey days

U = uncommon (ave. less than 5) Number which follows is average of data from all survey days

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

HABITAT PREFENCE = habitat type most frequently recorded in during survey. If more than one then listed in descending order of usage.

G = grassland, open lava and scattered vegetation

T = thickets of brush and trees

E = edge habitat: roadsides, forest edge

U = urban: houses, rubbish dumps, livestock pens

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APPENDIX D

Organizations and Persons Consulted

APPENDIX D
ORGANIZATIONS AND PERSONS CONSULTED

A. FEDERAL GOVERNMENT

Chief Fish & Wildlife Service U. S. Department of the Interior 300 Ala Moana Blvd. Room 5302 PJKK Federal Building Honolulu, Hawaii 96813	Mr. Kisuk Cheung, Chief Engineering Divison U.S. Army Enineer District Honolulu Building 230 Fort Shafter, Hawaii 96858
Chief National Park Service U. S. Department of the Interior 300 Ala Moana Blvd. Room 6305 PJKK Federal Building Honolulu, Hawaii 96813	Mr. Alvin K. H. Pang, Director Honolulu Insuring Office Federal Housing Administration Department of Housing and Urban Development P. O. Box 3377 Honolulu, Hawaii 96801
Chief *Geological Survey* U. S. Department of the Interior 300 Ala Moana Blvd. Room 6110 PJKK Federal Building Honolulu, Hawaii 96813	Mr. Jack P. Kanalz State Conservationist USDA, Soil Conservation Service P. O. Box 50004 Honolulu, Hawaii 96850

B. STATE OF HAWAII

Mr. Yukio Kitagawa Chairman, Board of Agriculture Department of Agriculture State of Hawaii Honolulu, Hawaii 96814	Mr. Mitsuo Shito Executive Director Hawaiian Housing Authority P. O. Box 3046 Honolulu, Hawaii 96802
Mr. Roger A. Ulveling Department of Business and Economic Development State of Hawaii P. O. Box 2359 Honolulu, Hawaii 96804	Director Office of Environmental Quality Control State of Hawaii 550 Halekauwila Street Room 301 Honolulu, Hawaii 96813
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Dr. Stephen Lau, Director Water Resources Research Center University of Hawaii at Manoa Honolulu, Hawaii 96822	Mr. William Paty, Chairman Department of Land and Natural Resources State of Hawaii P. O. Box 621 Honolulu, Hawaii 96809
Mrs. Hoaliku Drake Planning Director Department of Hawaiian Home Lands 335 Merchant Street 3rd Floor Honolulu, Hawaii 96813	Dr. Edward J. Kormondy Office of the Chancellor University of Hawaii at Hilo Hilo, Hawaii 96720

C. COUNTY OF HAWAII

Mr. George Yoshida, Director Department of Parks and Recreation County of Hawaii 25 aupuni Street Hilo, Hawaii 96720	Mr. William H. Sewaki, Manager Department of Water Supply County of Hawaii 25 Aupuni Street Hilo, Hawaii 96720
Mr. Duane Kanuha, Director Planning Department County of Hawaii 25 Aupuni Street Hilo, Hawaii 96720	Mrs. Lynn Maunakea, Director Department of Research and Development County of Hawaii 25 Aupuni Street Hilo, Hawaii 96720

D. OTHERS

Manager Engineering Department Hawaii Electric Light Co., Inc. P. O. Box 1027 Hilo, Hawaii 96720	President Kona Jaycees c/o Kona Credit Union Kailua-Kona, Hawaii 96740
Supervising Engineer Hawaiian Telephone Company P. O. Box 425 Hilo, Hawaii 96720	Chairman West Hawaii Committee P. O. Box 1761 Kailua-Kona, Hawaii 96740
Trustees Pernice Pauahi Bishop Estate P. O. Box 3466 Honolulu, Hawaii 96801	Chairman Kona Soil and Water Conservation District RR #1, Box 519 Captain Cook, Hawaii 96704

President Kona Outdoor Circle c/o Ron Burla & Associates P. O. Box 1148 Kailua-Kona, Hawaii 96740	Chairman Kona Citizens Planning Council P. O. Box 926 Kealakekua, Hawaii 96750
Manager GASCO, Inc. Hawaii Division P. O. Box 1397 Hilo, Hawaii 96720	Director Life of the Land General Delivery Pahoa, Hawaii 96778
Secretary Shoreline Protection Alliance P. O. Box 4247 Honolulu, Hawaii 96813	President Kona Conservation Group RR #1, Box 125 Captain Cook, Hawaii 96704
President Kona Civic Club Kailua-Kona, Hawaii 96740	Chairman Hawaii Leeward Planning Conference P. O. Box 635 Kailua-Kona, Hawaii 96740
President Hawaiian Civic Club Kailua-Kona, Hawaii 96740	Kobayashi Development & Construction, Inc. 1150 South King Street Suite 901 Honolulu, Hawaii 96814
Mr. Joe Tassil Organizations Kona RR #1, Box 249-B Holualoa, Hawaii 96725	Kona Coast Company c/o Huehue Ranch Kailua-Kona, Hawaii 96740
Director Kona Board of Realtors c/o McCormack Realty P. O. Box 1360 Kailua-Kona, Hawaii 96740	President Lanihau Corporation 3210 East Kopaka Street Honolulu, Hawaii 96801
President Kona Hotel Manager Association Keauhou Beach Hotel Keauhou, Kona, Hawaii 96740	Lilioukalani Trust First Hawaiian Bank Trust Division P. O. Box 3200 Honolulu, Hawaii 96801
President Kona Chamber of Commerce P. O. Box 635 Kailua-Kona, Hawaii 96740	Union Investments, Inc. 460 Ena Road, Room 408 Honolulu, Hawaii 96815

Revised
ENVIRONMENTAL IMPACT STATEMENT for

KAILUA-KONA SEWERAGE SYSTEM, PHASE IV (NORTHERN ZONE)

Kailua-Kona, Hawaii

JULY 1981

PREPARED FOR:

Department of Public Works
County of Hawaii

RMTC

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DEPARTMENT OF PUBLIC WORKS
COUNTY OF HAWAII

REVISED

ENVIRONMENTAL IMPACT STATEMENT

FOR THE

KAILUA-KONA SEWERAGE SYSTEM
PHASE IV (NORTHERN ZONE)

This Environmental Document is Submitted
Pursuant to Chapter 343, HRS

PROPOSING AGENCY:

Department of Public Works
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

ACCEPTING AUTHORITY:

Governor, State of Hawaii

EDWARD HARADA
Chief Engineer

July 20, 1981
Date

PREPARED BY:

R. M. Towill Corporation
677 Ala Moana Blvd., Suite 1016
Honolulu, Hawaii 96813

JULY 1981

CORRECTION

THE PRECEDING DOCUMENT(S) HAS
BEEN REPHOTOGRAPHED TO ASSURE
LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING