APPENDIX

KEALAKEHE PLANNED COMMUNITY

Kealakehe, North Kona, Hawaii

FINAL
ENVIRONMENTAL IMPACT STATEMENT

PROPOSING AGENCY:
STATE OF HAWAII
HOUSING FINANCE AND DEVELOPMENT CORPORATION

PREPARED BY:
BELT COLLINS AND ASSOCIATES
SEPTEMBER 1990

CHAPTER XIII
APPENDIX

The following reports are included in this Appendix to the Environmental Impact Statement for the Kealakehe Planned Community.

Archaeology	-	Paul H. Rosendahl, Ph.D. Inc.
Botanical Survey	-	Char & Associates
Fauna Survey	-	Phillip L. Bruner
Noise Impacts	-	Y. Ebisu & Associates
Social Impacts	-	Community Resources, Inc.
Traffic Impacts	-	Pacific Planning & Engineering, Inc.
Air Quality Impacts	-	Barry Neal
Market Analysis	-	KPMG Peat Marwick
Public Revenues/Costs	-	Ernst & Young

ARCHAEOLOGY REPORT

Report 652-010890

Archaeological Inventory Survey Kealakehe Planned Community Project Area

Lands of Kealakehe and Keahuolu North Kona District Island of Hawaii

PHRI

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Report 652-010890

Archaeological Inventory Survey Kealakehe Planned Community Project Area

Lands of Kealakehe and Keahuolu North Kona District Island of Hawaii

by

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SUMMARY

At the request of Mr. Lee Sichter of Belt, Collins and Associates, on behalf of their client, the State of Hawaii, 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 survey field work was conducted September 5-October 13, 1989 and consisted of a 100%-coverage pedestrian survey, augmented with an aerial reconnaissance survey. During the survey, 78 sites were newly identified and four previously identified sites were relocated. Two of the previously identified sites had already been assigned State Inventory of Historic Places (SIHP) site numbers (Site 00002* [Mamalahoa Trail] and Site 05011 [ahupua'a boundary wall]).

The predominant feature types present in the project area are rock mounds and pahoehoe excavations, which together comprise 72.3% of the 840 identified features. The predominance of these and other features such as modified outcrops, terraces, small enclosures and low mounded walls indicates relatively intensive use of the area for agricultural purposes.

Among the 82 sites identified within the project area, 21 are assessed as having information value that has been mitigated during this survey, and no further work is determined necessary for these 21 sites. Further data collection only is recommended for 42 sites, which appear to have value only for information content. Ten sites are recommended for interpretive development, following further data collection, and five are recommended for provisional interpretive development, pending results of further data collection. Four features at four sites are recommended for provisional preservation "as is," pending the identification of human skeletal remains in or under these features.

In addition to the above recommendations, it is recommended that a systematic sampling program be designed and implemented during the data collection phase. Such a program should provide a more workable and accurate means of documenting the project area's numerous features.

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*State Inventory of Historic Places (SIHP) site designation system: all five-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"]).

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INTRODUCTION

BACKGROUND

This report presents the results of an archaeological inventory survey conducted at the 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 survey was conducted by Paul H. Rosendahl, Ph.D., Inc. (PHRI) at the request of Mr. Lee Sichter of Belt, Collins & Associates, on behalf of their client, the State of Hawaii. The overall purpose 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. The field crew consisted of four to eight persons under the direction of Supervisory Archaeologist Theresa K. Donham, M.A., with field supervision by Supervisory Field Archaeologist Amy Dunn and Field Archaeologist Keala Kauhi. Approximately 1,380 man-hours of labor were expended conducting the field work portion of the survey.

This report is the Final Report for the present project. Due to new information derived from data compilation and analysis, this report includes minor modifications to the findings and recommendations presented in the Interim Report on the project (Donham 1989).

SCOPE OF WORK

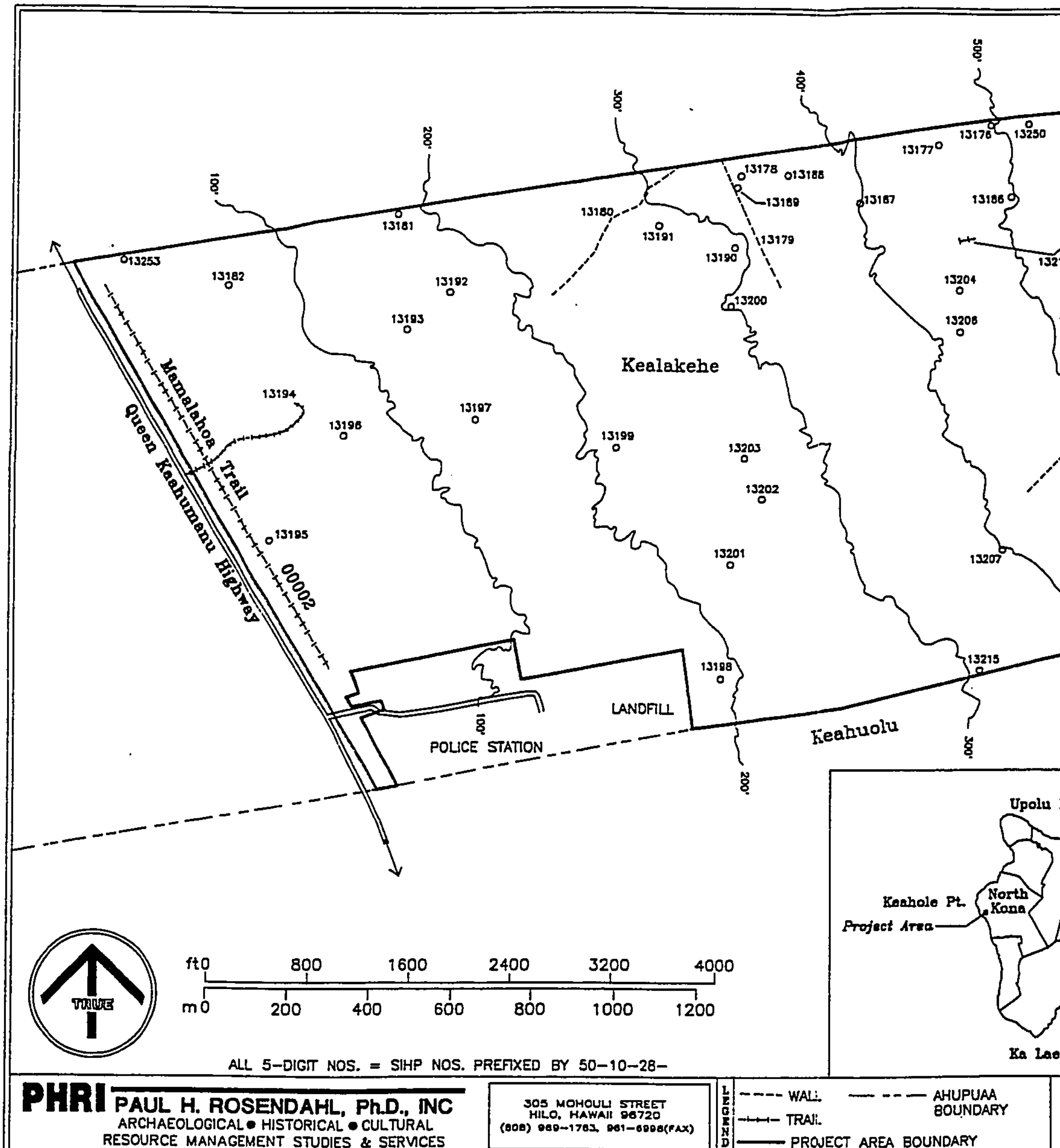
Prior to carrying out the field work, a general scope of work and specific field tasks were discussed with Dr. Ross H. Cordy, chief archaeologist in the Hawaii Department of Land and Natural Resources-Historic Sites Section/State Historic Preservation Office (DLNR-HSS/SHPO). Based on a preliminary review of available background literature and records, and based 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 current project:

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 significance of all archaeological remains identified within the project area was to be assessed in terms of the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60) and the criteria for evaluation of traditional cultural values prepared by the national Advisory Council on Historic Preservation (ACHP). These criteria are currently used by the DLNR-HHS/SHPO for the evaluation of cultural resources.

PROJECT AREA DESCRIPTION

The project area consists of two adjacent parcels which together comprise approximately 950 acres (Figure 1). The larger of the two parcels (c. 800 acres) consists of all undeveloped land in Kealakehe ahupua'a between Queen Kaahumanu Highway and Kealakaha Road. The smaller parcel (c. 150 acres) is located in Keahuolu ahupua'a, and is bounded on the south and east sides by Palani Road. The west side of the parcel is contiguous with the eastern boundary of a previously established survey area for a proposed Queen Liliuokalani Trust Estate development (PHRI Project 89-596). According to the property developers, the boundary of the Keahuolu parcel may be modified


Kealakehe
Keahuolu
Mamalahoa Trail
Queen Kaahumanu Highway
00002
LANDFILL
POLICE STATION
Upolu
Keahole Pt.
North Kona
Project Area
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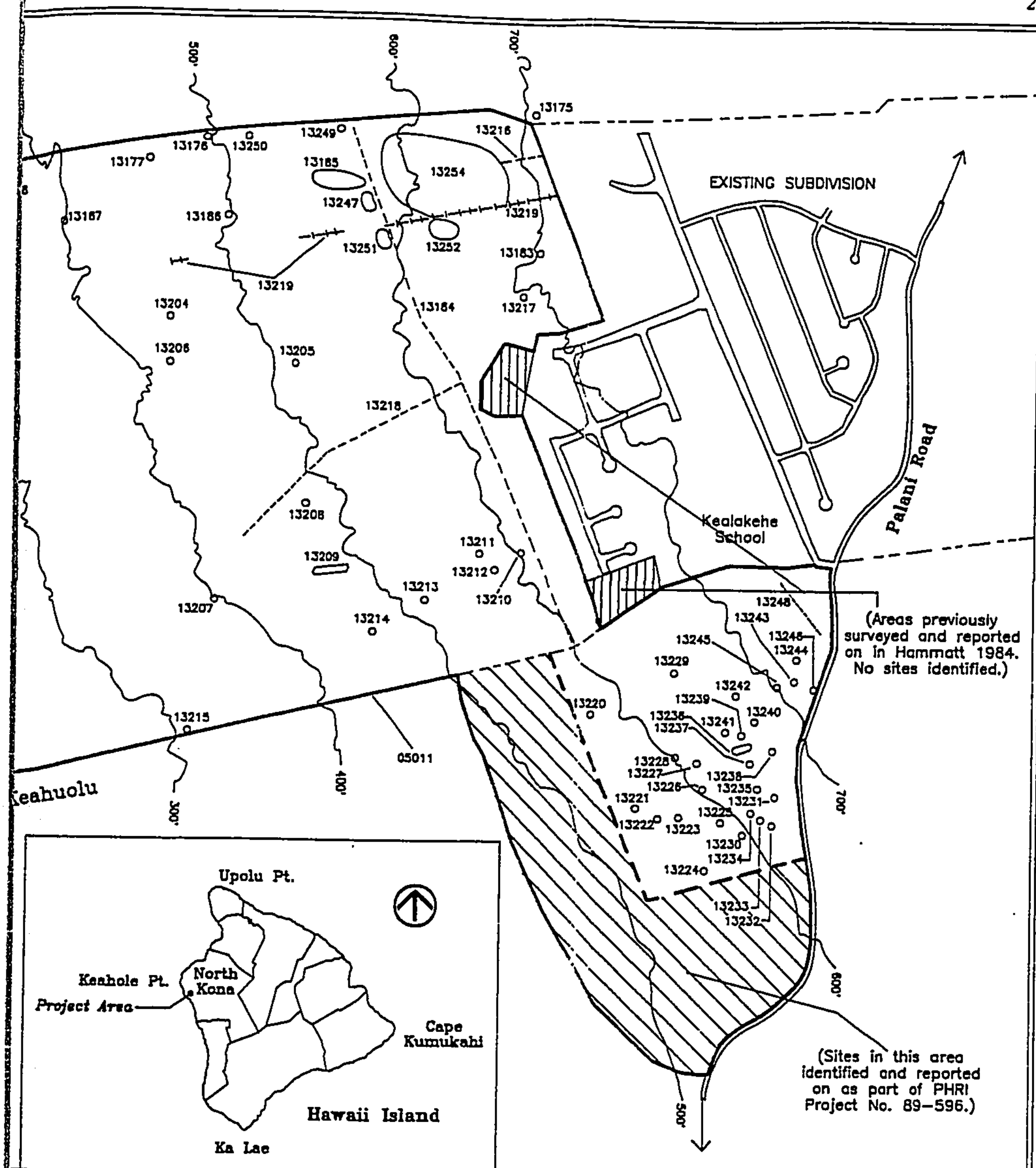
LEGEND
WALL
TRAIL
PROJECT AREA BOUNDARY
AHUPUAA BOUNDARY



AHUPUAA BOUNDARY
JECT AREA BOUNDARY

Kealakehe Planned Community
Inventory Survey
PHRI Project No. 89-652

FIGURE 1.
Project Area and
Site Location Map

during the course of development planning. If this happens, the findings and recommendations for the parcel will be modified to reflect the changes. For example, if recent suggested modifications in the western boundary of the Keahuolu parcel were to be effected, at least 34 additional archaeological sites would be added to the present project area site count.

Kealakehe and Keahuolu ahupua'a are situated along the western slope of Hualalai volcano, where Pleistocene to recent Hualalai Series flows form the surface mantle. These flows are comprised primarily of alkalic olivine basalt, and are both aa and pahoehoe types (Macdonald, Abbott, and Peterson 1983:366). The topography in the ahupua'a consists of pahoehoe flats, fissures, upthrusts, collapsed blisters and tubes, interspersed variously with fingers of aa that are generally oriented east-west. Although the topography is somewhat rough in places, its overall aspect is a gradual slope (drop of approximately 0.06 m per linear meter) from east to west. Elevation in the project area ranges from 90-750 ft AMSL. The lower portion of the project area, along Queen Kaahumanu Highway, is 2.3 km inland of the coast. The upper portion of the project area is approximately 5.7 km from the coast.

Annual median rainfall within the project area ranges from approximately 750 mm (30 inches) in the lower elevations to 1,000 mm (40 inches) in the upper elevations. In general, vegetation in the project area increases in density with increasing elevation and rainfall. Vegetation is extremely dense above 500 ft AMSL (above mean sea level); there is little to no surface visibility in much of this area, particularly in the Keahuolu portion.

Predominant tree species within the project area are kiawe (*Prosopis pallida* [Humb. and Bonp. ex Willd.] HBK), koa-haole (*Leucaena leucocephala* [Lam.] de Wit), alahe'e (*Canthium odoratum* [Frost.] Seem.), and Christmas-berry (*Schinus terebinthifolius* Raddi.). Understory plants consist predominantly of lantana (*Lantana camara* L.), klu (*Acasia farnesiana* [L.] Willd.), 'ilima (*Sida fallax* Walp.), fountain grass (*Pennisetum setaceum* [Forsk.] Chiov.), California grass, (*Brachiaria mutica* [Forsk.] Stapf, Jamaica vervain (*Stachytarpheta jamaicensis* [L.] Vahl), and air plant (*Bryophyllum pinnatum* [Lam.] Kurz).

In addition to the common plants listed above, several species are represented by scattered individuals or small clusters. These include kukui (*Aleurites moluccana* L. Willd.), ti (*Cordyline terminalis* L. Kunth), guava (*Psidium guajava* L.), mango (*Mangifera indica* L.), day flower or Wandering Jew (*Commelina diffusa* Burm. f.), sisal (*Agave sisalina* [Engelm.] Perrine), and uhiuhi (*Mezoneuron kauaiense* [Mann] Hbd.).

A major section of the project area is currently used for cattle grazing. This area is located between the north and south Kealakehe ahupua'a boundaries at c. 200-600 ft AMSL. The eastern, mauka (inland) boundary of the grazing land is the Site 13184 wall. It is likely that the grazing land has been used for cattle and other livestock for about 100 years (see Historical Background section). In addition to having been affected by livestock, the land evidences bulldozer grubbing and vegetation clearing, the latter perhaps by way of chain dragging. Surface feature disturbance and destruction was observed throughout this area, and it is expected that a considerable portion of the original archaeological remains in the area has been obliterated.

Bulldozer grubbing has also occurred in the upper and lower portions of the project area, particularly along the boundaries of existing subdivisions (upper area) and industrial developments (lower area).

Isolated instances of current plant cultivation (mango trees and herbaceous plants) were observed in the upper portion of the project area, in both Kealakehe and Keahuolu. Surface features in current use for cultivation include enclosures, modified outcrops, pahoehoe excavations, low curvilinear walls, and cleared areas with associated rock mounds. These features were recorded as recent. It should be noted that some of the agricultural features currently used are indistinguishable from the numerous ones assumed to be pre-contact or early historic—it is possible the ones used are earlier features which have been minimally modified. Likewise, it is also likely that some abandoned features of modern construction were not identified as such, due to construction form and lack of diagnostic artifacts.

HISTORIC BACKGROUND AND SUMMARY OF HISTORICAL DOCUMENTARY RESEARCH

The area of North Kona between Kailua Bay and Keauhou Bay to the south is generally recognized as the population core and fertile agricultural district of North Kona (Kirch 1985:166, Kelly 1983). To the north of Kailua Bay, beginning at Honokohau, is the relatively dry Kekaha District of North Kona, with its barren lava inlands and coastal fishponds (Springer 1986:121). Kealakehe is situated in the transition zone between these two constrasting environmental districts. This land might therefore possess a unique history of adaptation and use not readily characterized by the general patterns of either Kailua or Kekaha.

There is little historic information concerning traditional Hawaiian land use for the inland area of Kealakehe. Historical documentary research by Silva (1987) and more recently by Wong (Appendix B) failed to locate observer references to subsistence or settlement specific to the project area. Ellis, during his 1822 tour of Hawaii Island, described an area he referred to as the "suburbs of Kailua," which may have included lower Keahuolu and possibly lower Kealakehe. According to Ellis:

> The environs were cultivated to a considerable extent; small gardens were seen among the barren rocks on which the houses are built, wherever soil could be found sufficient to nourish the sweet potatoe [sic], the watermelon, or even a few plants of tobacco, and in many places these seemed to be growing literally in the fragments of lava, collected in small heaps around their roots (Ellis 1963:31).

Nineteenth century descriptions of inland Kealakehe and Keahuolu by government surveyors tend to reflect land assessment values that were not necessarily reflective of traditional Hawaiian land values. Their descriptions of Kealakehe present an environment more like Kekaha than the Kona agricultural lands. In Hammatt et al. (1987) there is a summary of three of these descriptions:

> It is worth noting that historical descriptions of the land makai [seaward] of the "government road" (Mamalahoa Highway), in the vicinity of the present project area (immediately east of this project area), tend to discount its productivity. The 1865 roster of government lands describes this area as including some land "which will do for goat pasture, balance nothing but rocks." Emerson in 1882, discounted the entire ahupua'a of Kealakehe as "of comparatively small value." McDougall in 1893 describes the land as "worthless" or at best as "of very little value". In that same year the Government Surveyor recommended that the land not be sold for less than about 33 cents an acre, a low price even for the time (Hammatt et al. 1987:67-68).

As indicated by Hammatt et al., the archaeological record of their study area in Kealakehe (immediately east of this project area) reflects that "in fact this land was utilized far more than historical records suggest" (1987:68).

During Emerson's 1880 Government Survey of North Kona, he identified the lower (makai [seaward]) edge of a forest zone, which he described as "lava covered with scattering forest and dense masses of ki root" (Kelly 1983:58). The land below this forest edge was described as "rocks covered with long grass" (Kelly 1983:58). According to Kelly's estimations, the forest edge occurred at an average elevation of 550 to 650 ft around Kailua and to the south (1983:58). However, it appears that the forest edge was somewhere between 750 and 800 ft elevation in Kealakehe (see reproduction of Emerson's map in Kelly 1983:59). This approximation places the nineteenth century forest edge very close to the eastern boundary of the project area. According to Emerson's documentation of nineteenth century vegetation, the project area would be within the kula zone.

At the time of the Mahele, Kealakehe was designated Government Land, and Keahuolu was granted to Ane Keohokalole (see Appendix B for background information on Keohokalole). Eleven kuleana land grants, which together constitute 45.46 acres, were registered for Kealakehe. The average award was 4.1 acres (See Appendix B). This average for Kealakehe is considerably greater than the average size of kuleana awards in the Kona agricultural district, which Kelly estimates to be around 2.3 acres (Kelly 1983:68). The average size of kuleana land claims, however, was 7.51 acres (Kelly 1983:68). Thus, it appears that residents in Kealakehe were awarded a closer approximation to their actual land claims than residents in other North Kona ahupua'a to the south.

All recorded kuleana LCA awards in Kealakehe are located to the east of the project area, between 1,000 and 1,500 ft AMSL (See Emerson survey map reproduced in Silva 1987). The patterning of kuleana awards in Kealakehe (within the forested zone as defined by Emerson) is very similar to the overall pattern of kuleana awards for the North Kona agricultural district. As noted by Kelly:

> Although there is ample evidence in the registered claims and other documents—as well as in the remnants of agricultural activity found on the ground—that Hawaiian farmers were cultivating kula lands in the 1840s, no kuleana gardens were awarded in that zone. The kula was given by the Board of Commissioners to the konohiki, the owner of the ahupuaa...The kula became the land in which the konohiki could graze their cattle and horses. This left the common farmer without access to grazing areas for their animals, or to garden lands that they had cultivated in the kula zone (Kelly 1983:67).

It was shortly after the systematic delineation of kula lands as grazing land that Kuakini Wall was constructed. This wall extends from Kahaluu Bay to the southern portion of Keahuolu, at an average distance of 1.6 km from the coastline. At the northern end in Keahuolu, the wall is at an elevation of 220 ft; further to the south, it is at an average elevation of 160 ft. The purpose of the wall was to keep the kula livestock contained and out of the coastal settlements. Kuakini Wall does not cross Kealakehe, and it is likely that the grazing zone here extended makai at least as far as Mamalahoa Trail, which is 2.3 km from the coastline at Honokohau.

According to an 1893 testimonial from McDougall, there appears to have been no major pasture demarcations in Kealakehe between the homesteads (c. 800 ft elevation) and the seashore (see Appendix B). McDougall offered $300 for c. 1,600 acres of Kealakehe land, which was valuable to him because he owned land on both sides, noting "..it would take more than all it is worth to fence it in" (Interior Dept. 3/9/1893).

Between 1895 and 1915, at least twenty homestead grants were awarded in Kealakehe. These grants were all located in the same general zone as the kuleana, at an elevation of between 800 and 1,500 ft. According to a partial listing of homestead grants in Silva (1987), awarded parcels averaged 20.7 acres. The homestead area was bounded on the east by the upper Government Road (Mamalahoa Highway) and on the west by a surveyed line, which is shown on the 1924 USGS Topographic map, between 750 and 800 ft elevation. This line appears to have been very close to the existing Kealakehe Road alignment, and correlates with the location of Emerson's forest edge boundary.

Historical evidence indicates that there would have been few to no residencies within the kula zone of Kealakehe during the nineteenth century, and that the zone was mostly given over to ranching. A possible exception to this pattern is indicated, but not yet documented, by historic records. Sometime during the late 1890s, a sisal mill was established in Keahuolu along the old Palani Road corridor. The location of this mill is shown on the 1924 USGS topographic map, and its location has been tentatively identified in the field (within the PHRI 89-596 project area). In conjunction with the mill was a 500-acre tract of sisal cultivation, referred to as the McWayne sisal tract (Kelly 1983:89). The location of the tract is yet to be determined; however, if it extended into Kealakehe, this industrial endeavor would have certainly left some type of agricultural surface features. There are scattered clumps of sisal within the project area, and a very concentrated growth in Keahuolu, near the hypothesized mill location. The mill ceased operations sometime before 1920, when the demand for sisal hemp by sailing vessels diminished.

As indicated above, a major portion of the project area (between 200 and 600 ft AMSL) appears to have been used for cattle grazing for about a century. The upper boundary of the grazing lands is about 0.6 km west of and 200 ft below the homestead/kuleana area boundary. Nearly all of the land between these two historic use area boundaries has been grubbed or recently developed for housing. A parcel at the northeastern corner of the project area (approximately 600 m N-S by 400 m E-W) remains undeveloped. On the basis of feature preservation in this area, it does not appear to have been intensively used for grazing land. It does appear to have been intensively used for agriculture, and may well have been in such use during the nineteenth and early twentieth century.

PREVIOUS ARCHAEOLOGICAL WORK

Coastal Areas

The earliest archaeological field investigations in Kealakehe and Keahuolu focused on the major sites located along the coastline. In his study of Hawaiian heiau, Stokes (1919) described three coastal heiau sites in Keahuolu (Halepau, Kawaluna, and Palihiolo). Halepua was reported as a small fishing heiau, whereas Kawaluna and Palihiolo were described by informants as former sites of human sacrifice. Stokes' narrative description of Palihiolo Heiau is given in Appendix B.

In 1930, Reinecke located 13 sites in Keahuolu (Sites 12-24) and 12 sites in Kealakehe (Sites 24-35) during a reconnaissance survey of coastal North Kona (Reinecke 1930:5-10). These sites consisted of platforms and house yards and were generally residential in nature. Two heiau were identified in Kealakehe, Hale o Lono (Site 33), and an unidentified heiau (Site 35).

Several of Reinecke's sites were relocated and were assigned B.P. Bishop Museum site numbers by Emory and Soehren in 1961, during their reconnaissance survey of coastal Koloko, Honokohau, and Kealakehe (Emory and Soehren 1971). During this study, which preceded development of Honokohau Harbor, 27 sites were identified in Kealakehe. These included ten house sites, ten burial sites, three enclosures, two heiau (Makaopio, Reinecke's Site 35, and Haleokane, Reinecke's Hale o Lono), and two indeterminate sites (Emory and Soehren 1971:3). Three of the Kealakehe sites, including the two heiau and a cluster of three house platforms, were recommended for preservation by Emory and Soehren. These sites are in the northern portion of Kealakehe, along the Alula Bay shoreline.

In the wake of development in and around the Honokohau Harbor area, excavation was conducted at three of the Kealakehe sites identified by Emory and Soehren (Ladd 1968, Sekido 1968). These included a house platform and burial site (Ladd 1968), and a habitation cave (Sekido 1968). Later expansion of the harbor area to the east prompted a 100-acre reconnaissance survey by Sinoto (1975a). During this survey three sites were relocated, and no further archaeological work was recommended for the area (Sinoto 1975a:3).

In 1980, Soehren examined a 40-acre parcel and an access road corridor in coastal Kealakehe, at the site of a proposed wastewater treatment plant (Soehren 1980). A single trail (SIHP Site 7704) was identified. According to Soehren, this trail connected Aimakapa Pond in Honokohau with a small settlement at Pawai Bay in northern Keahuolu (Soehren 1980).

The following year, Soehren surveyed a proposed pipeline corridor associated with the treatment plant. Three previously identified sites were relocated (SIHP Sites 1888-1890), and no further work was recommended (Soehren 1981).

Coastal reconnaissance in Keahuolu was conducted by Bevacqua in 1972. During this survey, nine sites were identified (Bevacqua 1972). Three years later, Sinoto surveyed a road corridor through coastal Keahuolu, during which seven sites were identified (Sinoto 1975b:1). All sites were described as being "small, semi-permanent or temporary structures associated with coastal, probably marine activities" (Sinoto 1975:3).

A series of reconnaissance survey reports were completed between 1973 and 1980 in conjunction with development of the old Kona Airport State Park along the shoreline in Keahuolu (Neighbor Island Consultants 1973, Fuke and Goldstein 1978, Estioko-Griffin and Lovelace 1980, and Neller 1980). Estioko-Griffin and Lovelace's survey relocated sites previously identified within the 89.7 acre parcel, and located additional sites, for a total of 35 sites. The majority of identified sites (28) were concentrated in an area just north of the old runway, along the shoreline at Pawai Bay. The most frequently identified site types included caves (11), petroglyphs (7), burials (5), and house sites (3) (Estioko-Griffin and Lovelace 1980:iii).

In 1978, Ching conducted a reconnaissance survey of all Keahuolu lands between the shoreline and Queen Kaahumanu Highway (987 acres). Ching's survey identified 59 sites with 140 component features, including the sites previously identified by Bevacqua and Sinoto. The most frequently occurring features were reported to be salt pans (29), cave shelters (25), pavings (21), and cairns (21) (Ching 1978:32).

A reconnaissance and testing survey was conducted in selected coastal Keahuolu parcels by Folk in 1980 (Folk 1980). Folk conducted a reconnaissance survey of a c. 20-acre proposed building site (current location of the Queen Liliuokalani Children's Education Center), wherein no sites were identified. He also conducted intensive-level mapping and recording of 21 sites in three kipuka, located near the shoreline, north of the old Kona Airport. Test excavations were also conducted in the center of the kipuka in order to determine if buried cultural deposits were present. During his study, Folk documented seven pavements, three caves, two platforms, four historic/recent campsites, a burial or shrine, a historic period animal enclosure, and three habitation areas (Folk 1980:21-22).

Inland Areas

Reports of archaeological work in inland portions of Kealakehe and Keahuolu generally post-date construction of Queen Kaahumanu Highway, c. 1974. Shortly after highway completion, Soehren conducted a reconnaissance survey of Honokohau II lands along the Honokohau/Kealakehe boundary. In his report, Soehren identified a trail (Site 1) that began at Aimakapa Pond and crossed into Kealakehe, where it terminated at "a series of burials at the base of the (aa) flow" (Soehren 1975:2). Soehren identified eight burials in Kealakehe on his project area map, but did not present descriptive information, as this site was outside of his project area. The features interpreted by Soehren as burials were relocated during this survey (SIHP Site 12975; 11 features identified). In addition to this site, Soehren located 12 burial sites, a house enclosure, two lava tubes and a C-shape within the 99.5 acre survey area (Soehren 1975:3-5).

In 1975, Sinoto conducted a reconnaissance survey of two proposed development parcels immediately east of Queen Kaahumanu Highway in Kealakehe (Sinoto 1977). Area A was located along the south boundary of Kealakehe, between the refuse disposal facility and Queen Kaahumanu Highway. Area B consisted of a parcel north of Area A; the parcel measured c. 275 m E-W by 400 m N-S and fronted the highway. Area B has not been developed to date; major portions of the area, however, have been grubbed and leveled. Undisturbed portions of Area B were reexamined during this survey. Sinoto located four sites, including the Kealakehe/Keahuolu Ahupua'a boundary wall in Area A (SIHP Site 5011), and three lava tube caves in Area B (Sites

5012-5014). Only one of these caves exhibited possible evidence of human occupation (5013). It could not be relocated during this survey and was apparently destroyed by bulldozing. The ahupua'a wall was relocated during this survey (SIHP Site 05011).

Sinoto examined a third small Kealakehe development parcel fronting Queen Kaahumanu Highway in 1983. This 6.9 acre area consisted of a narrow strip between the prior survey areas A and B. No sites were located in this area (Sinoto 1983:2).

In 1984, Hammatt conducted a reconnaissance survey of a 24-acre subdivision parcel located along the south boundary of Kealakehe, immediately west of Kealakehe School (Hammatt 1984). This parcel is located along the eastern boundary of the current survey area in Kealakehe, and the northern boundary of the Keahuolu portion of the current survey area. This area had apparently undergone prior land modification for cattle grazing, and by bulldozer grubbing. Hammatt located no sites in this area.

Three years later, Hammatt surveyed a 15-acre planned subdivision parcel along the northern boundary of Kealakehe, immediately east of the eastern boundary of the current survey area (Hammatt 1987). Eighteeen sites were located in this parcel, and further documentation and testing was recommended (Hammatt 1987:14).

Hammatt, Shideler, and Borthwick (Hammatt et al. 1987) returned to the 15-acre parcel in 1987 for intensive survey and testing. This study represents the first incidence of subsurface testing and intensive-level site recording in inland Kealakehe. During their study, Hammatt et al. produced scaled maps of all features within the project area and conducted excavations at 17 of 32 identified features. Twenty-five of the identified features were interpreted as agricultural; the remainder were interpreted as habitation features (Hammatt et al. 1987:65-69). Hammatt et al excavated eight of 11 faced mounds that had been determined to be possible burials; all of these tested features were redefined as clearing mounds, based on findings of test excavations (Hammatt et al. 1987:65).

In addition to 11 clearing mounds, Hammatt et al. identified agricultural features such as kuaiwi walls (4), enclosures (3), a modified outcrop, a terrace, a planting area, and a mound complex. The analysts note that "[w]hile this project area lies within the 'Kona Field System,' the modification of the land here bears little similarity to the original description of the system" (Hammatt et al. 1987:66).

Among the six habitation features tested by Hammatt et al., three (Sites 1, 14, and 14A) were interpreted as probable temporary "field hale" type features associated with agriculture in the area. Two features (Sites 9 and 11) were interpreted as work areas associated with Site 12, which was interpreted as a habitation site (Hammatt et al. 1987:69). Site 12 was actually located outside of the Hammatt et al. survey area, and was relocated during this survey (SIHP Site 13183). The site was remapped, but no further test excavations were conducted.

A single charcoal sample collected by Hammatt et al., from a hearth at Site 11, was assayed for radiometric age. A calendric range of AD 1645-1950 was determined for this sample (Hammatt et al. 1987:60). The date is interpreted as representing late pre-contact occupation of the area. According to Hammatt et al.:

> This age is consistent with other radiocarbon dates for later development of the Kona Field System and is appropriately late for an area which would have been of marginal productivity (Hammatt et al. 1987:60).

On the basis of their findings, Hammatt et al. concluded that "[t]he extensive agricultural utilization of the project area...suggests that this land was utilized far more than historical records suggest" (1987:68). According to their interpretation, the parcel studied lies within the traditional kula agricultural/vegetation zone. A second conclusion, based on their investigations, is that "...the project area was more closely integrated with upland settlements than with coastal residences" (Hammatt et al. 1987:70).

A second study conducted in 1987—a reconnaissance survey of a 28,800 sq ft proposed reservoir site in Kealakehe located 300 ft east of Palani Road—was conducted by PHRI (Walker and Haun 1987). A single complex with eight component features was identified within the survey area. Identified features included a wall network with associated linear wall sections, three terraces, two enclosures, a C-shape, and a rock mound (Walker and Haun 1987:5-6). The complex was interpreted as having agricultural features and possible animal pens in addition to habitation features. Additional data recovery was recommended (Walker and Haun 1987).

The same year, Bonk conducted a walk-through field inspection of undeveloped portions of Kealakehe between Kealakehe School and the shoreline (Bonk 1987). Bonk indicated that there were sites present in the upper portion of the area examined, and along the coast, where prior surveys had been conducted. He located only historic ranching features in the area between the coastal and upper elevation zones (Bonk 1987:11).

Reconnaissance surveys conducted in inland portions of Keahuolu include two studies conducted by PHRI between 1983 and the present. In 1983, Rosendahl surveyed three separate parcels—one consisting of 100 acres situated west of Queen Kaahumanu Highway, along the southern boundary of Keahuolu (Area 1), another consisting of 100 acres situated east of the highway and along the south side of Palani Road (Area 2), and another consisting of 12 acres situated along the southern edge of Keahuolu and the northern side of Palani Road (Area 3)(Rosendahl 1983). Rosendahl located five sites in Area 1, two large complexes and five additional sites in Area 2, and a large complex in Area 3. The Area 3 complex was interpreted as a probable continuation of the Area 2 complex. No SIHP numbers were assigned during this survey.

Rosendahl relocated two sites previously identified by Ching (1978) in Area 1, and identified the northern end and a possible east-west portion of Kuakini Wall (SIHP Site 7276), which crossed through survey Areas 2 and 3. Recommendations included intensive survey of all areas, preservation of Kuakini Wall, and preservation of portions of the Site E complex, identified as an extensive area (260 by 315 m) of numerous habitation and other features (Rosendahl 1983:13).

In 1989, PHRI conducted an inventory survey of undeveloped Keahuolu lands between the old Kona Airport and Palani Road, with the exception of the 150-acre parcel that was included in the current survey area. Analysis of survey findings is pending at this time. Preliminary findings indicate that 239 sites with at least 1,746 component features were identified. The majority of identified features are agricultural, and include pahoehoe excavations, rock mounds, terraces, and modified outcrops.

Keahuolu was included in a regional historic overview compiled by Kelly (1983), in conjunction with the Kuakini Highway Realignment Corridor mitigation study. This overview included approximately 30 ahupua'a between Keahuolu and Keokea to the south. Kelly summarizes early historic and traditional Hawaiian agriculture as it was practiced in the dry mid-slope inland areas (kula) of Kona (Kelly 1983:55-75). She also provides background for the historic processes that led to abandonment of kula farming by Hawaiians during the nineteenth century.

Archaeological field work along the Kuakini Highway Realignment Corridor was conducted 1980-83 by B.P. Bishop Museum (Schilt 1984). The corridor crossed 24 ahupua'a located between Palani Road and Kilohana Subdivision to the south. The northern end of the 4.96 km-long corridor was in Keahuolu. A total of 134 sites (455 features) were identified along the corridor; two sites were located in Keahuolu. These included a cairn and a modified outcrop.

Twenty-two radiocarbon dates were determined from samples collected during the Kuakini mitigation project (Schilt 1984:262). On the basis of the dated samples, their contexts, and other information, Schilt postulated that agricultural use of the kula was probably not intensive until after AD 1400-1500. Schilt suggests that erosional deposition of soil from agricultural areas located upslope was probably a major factor in permitting such use of the kula (Schilt 1984:274). She also suggests that due to differences in rainfall patterns, initial exploitation of the kula zone at the north end of the project area (Keahuolu) occurred later (c. AD 1550-1650) than use of this zone at the southern end (c. AD 1400-1650; 1983:274).

RESEARCH PROBLEMS AND APPROACH

Environment and Land Use

Kealakehe and Keahuolu are situated at the northern edge of an extensive traditional Hawaiian agricultural district known as the Kona Field System (Newman n.d.). The Kona Field System was characterized by Newman primarily on the basis of field configurations in the area above Kealakekua Bay. The definition of the field system has since been expanded to include a wide range of intensive agriculture landscaping patterns that occur in a continuous belt from Kealakekua Bay to Kailua Bay, an area of roughly 139 sq km (Kirch 1985:225). Knowledge of the northern margins of the field system is currently very scant, due to a lack of archaeological investigations in this area.

The rainfall and vegetation gradients, which generally follow elevational change within the Kona Field System, create distinctive ecological variation, which has implications for potential land use patterns. Kelly (1983) and Schilt (1984) outline four subzones along the ecological gradient which correlate with traditional Hawaiian cultivation zones, as identified in historic sources and in kuleana land claim descriptions (Kelly 1983:47-64, Schilt 1984:3-11). The four subzones and their estimated elevational ranges are:

(1) the kula, from 0 to c. 500 ft AMSL; (2) the kaluulu, or breadfruit zone, from c. 500 to 1,000 ft AMSL; (3) the apaa, from c. 1,000 to 2,500 ft AMSL; and (4) the amau, or upland jungle, from c. 2,500 to 4,000 ft AMSL (Schilt:1984:6). Potentially, the project area might therefore encompass portions of the kula and kaluulu subzones.

As indicated by Schilt, the elevational ranges of specific subzones appear to vary on a north to south gradient, along with variation in rainfall patterns. The upper extent of the kula zone should therefore be at a higher elevation in the northern reaches of the agricultural district, where rainfall isohyets swing inland, away from the coast. A higher elevation for the kula/kaluulu transition in Kealakehe is also supported by cartographic data from two primary sources. Emerson's survey map (discussed above) places the forest edge at approximately 750-800 ft in Kealakehe. In addition, the western boundary of both kuleana awards and homestead grants is at approximately 800 ft. However, the mauka extent of grazing lands in Kealakehe is at 600 ft.

Kelly and Schilt's environmental/land use models are both based on the premise that the boundaries of the traditional kula and kaluulu subzones coincided with nineteenth century general land use areas. Thus, the kula/kaluulu transition would coincide with the inland boundary of the grazing land, which coincides with the makai extent of the kuleana and homestead grants, which were confined to the kaluulu zone. For Kealakehe, this model does not work due to the disparity between the mauka boundary of the historic kula grazing land and the area designated for Native claims. It appears that in this case, archaeological data may provide a more accurate reflection of the traditional environmental/cultivation subzones than nineteenth century land use patterns.

Evidence provided in a prior Kealakehe study by Hammatt et al. (1987) indicates intensive agricultural land use between 700 and 800 ft AMSL. Hammatt et al. maintain that their study area is within the kula zone. This assumption appears to be based on the fact that their survey area was makai of the designated boundary for Native land awards. It may therefore not reflect the traditional subzone designation.

One of the research goals of further study in Kealakehe is to develop a more refined model of land use variability, using the elevational gradient and archaeological data. The inventory survey data could be used as a baseline for developing a formal typology of agricultural features and complexes that will permit comparison of feature occurrence and density along the elevational gradient. Ideally, specific functions (i.e., likely cultigens) and possible temporal patterns will eventually be suggested for the various feature types. These interpretations will be based on more systematic data collection and analysis to be conducted during the data collection phase.

Chronology

On the basis of prior analyses of archaeological data and age determinations of charcoal samples recovered in and around Kealakehe (discussed above), it is reasonable to expect that most of the inland habitation and agricultural features within the project area post-date AD 1300-1400. In order to test this assumption, and to better determine the culture history of the project area, it is important to locate and collect datable charcoal samples and to identify any variance in formal or functional types that may reflect temporal change.

One of the goals of field reconnaissance during this survey was to locate deposits in caves or other sites that had potential for containing carbonized material for dating, and to collect dating samples. Such deposits were located at only two sites; however, it is expected that buried deposits of carbonized material will be located during further data collection.

In the absence of numerous features with associated absolute dates, the determination of period of use through formal attributes becomes more crucial. It was hoped that minimally, certain types of agricultural and other features used during the nineteenth and/or twentieth century would be distinguishable from certain pre-contact period features.

FIELD PROCEDURES

Aerial reconnaissance of the project area indicated that cultural features occurred on all lava types present, and that much of the surface was not visible from the air due to heavy vegetation. Therefore, the pedestrian survey maintained a uniformly high-intensity level (c. 10.00 m [30 ft] intervals) for the entire project area. The survey crew consisted of four to five individuals, who traveled in parallel sweeps oriented north-south across the project area. Survey transects were flagged in order to ensure complete coverage, and all identified features were marked with PHRI temporary site numbers and plotted on a 1":200 ft scale aerial photograph. A total of 96 temporary site numbers were assigned during the reconnaissance. Subsequently, sites were assigned permanent State Inventory of Historic Places site numbers, as indicated in Table 1.

After completion of the pedestrian sweeps, a crew of four to eight individuals returned to all flagged sites for recording purposes. At this time, sites were tagged with metal site tags and were photographed, measured, and described; in certain cases, sites were cleared and mapped. An attempt was made to define as accurately as possible the boundaries of sites; overall site areas were measured along two perpendicular axes. In some areas, surface visibility affected the accuracy of site boundary definition. Further field work, particularly clearing, in some areas may indicate that some sites are parts of the same continuous complex. It was not possible to measure and describe every observed feature within the large agricultural complexes. An attempt was made to obtain an accurate count of the various agricultural feature types within a specific measured area of these large sites so that feature density could be estimated. Features counted, but not individually recorded in all cases, include rock mounds, pahoehoe excavations, and modified outcrops.

In general, surface visibility was such that all or nearly all surface features could be located with persons spaced c. 10.00 m apart on the sweep line. Surface visibility was very limited in the Keahuolu parcel and in the northern portion of the upper Kealakehe parcel. In these areas, it is therefore likely that not all features were observed during the pedestrian sweep, or during the recording phase. There are undoubtedly additional rock mounds, pahoehoe excavations, and other minor agricultural features that have not been enumerated here.

Among the 96 temporary site numbers assigned, six were combined with other temporary sites during the recording phase (Table 1). An additional four sites were found to be beyond the project area boundaries and were recorded as part of an adjacent survey project (PHRI Project 89-694). Five of the temporary sites, upon further inspection, were found to be noncultural.

Subsurface testing was conducted at Site 13188, where two 1.00 by 1.00 m sq units were excavated. All excavated soil was screened through 1/8" mesh, and all shell, lithic, botanical and faunal materials were collected. Recovered samples were returned to the Hilo laboratory for systematic sorting. A single charcoal sample was collected at Site 13188. This sample was sent to Beta Analytic, Coral Gables, Florida, for radiometric age determination.

Table 1.

CORRELATION OF SITE NUMBERS

SIHP Site Number	PHRI Temporary Site Number	SIHP Site Number	PHRI Temporary Site Number
00002	Mamalahoa Trail	13214	T-43
05011	T-94	13215	T-44
13175	T- 1	13216	T-45
13176	T- 2	13217	T-46
13177	T- 3	13218	T-47
13178	T- 4	13219	T-48
13179	T- 5	13220	T-55
13180	T- 6,18	13221	T-56,57
13181	T- 7	13222	T-58
13182	T- 8	13223	T-59
13183	T- 9*	13224	T-60
13184	T-10	13225	T-61
13185	T-11	13226	T-63,64
13186	T-12	13227	T-65
13187	T-13	13228	T-66
13188	T-14#	13229	T-67
13189	T-15	13230	T-68
13190	T-16	13231	T-69
13191	T-17	13232	T-70
13192	T-19	13233	T-71
13193	T-20	13234	T-72
13194	T-21	13235	T-73,74
13195	T-22	13236	T-75,77
13196	T-23	13237	T-76
13197	T-24	13238	T-78
13198	T-25	13239	T-79
13199	T-26	13240	T-80
13200	T-27	13241	T-81
13201	T-28	13242	T-82
13202	T-29	13243	T-83
13203	T-30	13244	T-85
13204	T-31	13245	T-86
13205	T-32	13246	T-87
13206	T-33	13247	T-88
13207	T-35	13248	T-89
13208	T-36	13249	T-90
13209	T-37,38	13250	T-91
13210	T-39	13251	T-92
13211	T-40	13252	T-93
13212	T-41	13253	T-96
13213	T-42	13254	T-95

* Identified as Site 12 in Hammatt, Shideler, and Borthwick (1987)
\# Identified as Site 1 in Soehren (1975)

FINDINGS

During the present project, 182 sites consisting of 840 component features were identified in the project area (Table 2, at end). Descriptive information is given for each site and recorded feature in Appendix A. Four of the sites (14 features) had been previously identified. Two of the previously identified sites had been listed on the State Inventory of Historic Places (SIHP). These are Mamalahoa Trail (SIHP Site 00002) and the Kealakehe/Keahuolu ahupua'a boundary wall (Site 5011). Other sites previously identified are Site 13188, a habitation cave (Hammatt et al. 1987), and Site 13253, a terrace complex interpreted by Soehren (1975) as a burial site. Both of these sites had been identified during reconnaissance surveys conducted in properties adjacent to the project area.

Among the 82 identified sites, 53 are in Kealakehe, 28 are in Keahuolu, and one (the ahupua'a boundary wall) is between the two lands. Overall site density is greater in the Keahuolu parcel, where 34% of the identified sites and 60% of the features occur on 16% of the total project area acreage. It is suspected that the higher site density in Keahuolu is a reflection of the generally higher elevation of that parcel (550-750 ft AMSL) and the lower incidence of bulldozer grubbing in that parcel, and possibly, the parcel's location farther south. Nearly half of the Kealakehe parcel is below 300 ft AMSL; only 22% of the identified sites and 8% of the total features occur at 300 ft AMSL or lower.

Twenty-nine of the identified sites consist of a single feature. These sites are primarily walls, trails, enclosures, and cairns. Multiple-feature sites consist of up to 120 features. Ten complexes contain 30 or more features; six of these complexes are in Keahuolu. All of the large complexes are predominantly agricultural features (discussed below).

The identified features represent 17 different formal categories (Table 3).

Formal Feature Types

Feature frequencies by formal types clearly indicate the predominance of pahoehoe excavations and rock mounds, which together comprise 72.3% of all features. Nearly half of the categories (8) are represented by less than 1% of the identified features. Features represented in the various formal categories are summarized below.

Cairns - With one exception, the cairns identified may be characterized as generally small, informal stacks, or loose conical piles of slabs and cobbles with no core filling or faced sides. A single cairn was located which has core filling and faced sides. This feature has been disturbed, and currently has two partial sides (one corner) intact. It was found at a Keahuolu agricultural complex consisting of 32 additional features (Site 13239, Feature B).

Table 3.

FEATURE COUNTS BY FORMAL CATEGORY

Formal Type	Count	Percent	Formal Type	Count	Percent
Cairn	26	3.1	Pavement	5	0.6
Cave	3	0.4	Platform	16	1.9
C-shape	1	0.1	Roadbed	1	0.1
Enclosure	22	2.6	Rock mound	350	41.7
Hearth	2	0.2	Stpst. trail	11	1.3
Kerbst. trail	5	0.6	Terrace	73	8.7
Midden scatter	1	0.1	Trail	2	0.2
Modified outcrop	46	5.5	Wall	18	2.1
Phh. excavation	258	30.7			
Subtotal:	**364**	**43.3**	**Total:**	**840**	**99.9**

At least six of the identified cairns are probably of recent construction and appear to delineate grubbing area perimeters. These are all located in the lower elevations of Kealakehe. Two cairns are definitely associated with a trail (Site 13202); all others are marking indeterminate features, places, or events. Among these remaining 19 features, two are in Keahuolu and 17 are in Kealakehe. Average height of the nonrecent unfaced cairns is 0.7 m; they are constructed of four to ten rocks stacked in a conical formation.

Caves - Three cave shelters were identified, two in Kealakehe (13183 and 13188) and one in Keahuolu (13230). The two Kealakehe caves have associated agricultural features, whereas Site 13230 is relatively isolated. This latter cave exhibits a partially walled entrance and has no midden deposit. Deposits are present in the two Kealakehe caves; both have been tested.

Site 13183 was tested by Hammatt et al. in 1987. The cave is situated at the west end of a collapsed lava tube that has been extensively modified with terraced fill and facing walls. A deposit 0.2 m thick was found just inside the dripline of this relatively small cave. Artifacts recovered here include 39 volcanic glass flakes and three bone picks. Charcoal, marine shell, and fish and pig remains were also recovered (Hammatt et al. 1987:39). Two enclosures, a large paved area, and a rock mound are immediately adjacent to the lava tube to the south. The area to the north has been grubbed. Hammatt et al. interpret the site as a habitation/work area.

Site 13188 was tested during the current project. It consists of two linear lava tube chambers that are both accessed through a vertical skylight opening at the center. Two 1.0 by 1.0 m test units were excavated at the site, one unit per chamber. The deposit inside the cave was found to have a maximum thickness of 0.08 m. A small quantity of marine shell fragments, burned and unburned kukui nut (*Aleurites moluccana* L. [Willd.]) and charcoal were recovered, in addition to nine volcanic glass flakes. A charcoal sample comprised of scattered flecks collected from TU-2 was submitted to Beta Analytic for age determination. This sample was determined to be modern (BETA-34210).

All of the caves occur at elevations of 550 ft or greater. The most intensive use is indicated for Site 13183, located at 710 ft AMSL.

C-Shape - The only C-shape identified was present at Site 13243 in Keahuolu. It is in direct association with two recent hearths and is most likely of recent construction.

Enclosures - Among the 22 enclosures identified, 11 are in current use as agricultural features and are probably of relatively recent construction. These 11 enclosures are present at four sites—13175 (8), 13183 (1), 13217 (1), and 13237 (1). All but one of these sites (13237) are in Kealakehe.

One of the enclosures (Site 13251) may have been associated with ranching. This enclosure is at the eastern edge of the grazing land in Kealakehe and has been extensively disturbed by bulldozing; it is the largest enclosure recorded within the project area (c. 756.0 sq m interior). The walls of the enclosure are in very poor preservation; however, they appear to have been bifaced and core-filled.

The remaining 10 enclosures exhibit estimated interior areas that range from 12.7-396.6 sq m. Four of these features appear to have been used for agricultural purposes. They consist of loosely stacked, unfaced walls that are generally mounded rather than vertical. Three of these agricultural enclosures (at Sites 13186, 13252, and 13254) are the three smallest abandoned enclosures, and are very similar in size and form to enclosures that are in current use or have recently been abandoned. The enclosures are in the northeastern corner of the Kealakehe parcel, at elevations of 500 ft AMSL or higher. This is the same area that the enclosures in current use are concentrated within.

Five enclosures at five sites exhibit bifaced, core-filled walls, and may have functioned in a ceremonial or habitation capacity instead of, or in addition to, an agricultural capacity. They are all rectangular to trapezoidal in plan. The largest of these bifaced enclosures (369.60 sq m) is at Site 13228, located at 600 ft AMSL in Keahuolu. This enclosure exhibits a paved interior and has a prominent natural knoll in the center. A second enclosure, with a possible ceremonial function, is at Site 13213, located at 510 ft AMSL in Kealakehe. This 155.0 sq m enclosure is situated immediately adjacent to an associated platform.

Three bifaced, core-filled enclosures with possible habitation as well as agricultural functions are present at Sites 13183, 13213, and 13214. These sites are in Kealakehe, at 450-700 ft AMSL. Interior area of these features ranges from 93.1 (13183) to 172.0 sq m (13213). The enclosures at Sites 13213 and 13214 have interior features such as platforms, paved areas, and pahoehoe excavations. The Site 13183 enclosure has been disturbed by bulldozers and the interior features are indeterminate. The site is associated with a habitation cave as well as an agricultural enclosure that is in current use (for a mango tree).

Hearths - The two hearths identified are of recent construction and use. They are both at Site 13243 in Keahuolu. A C-shape and windbreak wall are also present at this site.

Kerbstone Trails - Five kerbstone trail sections were identified, three in Kealakehe and two in Keahuolu. The longest section is a portion of Mamalahoa Trail (Site 00002); this portion is oriented NW-SE, parallel to Queen Kaahumanu Highway at about 50 ft AMSL. The trail continues in both directions beyond the project area.

Two east-west (mauka-makai) trail sections were located in upper Kealakehe, at 550-700 ft AMSL. The longest of these is Site 13219, identifiable for 250.0 m. This intact section is cut at its east end by rip-rap and at its west end by the Site 13184 wall. Additional isolated sections were located west of the grazing land wall, indicating that the trail continues makai for an unknown distance (probably to Mamalahoa Trail or to Honokohau). This trail apparently continued eastward to a junction with a kerbstone trail that followed the approximate alignment of Palani Road. From this junction, it continued to the upper Government Road, which followed the alignment of the current Mamalahoa Highway (Emerson Survey Map 1882).

Site 13212 is a 62.0 m long kerbstone trail section located near the southern boundary of Kealakehe. The east and west ends of the section are currently defined by surface disturbance and are extremely vague. This trail may have continued east to intersect with the trail that followed the Palani Road alignment; however, cartographic evidence for this continuation is presently not available.

The two kerbstone trail sections identified in Keahuolu (13234 and 13244) are 244.0 and 350.0 m long, respectively. It is likely that these sections, which are along the eastern boundary of the survey area, represent the same trail. This trail is probably the first historic period alignment of the existing Palani Road (Emerson Survey Map 1882).

Midden Scatter - A single surface midden scatter was identified at Site 13209 in Kealakehe. This scatter occurs in association with 55 other features, including platforms, terraces, cairns, a steppingstone trail, and 40 pahoehoe excavations. The midden deposit is in a natural pahoehoe depression and covers a 44.8 sq m. It consists of marine shell fragments mixed with organic soil c. 0.08 m thick.

Modified Outcrops - Modified outcrops were identified at eight sites, two of which are in Keahuolu (13241 and 13246 [26 features]). Sites with modified outcrops range in elevation from 300 ft AMSL (one site) to 750 ft AMSL. Moderately concentrated outcrops occur at Sites 13185 (12) and 13241 (25). Twenty-eight additional features are present at Site 13185, and 24 additional agricultural features are present at Site 13241.

Modified outcrops consist of natural pahoehoe depressions, slopes, or flats that have been cleared of large loose rocks and filled with gravels and small cobbles. The larger stones are generally arranged around or near the perimeter of the cleared area in loose piles or alignments. In some cases, the resulting feature is somewhat terrace-like in appearance. Modified outcrops are distinguished from pahoehoe excavations in that the lava mantle is not penetrated. They may otherwise have similar morphological characteristics.

The majority of the modified outcrops were not individually measured or recorded during the inventory survey. It is likely that there are considerably more of these features within the project area. They are currently assumed to represent agricultural activities.

Pahoehoe Excavations - Pahoehoe excavations were observed at 25 sites. Most of the excavations (173 of 258, 67%) are at 14 sites in Keahuolu, between elevations of 550 and 750 ft AMSL. Counts of 20 or more pahoehoe excavations were obtained at four sites, 13209 in Kealakehe (40), and 13221 (25), 13227 (48), and 13239 (20) in Keahuolu.

Characteristic pahoehoe excavations consist of small lava blisters that have the surface broken away, creating a hole where the gas pocket existed. Depth of the hole usually ranges from 0.40 to 0.90 m. The blocks and pieces of pahoehoe debris broken away are usually arranged around the perimeter of the hole in a circular alignment, or are in loose piles to the outside. In some cases, the large blocks are inside the hole, aligned against the walls. The hole is often partially filled with pieces of pahoehoe that are size-sorted (smaller pieces on the bottom, larger pieces on top). The gravels that occur in lower layers of these holes are often very angular and unweathered, and appear to be artificially produced by crushing larger rocks. Soil is often mixed with the gravels; the soil is not visible unless the upper layer of larger rocks is removed.

Comparison of surface area values for recorded pahoehoe excavations suggests that there may be at least two distinct size groups. Half of the measured excavations have surface areas between 3.0 and 10.0 sq m. Only one excavation exhibits an area that is between 10.0 and 40.0 sq m (17.3 sq m), yet 35% exhibit areas greater than 40.0 sq m (43.20-

77.19 sq m). This pattern may, however, be a result of sampling error, since the majority of the observed excavations were not individually measured.

Pahoehoe excavations that occur within the project area are assumed to have functioned as agricultural features. These features are referred to as "planting pits" by Soehren (1975), who observed an unknown quantity in Honokohau, but states that "[n]o attempt was made to record such features" (1987:1). It is suspected that pahoehoe excavations and modified outcrops were disregarded in other prior studies of Kealakehe and Keahuolu. These features, together with rock mounds, are clearly the predominant agricultural features within the project area. Any attempt to measure the spatial patterning and relative intensity of agricultural activities must rely heavily upon these features. It is therefore important that a typological system, based on quantifiable variables, be developed for recording pahoehoe excavations.

Pavements - Five paved areas were recorded at three Kealakehe sites within the project area—13183 (1), 13203 (1), and 13252 (3). These features consist of a single layer of pebble-size pahoehoe or aa that is spread over a flat surface. The pavements at Sites 13183 and 13252 are associated with other habitation and agricultural features. At Site 13203, the pavement is associated with a terrace that is interpreted as an agricultural feature. It is difficult to assign a feature-specific function to the pavements; they may reflect general yard area landscaping.

Platforms - Sixteen platforms were identified at nine sites, eight of which are in Kealakehe. Concentrations of platforms occur at Sites 13181 (4) and 13253 (3). Both of these sites are along the northern boundary of Kealakehe, in relatively low elevations (300 ft and 50 ft AMSL, respectively). Platforms at both sites are tentatively interpreted as burial monuments. The platforms at Site 13181 are rectangular in plan and have surface areas of 9.00 to 31.90 sq m. Platform heights range from 0.75 to 1.25 m. At Site 13253, the platforms are oval to five-sided, with surface areas of 6.25 to 23.00 sq m. Maximum height of these platforms is 0.73 m. In addition to the size, shape, and height differential between platforms at these sites, the construction techniques and materials is different. Likewise, the site settings contrast markedly. Site 13181 is on a very prominent ridgetop, whereas Site 13253 is in a ravine at the base of a high aa flow.

Three additional platforms have been interpreted as possible burial features. These are at Sites 13178, 13209, and 13223. The platforms all have relatively small surface areas (1.30 to 13.30 sq m) and are less than 1.00 m high.

Platforms interpreted as habitation features are present, one each, at Sites 13209, 13210, and 13214. These sites are all in southern Kealakehe, between 450 and 650 ft AMSL. The platforms exhibit a very uniform surface area (42.7 to 49.4 sq m) and range in height from 0.75 to 1.20 m.

Roadbed - A historic machine-made roadbed was identified in Keahuolu (Site 13246). This feature represents an old Palani Road alignment; other portions of the same alignment are present southwest of the current project area, along the present Palani Road.

Rock Mounds - During enumeration and recording of the 350+ rock mounds observed within the project area, a distinction was made between faced mounds, linear mounds, and circular to oval mounds.

Faced mounds exhibit at least one side that is stacked vertically and faced. Most of the faced mounds are faced on all sides. They are distinguishable from platforms in that their surfaces are rough, mounded, and are not paved. Thirteen faced mounds were identified at four sites; three in Kealakehe (13193 [1], 13252 [3], and 13254 [6]), and one in Keahuolu (13240 [3]). Nine of the faced mounds are at two adjacent sites that are probably part of the same agricultural complex. These mounds are generally rectangular to circular in plan and have surface areas that range from 5.7 to 16.5 sq m. Heights range from 0.6 to 1.5 m.

A number of faced rock mounds were identified by Hammatt et al. (1987) in their project area, which is just east of the eastern edge of Site 13254. Hammatt et al. tested eight mounds in order to determine if human skeletal remains were present beneath them (Hammatt et al. 1987:8,63,64). No skeletal remains, midden, or artifacts were recovered, and it was concluded that the faced mounds were relatively formalized "clearance mounds."

Linear rock mounds are low, unfaced mounds that are at least twice as long as they are wide. Ninety-seven linear mounds were observed at 14 sites within the project area. Ninety-three of these mounds (nine sites) are in Keahuolu. The most concentrated occurrence is at Site 13221, where 55 were enumerated.

In general, the linear mounds are too short to be considered <u>kuaiwi</u> walls. As defined by Kirch (1985:228), <u>kuaiwi</u> walls are long, parallel field boundaries that generally follow the slope of the land. The longest linear mound recorded in the project area is 25.00 m long. Average length among 14 mounds from all 14 sites is 11.20 m (range 4.2-25.0 m). Width ranges from 1.00-4.00 m (average 2.10 m), and height ranges from 0.60 to 1.25 m.

A total of 240 circular to oval rock mounds were observed at 23 sites. A clear majority (209, 87%) of the mounds are in Keahuolu, at 15 different complexes. Within a sample group of 12 mounds from 10 sites, the average surface area at the base is 5.8 sq m (range 2.6-12.8 sq m), and the average height is 0.64 m (range 0.30-1.25 m). An unusually large mound was observed at Site 13211, which has a surface area at the base of c. 106.9 sq m. This mound has a central depression/cleared area, making it appear somewhat doughnut-shaped in plan view. A second unusual mound was observed at Site 13249. This feature is teardrop in plan, and also exhibits a depression in the center of the widest portion. It covers a surface area of c. 16.3 sq m.

Steppingstone Trails - Eleven steppingstone trail sections were located, all on aa lava flows. Ten of the sections are in Kealakehe, at ten different sites. Together, the ten sections cover 571.0 linear m. It is suspected that six of the sections are parts of two trails. Sections were observed at Sites 13186, 13204, 13206, and 13207, which may well represent the same north-south trail across Kealakehe. These sites are aligned at or just above the 400 ft elevation contour, from the northern boundary to within c. 250.00 m of the southern boundary. Trail sections at Sites 13194 and 13197 are very likely the same mauka-makai trail that crosses Mamalahoa Trail and continues to Aimakapa Pond on the coast. It is also likely that the section at Site 13253 once joined with this trail makai of Queen Kaahumanu Highway in Honokohau.

The single steppingstone trail section in Keahuolu is at Site 13242; the section is 70.0 m long and is oriented NE-SW.

Terraces - Seventy-three terraces were identified at 20 sites within the project area. Only six (8%) of the terraces are in Keahuolu (five sites). Metric dimensions are available for 47 terraces from 16 sites. Within this group, overall surface area ranges from 2.2 to 117.3 sq m. Average surface area is 28.2 sq m. Four terraces exhibit surface areas greater than 50.00 sq m. These features are at Sites 13176, 13207, 13249, and 13254, all in Kealakehe. Sixteen terraces have surface areas between 25.0 and 49.9 sq m; 17 have surface areas between 10.0 and 24.9 sq m, and 10 are less than 10.0 sq m in surface area.

Fifty-seven of the 73 identified terraces appear to have agricultural functions; two may have been used for habitation, one is possibly ceremonial, and 13 are possible burials. The possible burials all occur at two sites (13184 and 13253). The possible ceremonial terrace is at Site 13176; it is a large, stepped terrace situated on a prominent ridge, and is associated with a second large (117.30 sq m) terrace that may be a habitation or ceremonial feature.

Trails - Two trail sections were identified at Sites 13201 and 13202 in Kealakehe. These sections consist of cleared and packed corridors through aa; they are located c. 152.0 m apart and are probably sections of the same north-south footpath.

Walls - Eighteen walls were identified, two of which are in Keahuolu. Seven of the walls appear to be associated with ranching activities and are probably historic. One is an ahupua'a boundary (Site 5011), one is associated with recent camping activities (Site 13243 in Keahuolu), and nine are associated with agricultural activities. The nine agricultural walls occur at five sites, one of which is in Keahuolu.

Five of the agricultural walls (at Sites 13190, 13239, and 13252) are relatively short and are either curved or L-shaped. They range in length from 5.2 to 29.0 m, and appear to serve as windbreaks or soil retention features around the perimeters of planting areas.

Four agricultural walls can be considered kuaiwi walls. These are all in the northeast corner of the project area, in Kealakehe, at Sites 13216 (1) and 13254 (3). The walls are oriented with the slope of the land and are essentially parallel. They range in length from 44.0 to 103.00 m and are generally unfaced, with some faced sections.

In summarizing the general patterning of formal feature categories, it might be noted that although the overall density of features is greater in the Keahuolu parcel of the project area, there are distinct differences in the patterning of specific formal types. The Keahuolu parcel clearly contains the bulk of the relatively informal agricultural features, such as 96% of the linear rock mounds (93 of 97), 87% of the circular rock mounds (209 of 240), and 67% of the pahoehoe excavations. In comparison, 94% of the recorded platforms (15 of 16) are in Kealakehe, as well as 92% of the terraces (67 of 73), 91% of the enclosures (20 of 22), 89% of the walls (16 of 18), 77% of the faced mounds (10 of 13), and 100% of the pavements (5 of 5). This difference can only be partially explained by differences in the proportion of higher vs. lower elevations between the two parcels. A much clearer picture of this pattern will emerge upon completion of the analysis of survey data from lower elevations in Keahuolu (report on PHRI Project 89-596, pending).

Functional Categories

Within and among the seventeen formal groups described above, eight general functional categories are represented (Table 4).

Table 4.

FREQUENCY OF FORMAL FEATURE TYPES BY FUNCTIONAL CATEGORIES

Feature Type	Count	% of Category	% of Total
Agricultural Features			
Enclosures	15	2.0	-
Faced mounds	9	1.2	-
Linear rock mounds	97	13.2	-
Modified outcrops	46	6.3	-
Pahoehoe excavations	258	35.1	-
Pavements	3	0.4	-
Rock mounds	242	32.9	-
Terraces	57	7.7	-
Walls	9	1.2	-
Subtotal:	**736**	**100.0**	**87.6**
Habitation Features			
Caves	3	25.0	-
C-shapes	1	8.3	-
Hearths	2	16.7	-
Midden scatter	1	8.3	-
Pavements	1	8.3	-
Platforms	3	25.0	-
Wall	1	8.3	-
Subtotal:	**12**	**99.9**	**1.4**
Transportation Features			
Steppingstone trails	11	57.9	-
Kerbstone trails	5	26.3	-
Footpaths	2	10.5	-
Roadbeds	1	5.3	-
Subtotal	**19**	**100.0**	**2.3**
Possible Ceremonial Features			
Enclosures	2	40.0	-
Platform	2	40.0	-
Stepped Terrace	1	20.0	-
Subtotal:	**5**	**100.0**	**0.5**

Table 4. (cont.)

Feature Type	Count	% of Category	% of Total
Habitation or Agriculture Features			
Enclosures	3	50.0	-
Pavements	1	16.7	-
Terraces	2	33.3	-
Subtotal:	**6**	**100.0**	**0.7**
Indeterminate Markers			
Cairns	26	3.1	-
Land Division/Ranching Features			
Walls	8	88.9	-
Enclosure	1	11.1	-
Subtotal:	**9**	**100.0**	**1.1**
Possible Burial Features			
Faced Mounds	4	14.8	-
Platforms	10	37.0	-
Terraces	13	48.2	-
Subtotal:	**27**	**100.0**	**3.2**
Total:	**840**	**100.0**	**99.9**

category clearly indicates a predominance of agricultural features (87.6% of 840 features). Habitation features and possible habitation/agricultural features combined (2.1%) are proportionately less frequent than transportation features (2.3%) or possible burials (3.2%).

Agriculture - Agricultural features occur as single-component sites in only three instances (Sites 13217, 13237, and 13250). In two of these three cases, the isolated feature is in an enclosure that is in current use. The third single component agricultural site (13250) is a terraced rock mound. This feature is in an area of very high grass, and the absence of nearby features has not been substantially demonstrated at this time.

Among the agricultural features, 99.6% occur in complexes with one or up to 119 additional features. Complexes with agricultural features account for 43 of the 53 recorded complexes. Thirty-seven of the 43 complexes with agriculture features have either one or no features that fit another functional category. The most frequently occurring non-agricultural features in agricultural complexes are cairns and trails.

Feature counts and reliable overall site area data are available for 35 of the 37 complexes that are comprised solely or predominantly of agricultural features (Table 5). Among these 35 complexes, the total count for agricultural features ranges from two to 120, with a mean of 21 and

Table 5.

FEATURE COUNTS, SITE AREA, AND ELEVATIONS FOR AGRICULTURAL COMPLEXES

Kealakehe Sites				Keahuolu Sites			
No.	Fea. Cnt.	Area*	Elev.#	No.	Fea. Cnt.	Area*	Elev.#
13175	8	7,200	720	13220	3	120	540
13178	3	64	350	13221	80	2,100	530
13183	5	1,000	710	13222	19	600	550
13185	40	5,600	565	13224	28	1,600	540
13186	3	1,500	400	13225	7	340	580
13188	3	105	350	13226	13	924	590
13189	3	150	340	13227	120	3,500	600
13190	30	410	290	13229	10	600	640
13200	2	30	300	13231	8	600	630
13203	2	49	260	13233	6	750	610
13207	4	780	390	13235	33	4,250	620
13209	56	4,050	460	13236	6	750	650
13210	3	375	600	13238	20	180	650
13211	2	576	560	13239	33	1,200	640
13212	8	2,666	560	13240	33	1,500	660
13249	7	510	560	13241	49	4,140	630
13252	17	2,500	630	13247	4	3,750	590
13254	74	14,000	625				

* Sq m
\# Ft AMSL

median of eight. Twenty of the 35 complexes include one or more pahoehoe excavations. Counts of this formal type range from one to 48 per complex, with a mean of 12 excavations per complex. Twenty-five complexes contain one or more rock mounds. Counts of rock mounds range from one to 72 per complex, with a mean of 14. Sixteen complexes consist solely of pahoehoe excavations, rock mounds, or a combination of both. The remaining 21 sites have terraces, walls or modified outcrops.

A series of descriptive statistics were generated using the 35 agricultural complexes in order to determine if (a) feature density and formal types present were related to elevation, and (b) if the composition of the complexes varied between ahupua'a. Seventeen of the 35 complexes compared here are in Keahuolu and 18 are in Kealakehe.

Three elevational groupings were delineated; greater than or equal to 600 ft, 300-599 ft, and less than 400 ft. Fifteen complexes are at elevations of 600 ft or greater. These contain a total of 423 features (mean 28, range 3-120). Overall complex area of this group averages 2,836.33 sq m, and the average area per feature is 152.05 sq m.

Eighteen complexes are at elevations between 300 and 599 ft AMSL. These contain a total of 278 features (mean 15, range 2-80). Overall complex area of this group averages 1,414.72 sq m, and the average area per feature is 165.7 sq m.

Seven agricultural complexes are at elevations less than 400 ft. These contain a total of 46 features (mean 7, range 2-30). Overall complex area averages 1,588 sq m and average area per feature is 50.64 sq m. Three of these seven complexes include pahoehoe excavations (total of 21 excavations) and two include rock mounds (total of 12 mounds). It is only in these lower elevations that pahoehoe excavations outnumber rock mounds.

Among the upper elevation complexes (600 ft AMSL or greater), seven have pahoehoe excavations and 13 have rock mounds (seven have both). Total number of pahoehoe excavations in this group is 114 (44% of all pahoehoe excavations); average per complex is 16 (range 1-48). The average area per feature on this complexes is 71.3 sq m. Upper elevation complexes with rock mounds contain a total of 228 mounds (65% of all rock mounds). Average count per complex is 18, and the average area per feature is 96.60 sq m.

Upper elevation complexes contain twice as many rock mounds as pahoehoe excavations and a significantly higher proportion of all rock mounds in comparison to all pahoehoe excavations. The 300-599 ft elevation group includes 11 complexes with pahoehoe excavations and 12 complexes with rock mounds. A total of 108 excavations and 110 mounds are present, and mean counts per complex are very similar (nine excavations per site and ten mounds per site). The overall count for pahoehoe excavations here is not significantly different than the upper elevation count, and more complexes have excavations. For rock mounds, there is a decrease of over 50% in the overall count, and a slight decrease in the number of sites. Overall area per rock mound increases from 96.6 to 157.1 sq m.

The general trend indicated by these data is that rock mounds show a higher degree of correlation with elevational change than pahoehoe excavations. They may therefore reflect a more specialized use or a more limited range of associated cultigens than pahoehoe excavations.

Agricultural terraces exhibit a tendency to be more common and more dispersed between 300 and 600 ft AMSL. At 600 ft or above, 22 terraces occur at four sites, whereas between 300-600 ft, 38 terraces occur at 11 sites. Nine terraces occur at four sites with elevations less than 400 ft. As indicated above, most of the terraces are in Kealakehe; only six are in Keahuolu. If terrace frequency is related to elevational change, as suggested here, then the lower terrace count for Keahuolu is at least partially accounted for by this factor.

Comparisons between agricultural complexes in the two ahupua'a indicate differences in several characteristics. For the 18 Kealakehe complexes, overall site area ranges from 30.00 to 14,000.00 sq m, with a mean area of 2,309.17 sq m. In Keahuolu, area ranges from 120 to 4,250 sq m, with an average area of 1,582.5 sq m. As mentioned above, there is a significant difference in the frequency of rock mounds at the two ahupua'a. In Kealakehe, 70 rock mounds are present at 18 complexes. Maximum number of mounds per complex is 36. At Keahuolu, 278 mounds are present at 17 complexes; maximum number at a complex is 72. The average total agricultural features per complex varies considerably. For Kealakehe, an average of 14.55 features occurs per complex; in Keahuolu, the average count is 27.7, nearly double.

Habitation - The twelve features assigned a habitation function occur at nine sites, including one recent occupation (Site 13243). This latter site has four features and is one of two habitation sites in the Keahuolu parcel.

The three habitation caves (13183, 13188, and 13230) appear to represent temporary use. The most substantial occupation deposit is at Site 13183, which may represent a repeatedly used field shelter/work area. Permanent habitation is suggested, but not yet demonstrated, at three sites with platforms (13209, 13210, and 13214). A surface midden scatter is also present at Site 13209. These sites are all in the southeastern corner of Kealakehe, between 400 and 500 ft AMSL.

All other habitation sites are tentatively interpreted as temporary use areas. These include the recent hearths, wall and C-shape at Site 13243, and a pavement at Site 13252.

Habitation is considered a possible function at six features that occur at six complexes. Three of these complexes (13183, 13210, and 13214) have other features that have been assigned a possible habitation function. An enclosure and a paved area at Site 13252 may also have been associated with habitation, in addition to the modified lava tube and cave. At Site 13210, a terrace may have been used for habitation, in addition to the platform. At Site 13214, an enclosure surrounds the platform that appears to be associated with habitation. A possible habitation terrace occurs at Site 13176, and a second enclosure that may have surrounded a house yard occur at Sites 13213, located just east of Site 13214. With the exception of the recent features, all habitation sites appear to date to the Pre-Contact Period.

Transportation - Among the 19 transportation sites, five are kerbstone trail sections that can be assigned to the nineteenth century. One of the sites (13246) is a twentieth century roadbed, and the 13 steppingstone trails and footpaths are most likely pre-contact to early historic. As discussed above, most of the trails are in Kealakehe.

A minimum of four trails are represented by the 11 steppingstone trail sections, and one trail is probably represented by the two footpath sections. In general, the steppingstone trail sections and footpaths were only discernible across aa. A minimum of two north-south routes and two mauka-makai routes are represented by these 13 trail sections.

The five kerbstone trail sections represent a minimum of four trails. Two are oriented mauka-makai and are situated in the north and south portions of Kealakehe, respectively. One (Mamalahoa Trail) is oriented north-south, and one appears to follow the Palani Road alignment, which is generally north-south and mauka-makai. The latter trail, represented by two sections, is in Keahuolu.

Possible Burials - Features that may contain human interments occur at seven sites and include faced mounds, platforms, and terraces. The most concentrated occurrence of these features is at Site 13253, where seven terraces and three platforms are present. This site was described by Soehren (1975) as a burial area. For the most part, the features exhibit formal characteristics of burial monuments. A second concentration of probable graves is at Site 13181, where four platforms occur. This site and Site 13253 are located along the northern boundary of Kealakehe. A third concentration of possible burials is at Site 13185, where six faced terraces occur. Additional agricultural features are present at this site and the probability of burials being present here is felt to be not as great as at the preceding two sites.

Four faced mounds, three at Site 13254 and one at 13193, are included in the list of possible burials. On the basis of findings during excavation of eight faced mounds in Kealakehe by Hammatt et al. (1987), the likelihood of locating skeletal remains in these features is not extremely high, but the possibility nevertheless exists.

Possible Ceremonial - Five features at four sites have attributes that suggest their use as ceremonial structures. These include a large stepped terrace (Site 13176) located along the northern boundary of Kealakehe, a terrace and platform complex (Site 13205) in Kealakehe, a large platform at the major agricultural complex in northeastern Kealakehe (Site 13254), and an enclosure in Keahuolu (Site 13228).

Subsurface Findings

Subsurface materials were collected from two test units at Site 13188. Both test units were 1.00 by 1.00 m sq, and were excavated to the bedrock floor of the cave. The deposit in Test Unit 1 (TU-1) was only 0.03 m thick. The deposit in TU-2 was 0.08 m thick. Both deposits consisted of a single stratigraphic layer (Layer I) consisting of dark reddish-brown loam with numerous rootlets.

A total of 6.31 g of marine shell and shell fragments was recovered from the two test units (Table 6). Despite the greater volume of soil removed from TU-2, both units produced similar total weights of marine material (3.01 g for TU-1 and 3.12 g for TU-2).

All shellfish remains recovered are 1/4" size grade; no shellfish remains were present in the 1/8" size grade material, which was examined in the laboratory. As indicated (Table 6), only small amounts of four shellfish species were present in the cave deposit. The overall volume of the remains, and the similarity of represented species in both test units suggests that a single incidence of occupation may be represented. Among the 15 enumerated shell pieces, eight are complete Isognomonidea valves, one is a complete Thaididae shell, and two are complete *N. picea*.

Table 6.

SUMMARY OF MIDDEN REMAINS, SITE 13188

Midden	TU 1 Weight (g)	TU 1 Count	TU 2 Weight (g)	TU 2 Count	Total Wt.
Cypraeidae	0.38	4	0.65	1	1.21
Isognomonidae	1.68	5	0.65	3	2.33
Nerita picea	0.56	4	-	-	0.56
Thaididae	0.39	1	1.82	1	2.21
Total Shellfish:	**3.01**	**14**	**3.12**	**5**	**6.31**
Kukui nut shell	2.11	4	-	-	2.11

All kukui nut shell remains were recovered from TU-1. The kukui nut shell is fragmented and is partially charred. Pieces of charred woody plant remains were present in TU-2; all of these pieces were collected, and were used collectively as a dating sample (discussed below).

In addition to the midden remains, nine volcanic glass pieces were recovered from TU-1. All volcanic glass pieces are minute flakes with no modifications.

Age Determinations

A single radiometric dating sample was collected from Site 13188 during subsurface testing. This sample was comprised of numerous small woody plant flecks that were scattered throughout Layer I of TU-2. The sample was determined to have a count rate statistically indistinguishable from the modern count rate at the 1/2 sigma level (BETA 34210).

Although the radiometric sample was determined to be indistinguishable from modern, the presence of volcanic glass flakes in association with the sample indicates a likely occupation sometime before the twentieth century. The carbonized materials scattered in the deposit may have been derived from a brush fire, rather than from a fire inside the cave. The entrance to the cave is oriented in such a manner that wind-born materials can easily accumulate inside.

A date extending into the modern period was also obtained from a hearth at Site 11, located in an area immediately east of this survey area (Hammatt et al. 1987). A calendric range of AD 1645-1950 was determined for this sample (Hammatt et al. 1987:60). Site 11 was located along the western boundary of Hammatt's project area and is very likely part of the Site 13183 complex, which includes a cave (Feature A) that was also tested by Hammatt et al. as Site 12.

CONCLUSION

DISCUSSION

The observations presented in the preceding section, concerning agricultural feature patterning, relative density of features within agricultural complexes, and the relationship between certain formal agricultural feature types and elevation, provide some indication of the research potential of sites within the project area. Subsequent work could explore this potential more fully by simply altering data collection procedures: the conclusions in the preceding section are limited primarily by the collection procedures employed during the project. For example, the determination of site boundaries (hence overall site area) is a relatively subjective procedure that becomes severely affected by surface visibility. Procedures to assure more accurate boundary delineation would enhance the accuracy, and thus utility and range, of research results.

In order to obtain reliable data for continued analysis of the agricultural complexes, it is recommended that a systematic sampling approach be adopted, whereby sample blocks or transects are cleared of vegetation, and all features within the designated area are plotted and recorded. These sample transects or blocks should be located independently of the existing sites, in order to control for those features not located between survey sweeps in areas of dense vegetation.

The use of sampling blocks will provide a reliable basis for feature density and relative frequency of types, and provide a more realistic framework for comparing elevational variation. A sampling scheme will also help determine the best means for identifying site boundaries (or the absence of such) in areas where this is problematic. For example, it is suspected that several of the complexes in Keahuolu are currently delineated on the basis of no visibility, rather than the absence of features. Total clearing of the entire 150-acre parcel is not feasible; however, boundary delineation would be nearly accomplished if every complex were cleared in order to determine site boundaries. The area incorporated by agricultural complexes recommended for further data collection is 55,650 sq m. A systematic sampling approach should provide sufficient data for the mitigation of adverse effects on a large proportion of the agricultural complexes recommended for further data collection.

In conjunction with a sampling approach, a more exact and replicable feature typology should be developed. With a proper typology, the spatial patterning of various feature types can be rapidly recorded, without the time-consuming process of drawing each feature to scale. Given the expanse of the project area and extensive amount of clearing that will have to be completed for detailed scaled mapping, this procedure will of necessity be limited to a relatively small proportion of the area recommended for further work. Plotting features by type will provide a much larger data base for examining spatial patterns.

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

A summary of tentative general significance assessments is given (Table 7) in order to facilitate DLNR-HSS/SHPO review and cultural resource management planning. Significance categories are based on the National Register criteria for evaluation, as outlined in the Code of Federal Regulations (36CFR Par 60). Sites determined to be potentially significant for information content (Category A, Table 7) 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."

In order to facilitate future client management decisions regarding site treatments, sites were further evaluated in terms of PHRI Cultural Resource Management (CRM) value modes which are derived from the previously mentioned evaluation criteria. The archaeological sites are evaluated in terms of potential scientific research, interpretive, and/or cultural values. **Research value** refers to the potential of archaeological resources for producing information useful in the understanding of culture history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. **Interpretive value** refers to the potential of archaeological resources for public education and recreation. **Cultural value** refers to the potential of archaeological resources to preserve and promote cultural and ethnic identity and values. See Table 2 (at end) for CRM value mode assessments for individual sites.

Based on the above federal and state criteria, of the 82 sites identified within the project area, 63 are assessed as significant solely for information content (National Register Criterion D). Ten sites are assessed as significant for information content and as being excellent examples of a site type (National Register Criterion C). Among these ten sites, three also have high cultural value and seven have a provisional assessment of high cultural value, pending the findings of subsurface investigations. Four sites are assessed as having information value and as provisionally having high cultural value, pending the findings of subsurface testing. Finally five sites with information value have provisional assessments of high interpretive and cultural values, pending the results of further data collection.

No Further Work - Of the 63 sites identified as having significant information content, 21 are assessed as having information content at the level of local analysis, and have been subjected to an adequate level of data recovery for the mitigation of the information loss (Significance Category X, Recommended Treatment Category NFW). These include six cairn sites (13177, 13191, 13192, 13195, 13196, and 13199), three recent agricultural enclosures (13175, 13217, and 13237), a recent campsite (13243), two historic walls (13215 and 13216), four small complexes consisting of one cairn and a single agricultural feature (13182, 12198, 13208, and 13245), a bulldozed enclosure (13251), an isolated rock mound (13250), two small agricultural complexes (13200 and 13249) and a cave that was tested during this project and was determined to have little additional new information (13188). These sites have been mapped, described, and photographed, and their locations have been plotted; no further work is recommended.

Further Data Collection - Forty-two sites are tentatively assessed as having information value at the local or regional level of analysis, and are recommended for further data collection (Significance Category A, Recommended Treatment FDC). They potentially contain information pivotal to understanding prehistoric and early historic settlement and agricultural land use patterns in leeward Hawaii, in addition to providing locally significant information. The majority of these sites are agricultural complexes, some of which include habitation or possible habitation features (31 sites, 76% of category). They include Sites 13186, 13187, 13189, 13190, 13203, 13207, 13210-14, 13220-22, 13224-27, 13228, 13231-33, 13235, 13236, 13238-41, 13246, 13247, and 13252.

Six sites are walls that require additional data collection in order to determine period of construction and intended function; they include Sites 5011, 13179, 13180, 13184, 13218, and 13248. Two sites recommended for further data collection have habitation (13183) or possible habitation (13230) cave features, and three of the sites are trail sections that could not be satisfactorily located and followed during this survey (Sites 13201, 13202, and 13244). Additional data collection is recommended as a mitigatory step if these sites or portions of these sites are affected by development.

Further Data Collection with Interpretive Development - Ten sites are recommended for interpretive development, following further data recovery. Three of these sites are trails which have both interpretive and cultural value, in addition to information content (Significance Categories A,B,C; Recommended Treatment Categories FDC, PID). They include the Site 13194 steppingstone trail, the Site 13219 kerbstone trail, and Mamalahoa Trail (Site 2).

Seven sites have high interpretive value as excellent examples of a site type and also have provisional cultural value as containing either possible burial features or ceremonial features (Significance Categories A,B, provisional C; Recommended Treatment categories FDC, PID). Site 13176 has the best-preserved, largest, and most formalized stepped terrace in the project area; it is interpreted as a possible ceremonial feature, pending further data collection. Sites 13181 and 13253 are unique complexes believed to consist solely of burial features. Site 13185 is a unique complex comprised of very distinctive, formalized faced terraces, some of which are believed to contain burials. Site 13209 is a habitation/agricultural complex which exhibits a wide range of formal feature types, including a possible burial platform. Finally, Site 13254 is a major agricultural complex which contains the only well-preserved examples of <u>kuaiwi</u> walls and a very wide range of formal feature types. It is thought to include habitation platforms, possible burial features (faced mounds), and a possible ceremonial platform.

Further Data Collection with Provisional Preservation As Is - Four sites include or consist of features that may contain human interments, and are recommended for

Table 7.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

Site Number	Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
13175	-	+	-	-	-	+	-	-
13177	-	+	-	-	-	+	-	-
13182	-	+	-	-	-	+	-	-
13188	-	+	-	-	-	+	-	-
13191	-	+	-	-	-	+	-	-
13192	-	+	-	-	-	+	-	-
13195	-	+	-	-	-	+	-	-
13196	-	+	-	-	-	+	-	-
13198	-	+	-	-	-	+	-	-
13199	-	+	-	-	-	+	-	-
13200	-	+	-	-	-	+	-	-
13208	-	+	-	-	-	+	-	-
13215	-	+	-	-	-	+	-	-
13216	-	+	-	-	-	+	-	-
13217	-	+	-	-	-	+	-	-
13237	-	+	-	-	-	+	-	-
13243	-	+	-	-	-	+	-	-
13245	-	+	-	-	-	+	-	-
13249	-	+	-	-	-	+	-	-
13250	-	+	-	-	-	+	-	-
13251	-	+	-	-	-	+	-	-
Subtotal:	0	21	0	0	0	21	0	0

General Significance Categories:

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

Recommended General Treatments:

FDC = Further data collection necessary (intensive 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);
PAI = Preservation "as is", with no further work (and possible inclusion into landscaping), or minimal further data collection necessary

Table 7. (cont.)

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
05011	+	-	-	-	+	-	-	-
13179	+	-	-	-	+	-	-	-
13180	+	-	-	-	+	-	-	-
13183	+	-	-	-	+	-	-	-
13184	+	-	-	-	+	-	-	-
13186	+	-	-	-	+	-	-	-
13187	+	-	-	-	+	-	-	-
13189	+	-	-	-	+	-	-	-
13190	+	-	-	-	+	-	-	-
13201	+	-	-	-	+	-	-	-
13202	+	-	-	-	+	-	-	-
13203	+	-	-	-	+	-	-	-
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:	**42**	**0**	**0**	**0**	**42**	**0**	**0**	**0**

Table 7. (cont.)

Site Number	Significance Category				Recommended Treatment			
	A	X	B	C	FDC	NFW	PID	PAI
00002	+	-	+	+	+	-	+	-
13194	+	-	+	+	+	-	+	-
13219	+	-	+	+	+	-	+	-
Subtotal:	3	0	3	3	3	0	3	0
13178	+	-	-	*	+	-	-	*
13193	+	-	-	*	+	-	-	*
13205	+	-	-	*	+	-	-	*
13223	+	-	-	*	+	-	-	*
Subtotal:	4	0	0	4	4	0	0	4
13176	+	-	+	*	+	-	+	*
13181	+	-	+	*	+	-	+	*
13185	+	-	+	*	+	-	+	*
13209	+	-	+	*	+	-	+	*
13228	+	-	+	*	+	-	+	*
13253	+	-	+	*	+	-	+	*
13254	+	-	+	*	+	-	+	*
Subtotal:	7	0	7	7	7	0	7	7
13197	+	-	*	*	+	-	*	-
13204	+	-	*	*	+	-	*	-
13206	+	-	*	*	+	-	*	-
13234	+	-	*	*	+	-	*	-
13242	+	-	*	*	+	-	*	-
Subtotal:	5	0	5	5	5	0	5	0
Total:	61	21	15	19	61	21	15	11

*Provisional assessment; definite assessment pending further data collection (i.e., testing features for presence/absence of skeletal remains) preservation in the event that human remains or evidence of mortuary use is identified during further data collection (Significance Category A, provisional C; Recommended Treatment Category FDC, provisional PAI). The potential burial features include a platform at Site 13178, an isolated faced mound (Site 13193), a platform at Site 13205, and two platforms at Site 13223.

Further Data Collection with Provisional Interpretive Development - Five sites that are currently significant for information content may be found to exhibit both interpretive and cultural values, pending the results of further data collection (Significance Categories A, provisional B and C; Recommended Treatment Category FDC, provisional PID). These include five trail sections, three of which may be found to connect with each other, resulting in the identification of major mauka-makai or north-south routes. These include Sites 13197, which may well connect with Site 13194, currently assessed as having high interpretive and cultural value; and Sites 13204 and 13206, which may connect to form a north-south route across the ahupua'a. Provisional interpretive and cultural value is also assigned to the Site 13242 trail section and the Site 13234 kerbstone trail, which may represent the original alignment of Palani Road. For these sites, an assessment of interpretive and cultural values is contingent upon identifying additional connective sections, or continuations of the existing sections.

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Table 2.

SUMMARY OF IDENTIFIED SITES AND FEATURES

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	*CRM Value Mode Assess.			#Field Work Tasks		
			R	I	C	DR	SC	EX
00002	Kerbstone trail (Mamalahoa Trail)	Transportation	M/H	H	M	+	-	-
05011	Wall	Land division	M	M	M/H	-	-	-
13175	Complex (8)	Agriculture	L	L	L	-	-	-
	A-H Enclosure							
13176	Complex (4)	Agric.-transp.- poss. ceremonial	M	M	M/H	+	-	+
	A Stepped terrace B Terrace C Modified outcrop D Steppingstone trail							
13177	Cairn	Indet. markers	L	L	L	-	-	-
13178	Complex (3)	Agriculture- poss. burial	M/H	L	L/H	+	-	+
	A Platform B Phh. excavation (2)							

***Cultural Resource Management Value Mode Assessment:**

Nature: R = scientific research
I = interpretive
C = cultural
Degree: H = high
M = medium
L = low

#Recommended Further Data Collection Field Work Tasks:

DR = detailed recording (scaled drawings, photographs, and written descriptions)
SC = surface collections
EX = test excavations

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
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 Platform (2) B Platform C Platform							
13182	Complex (2)	Agric.-marker	L	L	L	-	-	-
	A Cairn B Phh. excavation							
13183	Complex (5)	Habitation-agriculture-poss. burial	H	M	L/H	+	+	+
	A Lava tube cave B Pavement C Enclosure D Rock mound E Enclosure							
13184	Complex (2)	Land division	M	M/L	M	+	-	-
	A Wall B Wall remnant							
13185	Complex (40)	Agric.-poss. burial/ poss. habitation	H	M/H	M/H	+	-	+
	13 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							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13187	Complex (3)	Agriculture	M	L	L	+	-	-
	A Phh. excav. B Phh. excav. C Phh excav.							
13188	Complex (3)	Habitation	M	L	L	+	+	+
	A Cave B Terrace C Terrace							
13189	Complex (2)	Agriculture	M	L	L	+	-	+
	A Terrace B Terrace							
13190	Complex (30+)	Agriculture	M/H	L	L	+	-	+
	A Wall B Phh. excavation (2) C Modified outcrop D Phh. excavation (6) Plus ten rock mounds and ten phh. excav.							
13191	Cairn	Indet. marker	L	L	L	-	-	-
13192	Cairn	Indet. marker	L	L	L	-	-	-
13193	Mound	Poss. burial/ agriculture	L/M	L	L/H	+	-	+
13194	Steppingstone trail	Transportation	M/H	M	M/H	+	-	-
13195	Complex (2)	Historic marker	L	L	L	-	-	-
	A Cairn B Cairn							
13196	Complex (2)	Indet. marker	L	L	L	-	-	-
	A Cairn B Cairn							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13197	Steppingstone trail	Transportation	M/H	L	M/H	+	-	-
13198	Complex (2)	Indet. marker-quarry/agriculture	L	L	L	-	-	-
	A Cairn B Phh. excavation							
13199	Cairn	Recent marker	L	L	L	-	-	-
13200	Complex (2)	Agriculture	M	L	L	-	-	-
	A Rock mound B Rock mound							
13201	Trail	Transportation	M	L	M	+	-	-
13202	Complex (3)	Transportation-marker	M	L	M	+	-	-
	A Cairn (2) B Trail							
13203	Complex (2)	Agriculture/ poss. habitation	M/H	L	L	+	-	+
	A Terrace B Pavement							
13204	Steppingstone trail	Transportation	M	M	M	+	-	-
13205	Complex (2)	Habitation/ poss. ceremonial	H	M	M/H	+	-	+
	A Platform B Enclosure							
13206	Steppingstone trail	Transportation	M	M	M/H	+	-	-
13207	Complex (5)	Transportation-agriculture/ poss. habitation	M/H	M	M	+	+	+
	A Steppingstone trail B Terrace (3) C Terrace							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13208	Complex (4)	Agriculture-marker	L	L	L	-	-	-
	A Modified outcrop							
	B Cairn							
	C Cairn							
	D Cairn							
13209	Complex (56+)	Habit.-marker-agric.-transp.-poss. burial	H	M	M/H	+	+	+
	A Steppingstone trail							
	B Cairn							
	C Stepped terrace							
	D1 Terrace							
	D2 Platform							
	D3 Rock mound							
	E Platform							
	F Stepped terrace							
	G Modified outcrop							
	I Cairn							
	J Cairn							
	K Modified outcrop (3)							
	L Cairn (collapsed)							
	M Midden deposit							
	Plus 40+ Phh. excavations							
13210	Complex (3)	Habitation/agriculture	H	L	L	+	-	+
	A Platform							
	B Terrace							
	C Terrace							
13211	Complex (2)	Agriculture	M	L	L	+	-	-
	A Rock mound							
	B Terrace w/wall							
13212	Complex (8)	Agriculture-transportation	M	L	M	+	-	-
	A Phh./aa excavation							
	B Terrace (6)							
	C Kerbstone trail							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13213	Enclosure	Agriculture/ poss. habitation	M	L	L	+	-	+
13214	Complex (2)	Agriculture/ poss. habitation	M	L	L	+	-	+
	A Enclosure B Platform							
13215	Wall	Ranching	L	L	L	-	-	-
13216	Wall	Land division/ agriculture	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	+	-	-
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. excav.							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13223	Complex (4) A Enclosure B Platform C Terrace w/six cleared depressions D Platform	Agriculture/ habitation/ poss. burial	H	M	L/H	+	-	+
13224	Complex (28+) A Terrace Plus 19 phh. excav. and 8 rock mounds	Agriculture	M	L	L	+	-	-
13225	Complex (7) A Phh. excav. (3) B Linear rock mound Plus 3 circular rock mounds	Agriculture	M	L	L	+	-	-
13226	Complex (13) A L-shaped rock mound/wall Plus 7 phh. excav., 4 rock mounds, and 1 terrace	Agriculture	M	L	L	+	-	-
13227	Complex (120) 59 Circular rock mounds 48 Pahoehoe excavations 13 Linear rock mounds	Agriculture	H	M	M	+	-	+
13228	Enclosure	Indet./possible ceremonial	M/H	M	M/H	+	-	+
13229	Complex (10+) A1 Cairn w/3 enclosed phh. excavations A2 Modified pahoehoe excav. A3 Modified pahoehoe excav. A4 Modified pahoehoe excav. B Modified pahoehoe excav. Plus 5+ rock mounds	Agriculture	M	L	L	+	-	-
13230	Walled cave	Habitation	H	L	L	+	+	+

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13231	Complex (8+)	Agriculture	M	L	L	+	-	-
	1 Linear rock mound 7 Rock mounds							
13232	Complex (10)	Agriculture	M	L	L	+	-	-
	10 Phh. excavations							
13233	Complex (6+)	Agriculture	M	L	L	+	-	-
	3+ Linear rock mounds 3+ Rock mounds							
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							
13236	Complex (6)	Agriculture	M	L	L	+	-	-
	1 Linear rock mound 5 Rock mounds							
13237	Enclosure	Agriculture (recent)	L	L	L	-	-	-
13238	Complex (20)	Agriculture	M	L	L	+	-	-
	10 Phh. excavations 10 Rock mounds							
13239	Complex (33)	Agriculture	M/H	M	L	+	-	-
	A Wall B Cairn C Terrace Plus 20 phh. excav. and ten rock mounds							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13240	Complex (33+)	Agriculture	M	L	L	+	-	-
	20+ Rock mounds 10+ Phh. excavations							
13241	Complex (49)	Agriculture-poss. habit.	M	M	L	+	-	+
	A Terrace B Modified outcrop 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) (recent)	Habitation	L	L	L	-	-	-
	A C-shape B Hearth C Hearth D Wall							
13244	Kerbstone trail	Transportation	M	M/L	M	+	-	-
13245	Complex (3)	Marker-agriculture	L	L	L	-	-	-
	A Cairn (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							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13247	Complex (4)	Agriculture	M	L	L	+	-	-
	A Linear mound (2) B Cleared depression C Stepped terrace							
13248	Wall	Land division	M/H	M	M/H	+	-	-
13249	Complex (7)	Agriculture	M	L	L	-	-	-
	A Terrace B1 Terrace B2 Linear mound C Terrace D Terrace E Rock mound F Rock mound							
13250	Terraced rock mound	Agriculture	M	L	L	-	-	-
13251	Enclosure	Agriculture/ ranching	M	L	L	-	-	-
13252	Complex (17)	Agriculture- possible habitation	H	M	L/M	+	-	+
	A Faced mound B Faced mound C Enclosure D Faced mound E1 Walled pavement w/2 cairns and a rock mound E2 Cairn E3 Cairn E4 Phh excavation E5 Rock mound E6 Wall E7 Wall F Terrace w/central depression G Terrace H L-shaped wall I Pavement J Pavement K Rock mound							

Table 2. (cont.)

SIHP Site Number	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess.			Field Work Tasks		
			R	I	C	DR	SC	EX
13253	Complex (11)	Burial-transp.	H	H	H	+	-	+
	A Platform							
	B Platform							
	C Terrace							
	D Terrace							
	E Terrace							
	F Terrace							
	G Terrace							
	H Terrace							
	I Terrace							
	J Platform							
	K Steppingstone trail							
13254	Complex (74+)	Habit.-agric.-transp.- poss. burial	H	M	M/H	+	-	+
	A Terrace							
	B Terrace							
	C Terrace							
	D Faced mound							
	E Faced mound							
	F Terrace							
	G1 Terrace							
	G2 Terrace							
	H Terrace							
	I Wall							
	J Faced mound							
	K Terrace (3)							
	L Terrace							
	M Terrace							
	N Terrace wall							
	O Terrace							
	P Wall							
	Q Terrace							
	R Steppingstone trail							
	S Wall/terrace							
	T Faced mound							
	U Faced mound							
	V Platform							
	W Terrace							
	X Enclosure							
	Y Faced mound							

APPENDIX A

SITE DESCRIPTIONS

SITE NO.: State: 00002
SITE TYPE: Mamalahoa Trail
TOPOGRAPHY: Relatively flat aa, general area affected by bulldozing
VEGETATION: Trail surface covered with fountain grass; surrounding area devoid of vegetation
CONDITION: Fair to poor
INTEGRITY: Affected by vehicular traffic
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 1,220.20 m by 4.20 m by 0.20 m (approx.)
DESCRIPTION: Mamalahoa Trail is generally a graded kerbstone horse trail/road that was constructed under government direction during the nineteenth century. Portions of the trail follow a prehistoric transportation route. The portion of Mamalahoa Trail that is within the project area is constructed from cobble and pebble size aa pieces, and is raised slightly above the surrounding aa surface. The trail surface has been affected by vehicular use and presently has two parallel tire tracks and a raised, humped center. The *sides of the trail slope downward to the surrounding surface*, and there is little to no evidence remaining of the kerbstone alignments that are present along well-preserved sections of the trail.

SITE NO.: State: 13175 PHRI: T-1
SITE TYPE: Complex (8 Features)
TOPOGRAPHY: Located on a western-sloping mixed pahoehoe/aa flow
VEGETATION: Mango trees, koa-haole, lantana, grass, Christmas-berry, liliko'i, noni and kukui nut tree.
CONDITION: Poor-good
INTEGRITY: Unaltered
PROBABLE AGE: Historic (recent)
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall site area measures c. 90 m N-S by 80 m E-W. The complex consists of eight bifaced enclosures, each situated around a single mango tree. A single piece of unmodified coral was observed outside of one of the enclosures (Feature F). No cultural deposit was observed; however, medium brown loam is present inside all features. The site is within a cattle pasture and the enclosures were probably built to protect the mango trees from livestock damage.

FEATURE A: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 5.30 m by 5.10 m by 1.10 m maximum wall height
DESCRIPTION: Feature A is a circular enclosure with a mature mango tree located in the center. It consists of large to small aa cobbles; larger cobbles are at the base of the walls and the smaller cobbles toward the top. The walls are bifaced and slightly wider at the base. The eastern segment of the wall is collapsed in three places. The remainder of the wall is in excellent condition. Average wall thickness is 0.6 m. Diameter of the mango tree is 0.7 m.

FEATURE B: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 5.00 m by 4.60 m by 0.60 m maximum wall height
DESCRIPTION: This circular enclosure is located 44 m from Feature A at 245 degrees Az. It is situated around a mango tree (0.35 m in diameter). The walls are bifaced and consist of aa cobbles stacked three to four courses high. Larger rocks are at the base of the walls, which is slightly wider than the top. Wall thickness is 0.6 m at the top.

FEATURE C: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 6.30 m by 6.30 m by 0.90 m maximum wall height
DESCRIPTION: Feature C is located 27 m from Feature B at 198 degrees Az. It is a circular enclosure built around a mature mango tree (0.60 m in diameter). Construction is similar to Features A and B; aa cobbles are stacked three to four courses high, with larger rocks at the base of the bifaced walls. The western side of the enclosure is the longest segment of the wall still standing, measuring 3.6 m. The wall thickness is 0.80 m at the top.

FEATURE D: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 4.90 m by 4.90 m by 0.65 m maximum wall height
DESCRIPTION: This circular enclosure is located 22.5 m from Feature C at 259 degrees Az. The walls are bifaced, and constructed from aa cobbles stacked one to three courses high. Only the base of the wall remains intact. Cobbles have fallen both inside and outside of the wall. The wall thickness is 0.70 m. A mango tree 0.70 m in diameter is present in the center of the enclosure.

FEATURE E: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 6.40 m by 5.50 m by 1.05 m maximum wall height

DESCRIPTION: Feature E is 24.5 m from Feature D at 138 degrees Az. It is a circular, bifaced enclosure with a mature mango tree located in the center. It consists of stacked aa cobbles with a core filling of smaller aa cobbles. Twenty-five percent of the wall has collapsed; the remainder has only partial collapse. Cobbles have fallen both inside and outside of the wall. The wall thickness is 0.80 m.

FEATURE F: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 5.00 m by 5.20 m by 1.10 m maximum wall height
DESCRIPTION: This circular enclosure is located 24.5 m from Feature F at 159 degrees Az. The walls are bifaced and consist of stacked aa boulders and cobbles with a core filling of smaller cobble. A mango tree 0.60 m in diameter is inside the enclosure. One piece of unaltered coral was located one meter outside of the northern wall.

FEATURE G: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 5.30 m by 5.20 m by 1.00 m maximum wall height
DESCRIPTION: Feature G is 30.70 m from Feature F at 341 degrees Az. It is a circular, bifaced enclosure with a mature mango tree located in the center. The enclosure consists of aa boulders and cobbles stacked four to six courses high, with a core filling of small to medium aa cobbles. Average wall thickness 0.80 m.

FEATURE H: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 4.80 m by 4.70 m by 1.10 m maximum wall height
DESCRIPTION: This ia a circular, bifaced enclosure, located 15.80 m from Feature G and 202 degrees Az. It consists of aa boulders and cobbles stacked three to four courses high, with a core filling of medium aa cobbles. Average wall thickness is 0.60 m.

SITE NO.: State: 13176 PHRI: T-2
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: Along the western edge and slope of a prominent pahoehoe/aa ridge. The aa runs along the naturally stepped slope with pahoehoe on top of the ridge.
VEGETATION: Thick immature koa-haole, klu, airplant
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-possible ceremonial-transportation
DESCRIPTION: The complex consists of a stepped terrace (Feature A), a terrace (Feature B), a modified outcrop (Feature C) and a short steppingstone trail (Feature D). Overall site dimensions are 33.4 m E-W by 8.4 m N-S. A complete Cellana sp. shell was observed on Feature B; no other portable remains were identified.

This site is located very close to the northern boundary of Kealakehe Ahupuaa, on a prominent ridge that affords a view of the entire lower portion of the land division and an extensive section of coastline.

FEATURE A: Stepped terrace
FUNCTION: Possible ceremonial
DIMENSIONS: 8.40 m by 13.4 m by 1.8 m maximum height
DESCRIPTION: This feature consists of two levels; the upper terrace measures 6.1 m NE-SW by 4.3 m, and ranges in height from 1.0 to 0.7 m. The lower level extends 9.1 m northwest and 2.8 m southwest from the base of the upper level, and has an average height of 0.80 m. The feature incorporates a naturally bi-leveled aa flow escarpment. The upper level is roughly rectangular in shape, with three faced sides, and the lower level is semicircular, with faced sections of fill along the natural scarp. The lower level is present along the three sides of the upper level, and is absent on the northeast side. Soil was noted at the northeastern edge of the terrace, where the fill gradually thins to meet a pahoehoe surface.

The upper terrace consists of weathered aa boulders, cobbles and pebbles. The surface is level, and paved with small cobbles and pebbles. The structure is faced on the west, north, and south sides; walls are vertical and nicely faced. The west face of the upper terrace is 0.7 to 1.0 m high and the north face is 0.7 m high. The east side is a natural pahoehoe outcrop. The lower level on the northwest side is not as regularly paved, and the fill stones are larger and looser. A possible filled hole or excavation is present on the northwest side of the lower level.

At the western point of the upper level is a rectangular opening built into the fill. This opening measures 0.60 m by 0.45 m by 0.70 m deep and is cleared except for some cobbles that have fallen in. This hole may have been made when the terrace was filled. The sides of the hole are vertical and faced; the base is a natural surface of gravel-sized rocks. The west edge of the hole is 0.68 m from the edge of the terrace.

FEATURE B: Terrace
FUNCTION: Agriculture
DIMENSIONS: 15.24 m by 7.70 m by 1.03 m maximum height
DESCRIPTION: This terrace is semicircular and faced

along the west, south and southeast sides. The faced sides were apparently vertical, but have since collapsed. Intact wall sections exist at the southwest corner and along the southeast side. Up to seven courses of stone are present along the intact side wall sections. The terrace is consists of aa boulders and cobbles and is paved on the surface with aa cobbles and pebbles. Pavement and fill thin at the northwest and northern sides, where the terrace surface meets a pahoehoe surface. A complete Cellana sp. shell, with edges gone, is visible within the fill along the west face of Feature B.

FEATURE C: Modified outcrop
FUNCTION: Indeterminate
DIMENSIONS: 2.60 m by 2.50 m by 0.45 m maximum height
DESCRIPTION: This feature is located adjacent to the southeastern side of Feature A, along an exposed pahoehoe shelf. It consists of a depression in the pahoehoe that has been cleared, and an associated rock pile. The pahoehoe depression is 1.0 m E-W by 0.50 m N-S. The rock pile is adjacent to the east side of the cleared depression; it is 1.9 m N-S by 1.36 m E-W, and has a maximum height of 0.45 m. A small circular hole (0.18 m by 0.20 m) is located in the center of the rock pile.

FEATURE D: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 1.70 m by 0.56 m by 0.05 m
DESCRIPTION: A short stepping stone path extends eastward from the southeastern corner of the upper terrace level of Feature A. This path follows along the edge of the aa scarp and passes along the south side of Feature C. It ends 3.0 m west from Feature B. The path consists of four similarly-sized pahoehoe slabs set closely aligned on the aa surface.

SITE NO.: State: 13177 PHRI: T-3
SITE TYPE: Cairn
TOPOGRAPHY: In a depression on an aa flow which slopes gently to the southwest.
VEGETATION: Koa-haole, airplant and grasses.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Marker
DIMENSIONS: 1.00 m by 1.10 m by 0.85 m
DESCRIPTION: The cairn consists of small aa boulders and large cobbles stacked in a pyramid, roughly circular at the base. It is stacked six courses high. No trail or other features are in the vicinity of the cairn.

SITE NO.: State: 13178 PHRI: T-4
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: On a gently sloping pahoehoe flow; in area of exposed outcrops.
VEGETATION: Kiawe, fountain grass, lantana and succulents.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-possible burial
DESCRIPTION: The overall site dimensions are c. 8.0 m by 8.0 m. The complex consists of a platform (Feature A) and two pahoehoe excavations (Feature B). No portable remains were noted.

FEATURE A: Platform
FUNCTION: Possible burial
DIMENSIONS: 2.05 m by 2.00 m by 0.40 m maximum height
DESCRIPTION: The platform consists of a ring-like perimeter of pahoehoe slabs and boulders that is filled with pahoehoe cobbles and aa clinkers. The perimeter is a single course high, and the surface of the platform is relatively level.

FEATURE B: Pahoehoe excavations (2)
FUNCTION: Agriculture
DIMENSIONS: 7.00 m by 4.00 m by 0.85 m maximum height
DESCRIPTION: Two cleared pahoehoe excavations spaced 2.5 m apart on a north-south axis comprise this feature. The northernmost excavation is 2.5 m west of Feature A. It is 2.75 m N-S and 2.0 m E-W, and consists of a cleared area along the west face of an excavated outcrop. Maximum depth of the excavation is 0.43 m. The southern excavation is a circular blister with an opening 1.75 m E-W by 2.0 m N-S and a maximum depth of 0.85 m. The southern perimeter of the excavation is open, and the cleared area inside is heavily vegetated.

SITE NO.: State: 13179 PHRI: T-5
SITE TYPE: Wall
TOPOGRAPHY: Located on a SW - facing, gradual slope; immediate surface topography is irregular and both pahoehoe and aa lava flows are present.
VEGETATION: Kiawe, koa-haole, fountain grass, air plants, impatiens.
CONDITION: Excellent
INTEGRITY: Possibly altered with modern modifications
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Land division/ranching
DIMENSIONS: 244.00 m by 0.72 m by 1.56 m (approx.)

DESCRIPTION: This bifaced core-filled wall consists of pahoehoe cobbles and small boulders with a core fill of cobbles and pebbles. The wall is oriented north-south and continues beyond the project area to the north. The overall length given here includes only that portion within the project area. At the northern boundary, this wall intersects with the Site 13180 wall. An aluminum cattle gate is mortared into the wall at this intersection.

SITE NO.: State: 13180 PHRI: T-6,18
SITE TYPE: Wall
TOPOGRAPHY: Located on a SW-facing gentle slope with irregular surface topography of both pahoehoe and aa lava flows.
VEGETATION: Kiawe, koa-haole, fountain grass, lantana, air plants, noni, ferns, and Christmas-berry
CONDITION: Excellent
INTEGRITY: Possibly altered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Land division/ ranching
DIMENSIONS: 518.00 m by 0.58 m by 1.12 m (approx.)
DESCRIPTION: The wall is oriented on a NE-SW axis. The NE end of the wall is bifaced and made of small pahoehoe boulders to large cobbles, with a core fill of pahoehoe pebbles. The wall incorporates a natural pahoehoe barrier along the northeastern portion.

The SW portion of the wall runs along an aa flow, and consists of aa. It is built with aa cobbles and pebbles, with no size sorting between facing and fill stones.

No mortar was used to actually hold the wall together, only except where modern additions were found. It could not be determined if this was an old wall with modern alterations or if this is a later wall with these features built in.

The NE portion of the wall has a salt lick trough and a water trough built into the wall. The salt lick trough is inset into the pahoehoe blocks with dimensions of 0.92 m by 0.48 m by 0.14 m deep. A canopy is created over the lick using 2" X 5 1/2" posts inset into the mortar (the wood is hand carved to make it fit into the post hole). The two braces and a cross board support the metal sheeting used for the roof. Braces are made with 2" X 3" pieces of lumber. The tin roofing is 1.3 wide by 2.46 m long. The water trough is made of concrete and is 2.60 m by 1.22 m by 0.58 m. Two metal bars stretch across the opening in the wall, over the water trough.

A gate is located at the intersection between the northeastern end of this wall and the Site 13179 wall. This is a modern aluminum cattle gate. Concrete is used to make the frame for the closing side of the gate.

SITE NO.: State: 13181 PHRI: T-7 ***(Figure A-1)***
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: On the crest and upper west-facing slopes of a prominent pahoehoe ridge, along the northern boundary of Kealakehe.
VEGETATION: Kiawe, koa-haole, and fountain grass
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Possible burial
DESCRIPTION: The overall dimensions of this site are c. 40.0 m N-S by 15.0 m E-W. The site consists of four platforms. Two marine shell fragments were observed on Feature A.

FEATURE A: Platform (2)
FUNCTION: Possible burial
DIMENSIONS: 14.00 m by 7.00 m by 2.50 m maximum height
DESCRIPTION: Feature A consists of two adjacent platforms built of small boulders and medium to large cobbles of basalt. The platforms are located on top of a linear outcrop oriented north/south.

The north platform is roughly rectangular with a fairly flat and level surface, and faced on the NE, NW, and SE sides. The faces are three to six courses high (.40 to 1.25 m). The south and southwest sides are built against the central portion of the outcrop. The dimensions are 3.5 m N-S by 3.5 m E-W.

The south platform is also roughly rectangular and about 0.50 m lower on the outcrop than the north platform. The surface is also paved and leveled with large pahoehoe cobble fill. The structure is faced on the SW, NW and east sides with small boulders from two to four courses high (0.50 m to 0.75 m high). The south platform dimensions are 3.0 m N-S by 3.0 m E-W. Two pieces of marine shell were found on this feature.

FEATURE B: Platform
FUNCTION: Possible burial
DIMENSIONS: 6.80 m by 4.00 m by 1.50 m maximum height
DESCRIPTION: This D-shaped platform is located approximately 30 m from Feature A at 351 degrees Az. It consists of pahoehoe boulders and cobbles. The south and west sides of the platform are faced, and range in height from 1.5 m at the west end to 0.50 m at the south end. The north side of the platform abuts a relatively vertical bedrock face and has an average height of 0.90 m.

FEATURE C: Platform
FUNCTION: Possible burial

Figure A-1. SITE 13181, FEATURE A. VIEW TO SOUTHEAST (PHRI Neg. 1301-4)

DIMENSIONS: 5.80 m by 5.50 m by 1.50 m maximum height
DECRIPTION: Feature C is a D-shaped platform located 12 m from Feature C at 225 degrees Az. It consists of pahoehoe boulders to cobbles. The north, south and east sides of the platform are faced and the western, straight side abuts a nearly vertical bedrock face. The faced sides range in height from 1.5 to 0.70 m, and the west side averages 0.50 m high. A small rectangular depression 0.60 by 0.45 m is located at the eastern end of the platform.

SITE NO.: State: 13182 PHRI: T-8
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: On an exposed pahoehoe outcrop along a gentle, southwest-facing slope.
VEGETATION: 'Ilima, koa-haole, uhaloa, and fountain grass.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Marker-agriculture
DESCRIPTION: The overall dimensions of this site measure c. 12.0 m N-S by 12.0 m E-W. The site consists of a cairn and a pahoehoe excavation. No portable or cultural remains were observed.

FEATURE A: Cairn
FUNCTION: Marker
DIMENSIONS: 0.50 m by 0.50 m by 0.70 m
DESCRIPTION: The cairn consists of a loosely piled formation five courses high and made of pahoehoe cobbles. The cairn is situated on top of a pahoehoe outcrop and the area around it is paved with pebbles.

FEATURE B: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 4.50 m by 3.70 m by 0.25 m
DESCRIPTION: Feature B is located 8 m from Feature A at 352 degrees Az. The excavation is generally cleared of rocks, but the area around the excavation may have been paved.

SITE NO.: State: 13183 PHRI: T-9 *(Figure A-2)*
SITE TYPE: Complex (5 Features)
TOPOGRAPHY: In a narrow, collapsed lava tube and on a relatively flat aa flow
VEGETATION: Lantana, koa-haole, fountain grass, mango, kukui nut, vines, succulents, Christmas-berry, and air plant.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation-agriculture-possible burial
DESCRIPTION: The overall dimensions of this site measure c. 50.0 m N-S by 20.0 m E-W. The site consists of a modified lava tube, pavement, two enclosures and a rock mound.

FEATURE A: Modified lava tube
FUNCTION: Habitation-possible burial
DIMENSIONS: 32.00 m by 5.10 m by 2.00 m
DESCRIPTION: This feature was previously recorded as Site 12 by Hammatt, Schidler and Borthwick (1987) during a survey of an adjacent project area to the east. It consists of a collapsed lava tube with a overhang and cave at the southwest end. The tube has been modified with pavement, rock fill, terracing and stacked walls. The entrance to the cave at the southwest end of the tube is currently blocked off by a wall-like pile of aa rubble. To either side of the cave mouth is a cleared, paved area that is protected by a pahoehoe overhang.

A one meter square test unit was excavated by Hammatt et al. near the center of the overhang floor, just inside the drip line. Two soil layers were identified; the uppermost consisted of the pavement fill with loose dark brown silt. This layer was 0.05 m thick and contained 10 volcanic glass flakes, marine shell, charcoal and echinoid (Hammatt et al. 1987:39). The second layer averaged 0.15 m thick and consisted of dark grayish-brown silt loam with marine shell midden, 29 volcanic glass flakes and one core, three bone picks, and fish and pig remains. The feature was interpreted as a probable habitation and work area (Hammatt et al. 1987:39).

FEATURE B: Pavement
FUNCTION: Agriculture/habitation
DIMENSIONS: 8.50 m by 8.00 m by 1.00 m
DESCRIPTION: Feature B is located immediately to the south of the collapsed lava tube, on the aa flat. The south end of the feature has been scraped away by a bulldozer, and this side may have been terraced prior to disturbance. The east edge is bounded by a smooth pahoehoe flow and the west side is bounded by a bulldozed pile of large boulders. The south portion of the pavement is densely packed pahoehoe cobbles. Other portions are sparsely paved with pahoehoe cobbles and gravel.

FEATURE C: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 2.60 m by 2.20 m by 0.45 m maximum height
DESCRIPTION: This enclosure is located 38 m from Feature A at 8 degrees Az. It stands on and incorporates a natural aa rise, and is currently in very poor condition. Three mango trees are growing in the center of the enclosure. A 1.2 m section along the southern end is still intact and

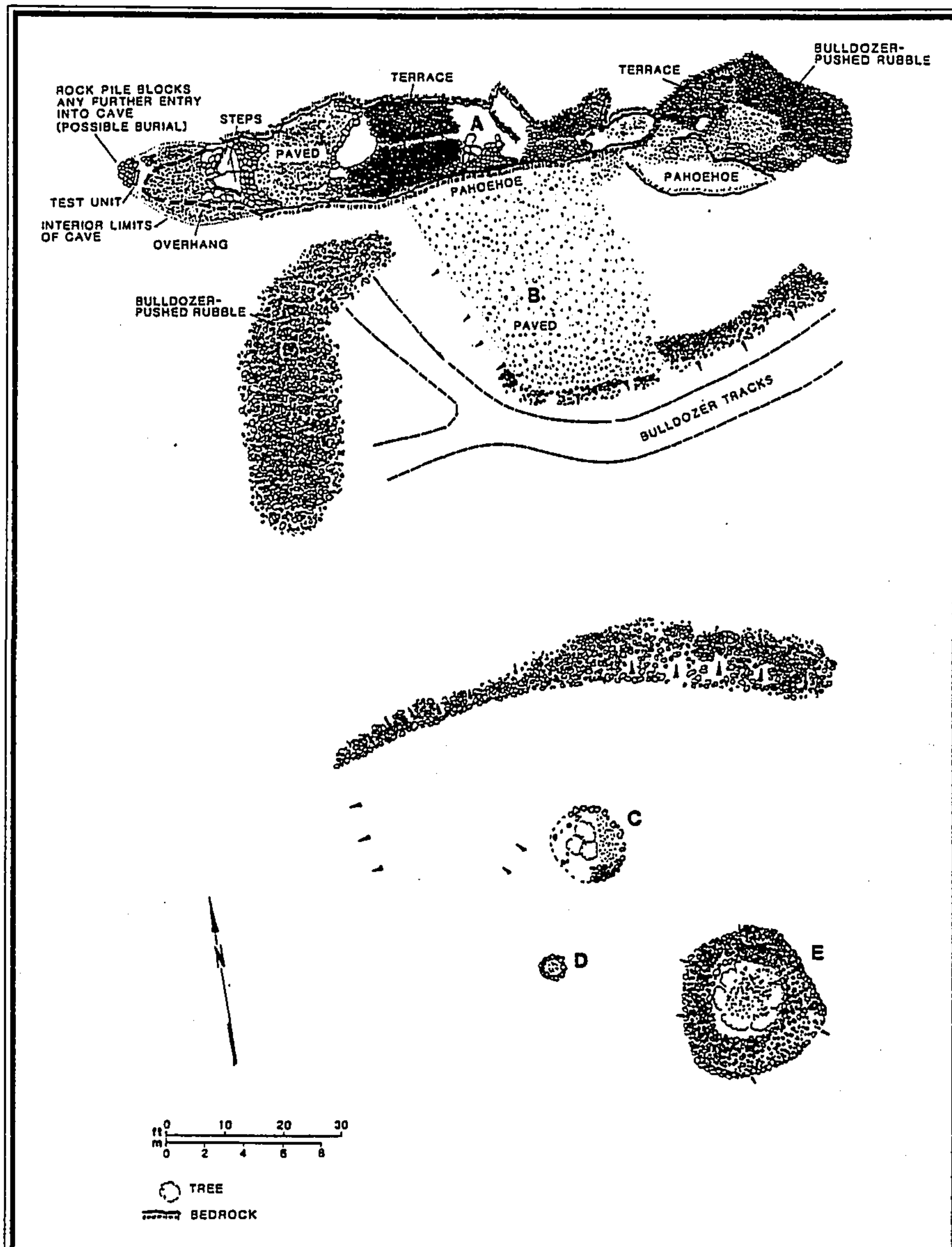

Figure A-2. SITE 13183

consists of two to three courses of aa cobbles. The remainder of the enclosure consists of a single course of aa cobbles which do not form an entire ring. Rubble created from the collapse of the wall extends c. 1.0 m along the interior side of the enclosure wall.

FEATURE D: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 2.60 m by 1.80 m by 0.50 m maximum height
DESCRIPTION: This small mound is located 4 m from Feature C at 20 degrees Az. The perimeter consists of pahoehoe and aa boulders, and the fill consists of pahoehoe cobbles and aa clinkers. The mound is circular and has a flat, paved surface. The perimeter stones are stacked one to two courses high, and height varies from 0.2 to 0.5 m.

FEATURE E: Enclosure
FUNCTION: Agriculture/habitation
DIMENSIONS: 9.80 m by 9.50 m by 1.10 m maximum height
DESCRIPTION: This disturbed enclosure is located 7.10 m from Feature C at 135 degrees Az. Only a portion of the wall along the northeast side of the enclosure is intact; all other sections are collapsed. *The intact portion of the wall* is faced on the exterior side and consists of aa cobbles, stacked 4-5 courses high. This section is 5.00 m long, 2.00 m wide and 1.10 m high. Overall shape of the feature is indeterminate; however, estimated interior dimensions are 5.30 m N-S by 4.47 m E-W.

SITE NO.: State: 13184 PHRI: T-10
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Uneven aa and pahoehoe flows; some alteration from bulldozing in immediate area.
VEGETATION: Koa-haole, kukui nut, Christmas-berry, air plant, fountain grass, and kiawe.
CONDITION: Good to poor
INTEGRITY: Feature A unaltered, Feature B dismantled
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Land division
DESCRIPTION: The site consists of a standing rock wall (Feature A) and the remnants of a dismantled rock wall (Feature B), which runs parallel to Feature A, along its west side.

FEATURE A: Wall
FUNCTION: Land division
DIMENSIONS: 1311.00 m N-S; 427.00 m E-W by 0.70 m by 1.15 m max. ht.
DESCRIPTION: The N-S section of this wall spans the entire width of the Kealakehe Ahupuaa, at or just above the 183.0 m (600 ft) elevation contour. The southern end of the wall connects with the boundary wall between Kealakehe and Keahuolu. At the northern end, the wall turns toward the east and continues 427.0 m to the existing housing subdivision. The eastern end of the wall is broken, and it is likely the wall continued mauka beyond its current location. The wall is double-faced with core filling, and is slightly wider at the base. The basal width averages 0.70 m, whereas the top width averages 0.55 m. It consists of pahoehoe and aa boulders and large cobbles, stacked five to nine courses high; smaller cobbles and pebbles were used for core fill. The wall is in generally very good condition; only one or two areas of collapse were noted along the N-S section.

FEATURE B: Wall remnant
FUNCTION: Land division
DIMENSIONS: 1311.00 m by 1.20 m by 0.60 m maximum height
DESCRIPTION: This is the basal remnant of a wider wall, located 2 to 3 m west of and parallel with the N-S section of Feature A. It currently consists of a base and associated rubble, which varies in height from 0.20 to 0.60 m. Portions of the wall remnant have been breached by bulldozers, but sections were observed across the entire width of the ahupua'a. It is possible that many of the stones in this feature were borrowed for construction of the more recent wall.

SITE NO.: State: 13185 PHRI: T-11
SITE TYPE: Complex (40 Features)
TOPOGRAPHY: In and along the sides of a distinct ravine which has vertical to steep sloping sides of pahoehoe and pockets of aa.
VEGETATION: Koa-haole, air plant, and lantana.
CONDITION: Good
INTEGRITY: Unaltered except by bulldozer
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-poss. burial/poss. habitation
DESCRIPTION: The overall site dimensions are c. 140 m E-W by 40 m N-S. The site consists of 13 faced terraces, 12 modified outcrops, 12 rock mounds, two+ pahoehoe excavations, and one cairn. The terraces and modified outcrops are generally located along the sides of the ravine, whereas the rock mounds are along the center. There were no portable remains or cultural deposits observed, however, soil is present at most features.

FEATURE - : Faced terraces (13)
FUNCTION: Agriculture/poss. burial/poss. habitation
DESCRIPTION: The terraces consist of aa and pahoehoe cobbles and pebbles, and range in height from 1.04 to 1.97 m. These features are built on natural shelves along the sides of the ravine and are generally elliptical. The faced sides exhibit very formalized, vertical stacking, and the

surfaces are leveled and paved. Length varies from 5.00 to 12.00 m along an east-west axis, and width varies from 1.0 to 3.0 m. The terraces are most concentrated near the center of the site, where the ravine is narrowest (9.00 to 14.00 m wide). There are slightly more terraces on the south side of the ravine.

FEATURE - : Modified outcrops (12)
FUNCTION: Agriculture/poss. habitation
DESCRIPTION: Many modifications are present on both pahoehoe and aa outcrops within the site. These include cleared and filled depressions, alignments along the edges of outcrops, and leveled aa deposits.

FEATURE - : Rock mounds (12)
FUNCTION: Agriculture/poss. habitation
DESCRIPTION: The rock mounds exist primarily in the center of the ravine, and most exhibit at least one or two faced sides. Shape of the mounds varies considerably; some exhibit nearly squared corners, whereas others are oval to round. Height of the mounds ranges from 0.85 to 1.24 m. Length ranges from 2.4 to 5.0 m, and width ranges from 1.6 to 4.6 m. The surfaces of the mounds are irregular, and most consist of aa cobbles, with no distinguishable core fill.

FEATURE - : Pahoehoe excavations (2+)
FUNCTION: Agriculture
DESCRIPTION: These two pahoehoe excavations are located out of the ravine, immediately to the south. They consist of excavated blisters that exhibit no formalized modification. Excavated blocks are scattered about the perimeters of the cleared holes. It is likely additional excavations exist in the area.

FEATURE - : Cairn
FUNCTION: Agriculture/marker
DESCRIPTION: The cairn is located in the western portion of the site, near the center of the ravine. It consists of pahoehoe slabs and aa cobbles. It is 0.56 m high and 0.90 m wide at the base.

SITE NO.: State: 13186 PHRI: T-12
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Exposed aa flow with lower vegetated aa flows on the north, east and south sides; gentle slope on the southwest side.
VEGETATION: Koa-haole, air plant, alahe'e, vines, lantana.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-transportation
DESCRIPTION: The overall site dimensions are c. 75.0 m N-S by 20.0 m E-W. The site consists of a steppingstone trail (Feature A) and an enclosure (Feature B). Marine shell midden was observed at Feature B.

FEATURE A: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 18.50 m by 0.40 m by 0.15 m
DESCRIPTION: The identifiable portion of this trail crosses an aa flow, and is distinguishable as a cleared path with larger aa slabs imbedded as stepping stones. The trail has some curves but generally runs NW-SE (340 degrees Az.). A few scattered pieces of *Conus* shell were observed along the trail.

FEATURE B: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 3.75 m by 3.40 m by 1.00 m maximum height
DESCRIPTION: This roughly square enclosure is located c. 50.0 m from Feature A at 130 degrees Az. It consists of aa boulders and cobbles, stacked three courses high, and one to two stones wide. Wall height ranges from 0.55 to 1.00 m, with maximum height at the northern corner. The surface inside the enclosure consists of aa rubble fill. A 1.30 m long section in the center of the northwestern wall is down, and it is uncertain whether there was a formal entranceway here at one time.

Two meters to the northeast is a stone alignment of aa boulders and cobbles. The alignment is roughly stacked and not faced; it is oriented N-S, and curves to the east at the southern end. The alignment is 6.00 m long, averages 0.75 m wide, and varies in height from 0.60 to 0.40 m.

SITE NO.: State: 13187 PHRI: T-13
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: Irregular pahoehoe flow with slight slope to the southwest.
VEGETATION: Koa-haole, alahe'e and grasses.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall site dimensions are c. 75.0 m N-S by 20.0 m E-W. The site consists of three pahoehoe excavations. No portable remains or cultural deposits were observed.

FEATURE A: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 8.90 m by 6.80 m by 0.95 m maximum depth

The excavated area of this feature is roughly oval. Excavated pahoehoe blocks are loosely stacked and arranged primarily on the southeast and north sides of the excavation.

FEATURE B: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 3.25 m by 2.70 m by 0.70 m maximum depth
DESCRIPTION: This excavation is 15.5 m from Feature A at 100 degrees Az. It is roughly oval and the excavated blocks are stacked mainly on the west and east sides of the excavation.

FEATURE C: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 8.70 m by 5.50 m by 0.90 m maximum depth
DESCRIPTION: This excavation is immediately to the south of Feature B. It is also roughly oval with excavated blocks stacked mainly on the south and east sides.

SITE NO.: State: 13188 PHRI: T-14 ***(Figures A-3/A-4)***
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: In a partially collapsed lava tube and shallow ravine in pahoehoe; general topography gently slopes to the southwest.
VEGETATION: Koa-haole, fountain grass, Christmas-berry, air plant, vines and kiawe.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation/ agriculture
DESCRIPTION: The overall site dimensions are c. 21.0 m E-W by 5.0 m N-S. The site consists of a cave (Feature A) and two terraces (Features B and C). Subsurface testing was conducted at Feature A, where midden, artifacts and soil deposits were found.

FEATURE A: Cave
FUNCTION: Habitation
DIMENSIONS: 17.00 m by 4.50 m by 1.00 m maximum ceiling height
DESCRIPTION: The cave consists of two interconnecting tube sections separated by a low ceiling and stacked rocks. The west tube is 9.7 m long by 2.0-3.0 m wide, and the east tube is 13.0 m long by 2.0-3.0 m wide. Both tubes have ceiling heights ranging from 0.40 to 1.0 m. Access to both sections of the cave is through a centrally located vertical opening in the tube ceiling. The entrance is 1.80 E-W by .70 N-S. Ceiling height at the entrance is 1.0 m. A series of pahoehoe slabs is stacked below the opening in order to aid access to the cave. Portable remains including shell fragments, coral and soil deposits containing charcoal were observed on the cave floor prior to testing.

Two 1 by 1 m. test units were excavated in the cave, one in each of the chambers. The units were located on either side of the entrance, where soil and midden accumulation appeared to be thickest. Test Unit 1 was excavated in the eastern chamber. The deposit here was found to be 0.03 m thick and consisted of very loose, dark reddish-brown loam with lots of rootlets. Material recovered from screened soil includes nine volcanic glass flakes, burned and unburned kukui nutshell fragments, and a small amount of fragmented marine shell.

Test Unit 2 was excavated in the western chamber, 1.20 m away from Test Unit 1. The deposit here was found to be 0.08 m thick and was more compacted than the fill in Test Unit 1. A charcoal sample for dating was collected from Test Unit 2. This sample was submitted to Beta Analytic and was determined to be of modern age (BETA-34210).

FEATURE B: Terrace
FUNCTION: Agriculture
DIMENSIONS: 3.50 m by 2.90 m by 0.60 m maximum height
DESCRIPTION: This rectangular terrace is located 20.0 m from the opening of Feature A at 50 degrees Az. It is situated in a pahoehoe depression along the lower slopes of a shallow ravine. The terrace consists of small to medium pahoehoe boulders and cobbles, with perimeter stones slightly larger than surface fill stones. The perimeter is raised on the east, south and west sides, and has faced walls on the west and south sides. Maximum height (0.60 m) is at the southwest corner; the east and west sides are 0.35 to 0.40 m high.

FEATURE C: Terrace
FUNCTION: Agriculture
DIMENSIONS: 3.00 m by 3.00 m by 0.56 m maximum height
DESCRIPTION: This L-shaped terrace is located 5.0 m west of Feature B, in the same ravine setting. It consists of small to medium pahoehoe boulders, with slightly larger perimeter stones. The perimeter is raised on the east, south and west sides, but none of the sides is formally faced. Height varies from 0.20 to 0.56 m. A soil deposit which averages 0.05 m deep is present along the east side of the terrace.

SITE NO.: State: 13189 PHRI: T-15
SITE TYPE: Complex (2 Features)

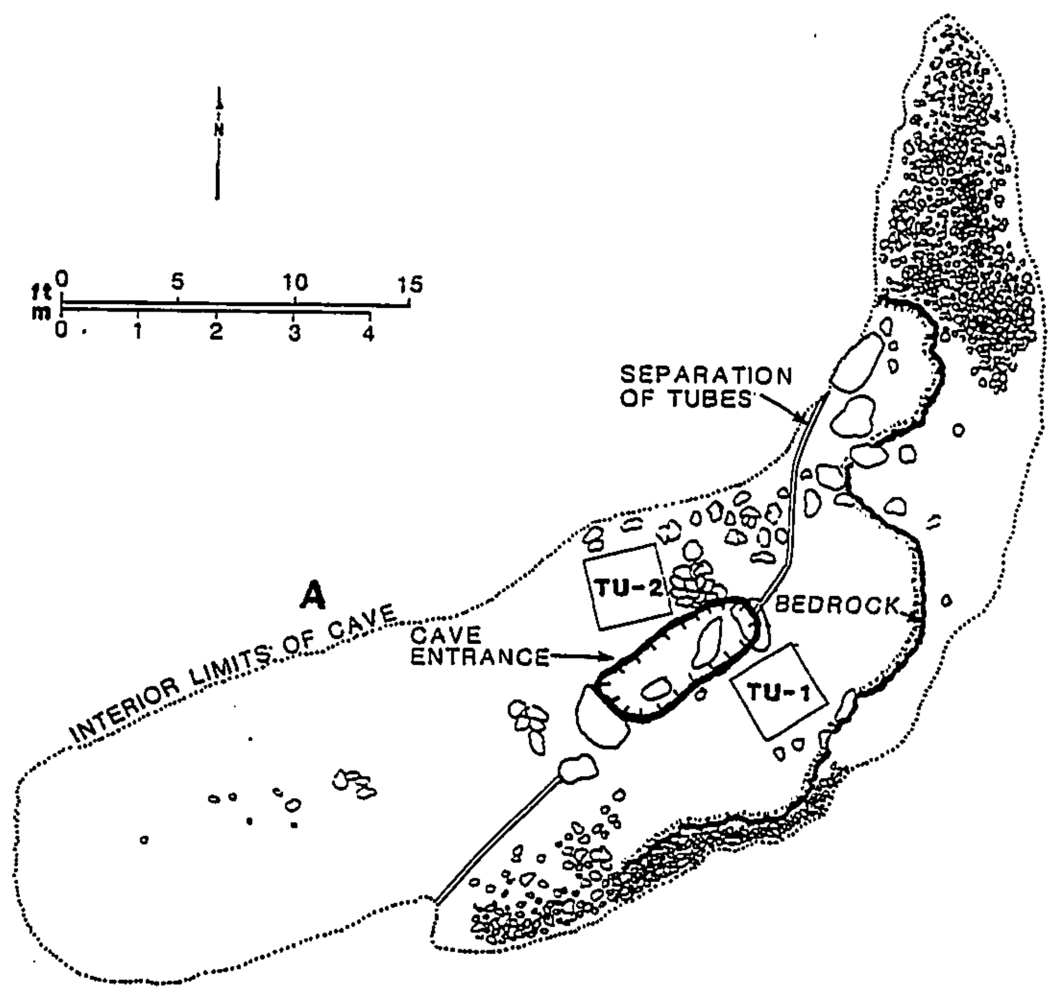

Figure A-3. SITE 13188, FEATURE A

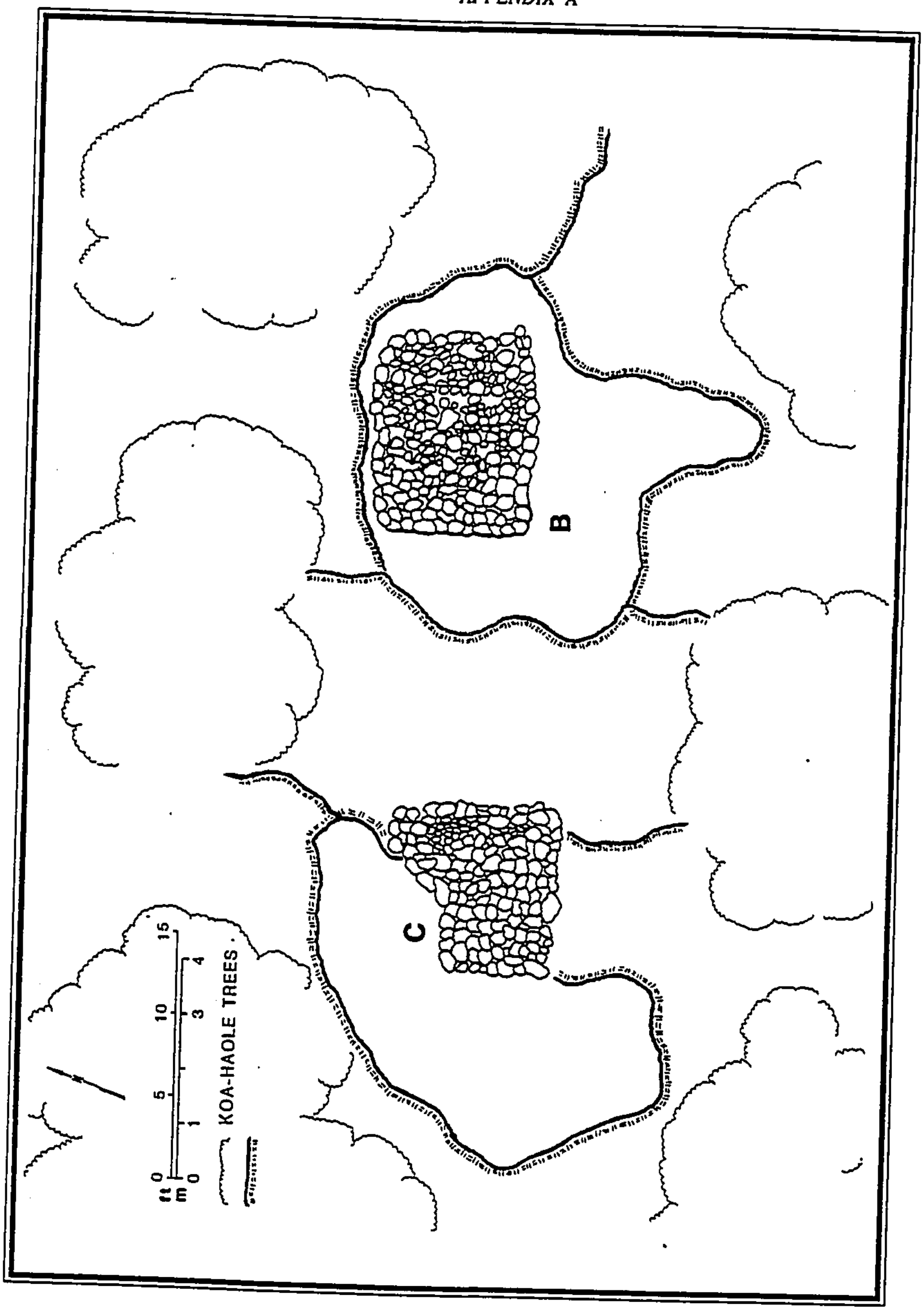

Figure A-4. SITE 13188, FEATURES B AND C

TOPOGRAPHY: On a gentle southwest facing pahoehoe slope.
VEGETATION: Koa-haole, fountain grass, air plant and alahe'e
CONDITION: Poor
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall site dimensions are c. 15.0 m NW-SE by 10.0 m SW-NE. The site consists of two terraces and a pahoehoe excavation. No portable remains or cultural deposits were observed.

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 7.20 m by 2.90 m by 0.45 m maximum height
DESCRIPTION: The terrace is adjacent to a pahoehoe excavation, which was apparently the source of building material. Pahoehoe boulders and cobbles were used in the perimeter, and the surface is paved with smaller pahoehoe pieces. Additional boulders are located to the southwest side of the terrace; these are currently scattered in no particular pattern.

FEATURE B: Terrace
FUNCTION: Agriculture
DESCRIPTION: This terrace is located 2.5 m from Feature A. Measurements could not be obtained due to the presence of a large wasp nest on the feature. The perimeter consists of pahoehoe boulders and cobbles and the surface is paved with pahoehoe cobbles and pebbles. The sides of this feature are formally aligned; however, no heights were obtained.

SITE NO.: State: 13190 PHRI: T-16
SITE TYPE: Complex (30 Features)
TOPOGRAPHY: On a southwest-facing, gentle slope with aa and pahoehoe.
VEGETATION: Koa-haole, fountain grass, alahe'e and kiawe.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall site dimensions are c. 41.30 m NE-SW by 10.0 m SE-NW. The site consists of a wall (Feature A), two pahoehoe excavations (Feature B), a modified outcrop (Feature C), a cluster of six pahoehoe excavations (Feature D), plus ten additional pahoehoe excavations and ten rock mounds. No portable remains or cultural deposits were observed; however, soil deposits were observed.

FEATURE A: Wall
FUNCTION: Agriculture
DIMENSIONS: 5.20 m by 1.00 m by 0.90 m maximum height
DESCRIPTION: This wall is at the highest point of the site, and overlooks the other features on the site. It is slightly curved and stands on an aa flow which appears to be leveled and paved with clinker to gravel rocks. The wall consists of stacked aa rocks and is oriented generally north-south. The west side is faced and the east side slopes outward from the top to the base; the top is irregular. There is no indication of core filling. The south end of the wall tapers down to the aa flow surface and the north end stops abruptly.

FEATURE B: Pahoehoe excavations (2)
FUNCTION: Agriculture
DIMENSIONS: 6.80 m by 3.60 m by 1.00 m maximum depth
DESCRIPTION: Feature B consists of two modified pahoehoe excavations situated side by side. They are located 39.30 m from Feature A at 40 degrees Az. Both excavations are roughly oblong and open to the west, roughly toward the downslope side. Both excavations are modified by stacking the excavated pahoehoe rock along the edges (inside and outside) and along the inside edges of a pahoehoe finger that divides the two features. The stacked pahoehoe cobbles vary in size from small to large. A soil deposit at least 0.15 m thick is present in the southern excavation, and there may be a layer of gravel in both excavations.

FEATURE C: Modified outcrop
FUNCTION: Agriculture
DIMENSIONS: 3.60 m by 3.60 m by 0.80 m maximum height
DESCRIPTION: This feature is located 11.0 m from Feature A at 115 degrees Az. It consists of an elliptical pahoehoe outcrop with pahoehoe boulders, slabs, and cobbles stacked below and on top of the edges to make a fairly level surface. The resulting configuration is terrace-like, and has a soil deposit c. 0.08 m thick on top. Immediately to the west side is a 3.2 by 2.8 m area of soil with an average thickness of 0.16 m. A few cobbles may have been placed along the west and northwest sides of this soil deposit.

FEATURE D: Pahoehoe excavation (6)
FUNCTION: Agriculture
DIMENSIONS: 15.40 m by 10.50 m by 2.00 m maximum depth
DESCRIPTION: Six pahoehoe excavations are clustered in this area, which is located 29.50 m from Feature A at 40 degrees Az. The excavations are present on a single outcrop and range in size from 0.88 m by 0.64 m to 5.80 m by

1.40 m. These excavations are located on the top, west, north and south sides of the pahoehoe outcrop. Adjacent to the excavations are large pahoehoe cobbles and small boulders, stacked up to three courses high. Soil deposits at least 0.08 to 0.12 m deep are present in the excavations.

FEATURE - : Rock mounds (10)
FUNCTION: Agriculture

FEATURE - : Pahoehoe excavations (10)
FUNCTION: Agriculture

SITE NO.: State: 13191 PHRI: T-17
SITE TYPE: Cairn
TOPOGRAPHY: On an aa ledge in a gently sloping aa field.
VEGETATION: Fountain grass, kiawe and Christmas-berry.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Marker
DIMENSIONS: 1.07 m by 0.83 m by 1.55 m maximum height
DESCRIPTION: The cairn consists of loosely stacked aa cobbles arranged in a conical shape. As a result of the configuration of the ledge on which it is located, the northwest side of the cairn is taller than the southeast side, which is 1.02 m high.

SITE NO.: State: 13192 PHRI: T-19
SITE TYPE: Cairn
TOPOGRAPHY: Top of a slight pahoehoe knoll; general area slopes to the southwest.
VEGETATION: Fountain grass, koa-haole and 'ilima.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Marker
DIMENSIONS: 2.20 m by 1.60 m by 1.20 m
DESCRIPTION: The cairn is pyramid-shaped and circular at the base. Fresh marks on the stones indicate possible historic construction.

SITE NO.: State: 13193 PHRI: T-20 *(Figure A-5)*
SITE TYPE: Faced rock mound
TOPOGRAPHY: Undulating pahoehoe flow sloping to the southwest; a steep slope directly to the southwest.
VEGETATION: Fountain grass, koa-haole and 'ilima.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Agriculture/possible burial
DIMENSIONS: 4.40 m by 4.30 m by 0.95 m maximum height
DESCRIPTION: This mound consists of loosely piled basalt cobbles and a few small boulders. It is generally circular and is rounded on the top. The east and south sides are faced with boulders, stacked 0.50 to 0.55 m high.

Two small cairns which appear very recent are located c. 15.0 m to the east and c. 20.0 m to the northeast.

SITE NO.: State: 13194 PHRI: T-21
SITE TYPE: Steppingstone trail
TOPOGRAPHY: The trail runs along the edge and across a major aa flow; in an area of pahoehoe outcrops and bulldozer disturbance.
VEGETATION: Fountain grass, koa-haole, 'ilima and morning glory vines.
CONDITION: Poor-fair
INTEGRITY: Unaltered except by bulldozer paths which cut across the trail.
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 374.00 m by 0.25-0.50 m(approx.)
DESCRIPTION: The trail consists of a cleared and packed path through the aa with spaced pahoehoe slabs that are inset into the aa. Most of the slabs are a minimum of 0.20 m and a maximum of 0.35 m in size. The rest of the slabs are small cobbles.

The western end of the trail is cut off by the Queen Kaahumanu Highway. Efforts to relocate it on the west side of the highway were unsuccessful. To the east of the highway, the Mamalahoa Trail appears to have crossed over this trail. To the east of the Mamalohoa Trail, it is broken by two different bulldozer paths over the aa. At the eastern end of the aa, the trail appears to make a sharp turn to the north. This turn may be an intersection between two trails; efforts to locate a continuation over the pahoehoe to the north and east were unsuccessful.

SITE NO.: State: 13195 PHRI: T-22
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Sllightly undulating pahoehoe flow; an aa flow c. 40.0 m to the north.
VEGETATION: Fountain grass, koa-haole and 'ilima
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Historic marker
DESCRIPTION: These cairns are located c. 9.0 m apart in a N-S line. They are possible survey markers.

Figure A-5. SITE 13193. VIEW TO WEST
(PHRI Neg. 1301-8)

FEATURE A: Cairn
FUNCTION: Historic marker
DIMENSIONS: 1.00 m by 0.80 m by 0.80 m
DESCRIPTION: This cairn is the northernmost of the two and consists of large aa cobbles, stacked with no apparent core fill. The cairn is pyramid shaped and circular at the base.

FEATURE B: Cairn
FUNCTION: Historic marker
DIMENSIONS: 1.10 m by 0.90 m by 0.70 m (approx.)
DESCRIPTION: This is the southernmost cairn; it consists of large aa cobbles and is pyramid shaped, with a circular base. The cairn is partially collapsed. This cairn appears to be located on the Mamalahoa Trail.

SITE NO.: State: 13196 PHRI: T-23
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Undulating pahoehoe terrain.
VEGETATION: Scattered Christmas-berry, alahe'e, koa-haole and small shrubs.
CONDITION: Poor-fair
INTEGRITY: Unaltered
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Marker
DESCRIPTION: Two cairns were identified at this site. They are located c. 3.00 m apart in an E-W line. They were possibly, constructed as survey markers or construction markers based on their close proximity to an east-west bulldozer path.

FEATURE A: Cairn
FUNCTION: Marker
DIMENSIONS: 1.45 m by 1.05 m by 0.60 m
DESCRIPTION: The eastern cairn consists of aa cobbles and small boulders, stacked with no indication of core fill.

FEATURE B: Cairn
FUNCTION: Marker
DIMENSIONS: 0.70 m by 0.70 m by 0.60 m
DESCRIPTION: The western cairn consists of aa cobbles and small boulders, stacked with no indication of core fill.

SITE NO.: State: 13197 PHRI: T-24
SITE TYPE: Steppingstone trail
TOPOGRAPHY: The terrain consists of an aa flow surrounding a 10.0 m wide pahoehoe flow. The flows are sloping seaward to the southwest.
VEGETATION: Scant scrub koa-haole with vines and grasses.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 40.00 m by 0.50 m by 0.10 m (approx.)
DESCRIPTION: The trail consists of a partially cleared and packed path across aa with randomly spaced pahoehoe slabs placed on the surface of the aa (not inset). The steppingstone slabs are small and average about 0.15 m by 0.15 m in size with an average thickness of 0.10 m. The steppingstones are irregularly spaced from 0.25 m to 1.0 m apart along the trail section. Many of the larger aa boulders and cobbles were left in place along the trail route.

The trail is oriented 180 degrees Az. and could be identified only where it crosses aa. Both ends as currently defined are at the north and south edges of the aa flow.

SITE NO.: State: 13198 PHRI: T-25
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Area of very irregular pahoehoe with scattered aa.
VEGETATION: Dense growth of koa-haole
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Marker-quarry
DESCRIPTION: A cairn (Feature A) and a pahoehoe excavation (Feature B) were identified at this site.

FEATURE A: Cairn
FUNCTION: Marker
DIMENSIONS: 1.77 m by 1.22 m by 1.38 m maximum height
DESCRIPTION: This feature consists of a naturally upthrusted pahoehoe slab on which are stacked two pahoehoe slabs. The dimensions include the natural feature. The height of the cairn varies from 0.70 m to 1.38 m.

FEATURE B: Pahoehoe excavation
FUNCTION: Quarry/agriculture
DESCRIPTION: The pahoehoe excavation is located 5.80 m from Feature A at 108 degrees Az.

SITE NO.: State: 13199 PHRI: T-26
SITE TYPE: Cairn
TOPOGRAPHY: On a southwest-facing aa flow.
VEGETATION: Sparse vegetation: Christmas-berry and fountain grass.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Recent historic
FUNCTIONAL INTERPRETATION: Recent marker

DIMENSIONS: 1.25 m by 1.20 m by 1.00 m
DESCRIPTION: The cairn consists of loosely piled aa cobbles and boulders, and has no core fill. A piece of lumber protrudes from the top, at the center of the cairn. The cairn is located adjacent to a bulldozer path and is probably associated with this feature.

SITE NO.: State: 13200 PHRI: T-27
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: In a valley formed by two aa ridges/ flows; scattered aa fingers overlying pahoehoe.
VEGETATION: Koa-haole, various grasses, prickly pear cactus, Christmas-berry and alahe'e
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Two rock mounds were identified at this site, within an area c. 9.80 m E-W by 3.0 m N-S.

FEATURE A: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 2.65 m by 2.20 m by 0.60 m maximum height
DESCRIPTION: This oval-shaped mound consists of small, loosely piled aa pebbles and cobbles.

FEATURE B: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 2.50 m by 1.99 m by 0.50 m maximum height
DESCRIPTION: Feature B is also oval-shaped and consists of aa pebbles and cobbles.

SITE NO.: State: 13201 PHRI: T-28
SITE TYPE: Trail
TOPOGRAPHY: Aa flow on a southwest-facing slope.
VEGETATION: Grass, koa-haole, 'ilima and morning glory vines.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: Length indeterminate; average 0.25 m wide
DESCRIPTION: This small footpath through aa is cleared and paved with packed aa clinkers. Tall grasses are growing in the trail at this particular point, whcih makes it easy to distinguish the trail from the flow.

Heavy vegetation and/or possible bulldozer destruction makes it difficult to determine the length of the trail. Possibly, this trail connects with the Site 13202 trail, located c. 152.00 m to the northeast. There has been a great deal of bulldozer activity within this immediate area.

SITE NO.: State: 13202 PHRI: T-29
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: On an aa flow, southwest exposure.
VEGETATION: Uhaloa, koa-haole, grass, vines, alahe'e, a'ali'i and Christmas-berry.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation-markers
DESCRIPTION: Two cairns (Feature A) and a trail (Feature B) were identified at this site. Considerable bulldozer disturbance has occurred in the immediate area of the site. Overall site area is c. 13.00 by 12.00 m.

FEATURE A: Cairns (2)
FUNCTION: Marker
DIMENSIONS: N cairn: 1.00 m by 1.00 m by 0.75 m. S cairn: 0.80 m by 0.60 m by 0.70 m.
DESCRIPTION: Both cairns consist of the same materials: loosely stacked aa cobbles and small boulders. The boulders range in size from 0.20 m minimum to 0.30 maximum. The cairns are c. 10.50 m apart, and both are located adjacent to the southwest side of the trail. The northern cairn is 0.10 m from the trail. The southern cairn is 0.20 m from the trail.

FEATURE B: Trail
FUNCTION: Transportation
DIMENSIONS: Indeterminate length, width averages 0.25 m
DESCRIPTION: The trail consists of a cleared path, paved with packed aa clinkers and pebbles. This feature may connect with trail Site 13202, located c. 152.0 m to the southwest.

SITE NO.: State: 13203 PHRI: T-30 ***(Figure A-6)***
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Along the northern face of a pahoehoe outcrop located in an aa flow; general exposure to the southwest.
VEGETATION: Koa-haole, a'ali'i, vines, lantana, 'ilima, uhaloa, and fountain grass.
CONDITION: Good to poor
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture/ possible habitation
DESCRIPTION: Overall complex area is c. 12.3 m N-S by 4.0 m E-W. Two features were identified: a terrace (Feature A) and a paved area (Feature B). No portable remains or soil deposits were observed.

FEATURE A: Terrace
FUNCTION: Agriculture/possible habitation

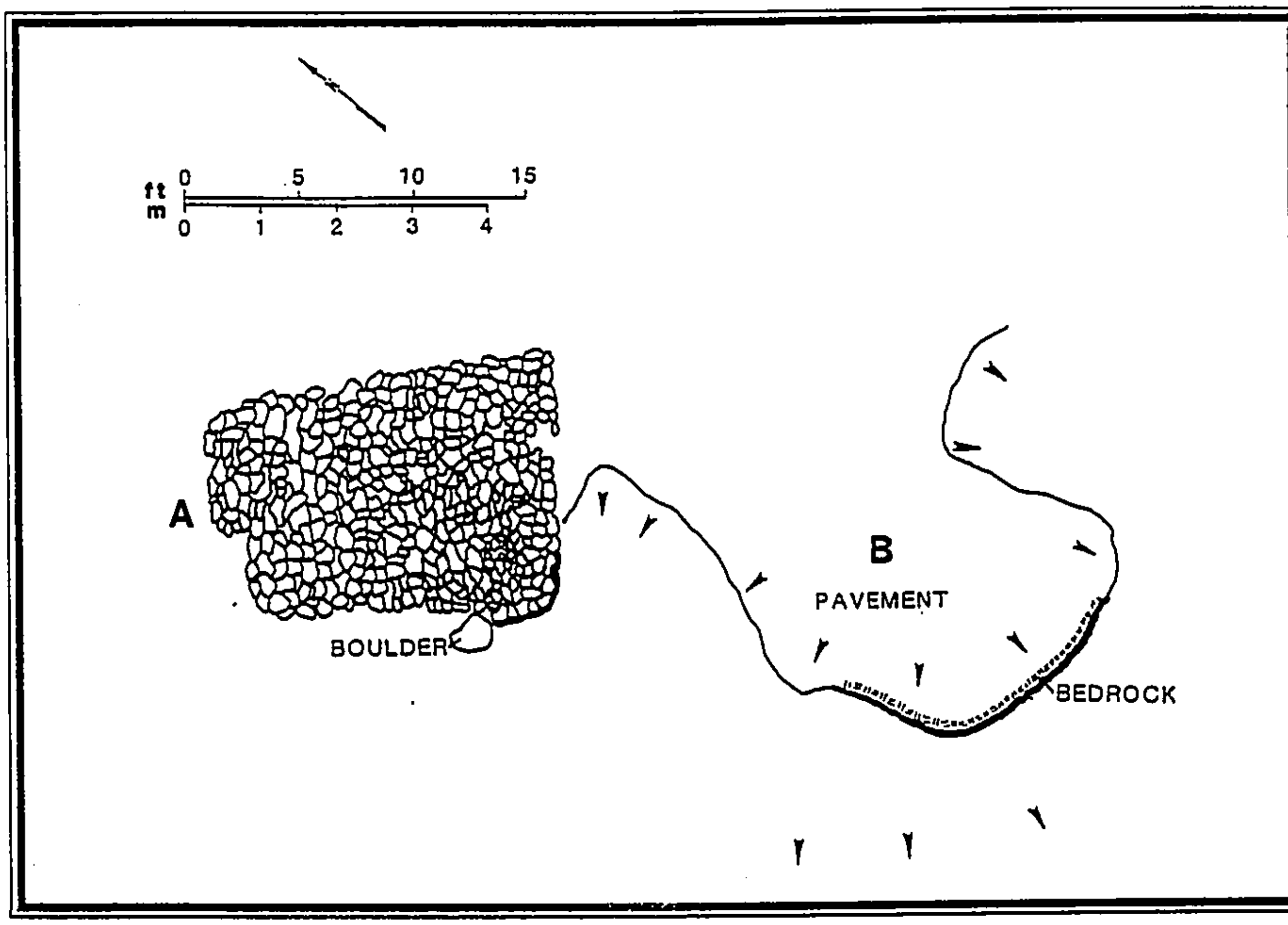

Figure A-6. SITE 13203

DIMENSIONS: 4.90 m by 4.00 m by 0.30 m maximum height
DESCRIPTION: Feature A is roughly rectangular, and consists of loosely stacked aa, large cobbles to small boulders. The terrace is faced on the northeast, southeast and southwest sides up to three courses high, although the facing is badly deteriorated. Maximum height is at the southern corner; minimum height (0.25 m) is at the west corner. The surface of the terrace is very uneven and has no indication of pavement.

FEATURE B: Pavement
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 6.60 m by 6.40 m by 0.75 m maximum height
DESCRIPTION: This pavement is located 3.0 m south of Feature A, on a slightly raised pahoehoe outcrop. It consists of aa pebbles and small cobbles that are slightly mounded. No definite perimeter is present; however, this feature may be a deteriorated terrace. The height of this feature varies from 0.50 m to 0.75 m.

There is evidence of paving surrounding Feature B on the south, west, and north sides. The paving is more like a path than an agriculturally paved area.

SITE NO.: State: 13204 PHRI: T-31
SITE TYPE: Steppingstone trail
TOPOGRAPHY: Undulating aa.
VEGETATION: Akia, koa-haole, a'ali'i, Christmas-berry, lantana and fountain grass.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 15.40 m by 0.84 m
DESCRIPTION: The trail is oriented NW-SE (308/128 degrees Az.). It consists of a cleared and packed path across aa with randomly spaced aa slabs set in the center of the path. The slabs range in size from 0.13 m by 0.15 m to 0.33 m by 0.46 m. The identifiable portion of the trail ends at the edges of the aa. This site may connect with the Site 13206 steppingstone trail, located c. 220.00 m to the south.

SITE NO.: State: 13205 PHRI: T-32 *(Figure A-7)*
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Top of aa flow ridge on the southwest edge of a high flow.
VEGETATION: Koa-haole, alahe'e, Christmas-berry, airplant, noni, fountain grass, scrub brush and one unknown tree.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation/possible ceremonial
DESCRIPTION: The site consists of a platform (Feature A) and an enclosure (Feature B). Overall site area is c. 30.0 m by 25.0 m. Portable remains observed include kukui nut shell adjacent to Feature A and a waterworn cobble, which is incorporated into the northwest wall of Feature B. A pahoehoe outcrop is incorporated into both features, and aa areas between the outcrop and the features are slightly cleared, with a few small boulders placed in gaps in the bedrock.

FEATURE A: Platform
FUNCTION: Habitation/possible ceremonial
DIMENSIONS: 6.00 m by 6.00 m by 1.05 m maximum height
DESCRIPTION: This is a roughly rectangular platform of aa boulders and cobbles. The southwest side is primarily natural aa outcrop with small boulders used as fill. The remaining three sides are faced. The southeast side is stacked three to seven courses to a maximum height of 1.05 m; this side is slightly collapsed. The northeast side is stacked three to four courses to a maximum height of 0.65 m. The northwest side is stacked one to three courses to a maximum height of 0.45 m.

The surface of the platform is generally flat and level. The northeastern portion is paved with aa cobbles. Kukui nut shells were found upslope against the side of the platform.

FEATURE B: Enclosure
FUNCTION: Habitation/possible ceremonial
DIMENSIONS: 15.50 m by 10.00 m by 1.10 m maximum wall height
DESCRIPTION: This enclosure is located 5.0 m from Feature A at 160 degrees Az. It is rectangular, and consists of aa boulders and cobbles. The intact portions of the walls are double-faced with aa cobble and small boulder core fill. Wall base boulders are up to 0.90 m in diameter.

The southeast wall is the best preserved portion of the enclosure. The wall facing was stacked three to six courses to a maximum height of 1.05 m and an average width of 1.10 m. The south corner is collapsed. The southwest wall has some remaining faced sections but is mostly collapsed. The average height is 0.50 m and the average width is 0.90-1.10.

There is a possible entrance in the southwest wall 5.0 meters from the west corner. It is a low cobble-filled area with a possible stepping stone. Some cobbles are located near the entrance.

A 2.0 m long section of the northwest wall is intact; the remainder is collapsed. The intact portion is stacked four courses to a maximum height of 0.95 m and a width of 0.65 m. The surface of the interior is irregular bedrock and loose rubble. Much of the loose rubble is probably from wall collapse.

SITE NO.: State: 13206 PHRI: T-33
SITE TYPE: Steppingstone trail
TOPOGRAPHY: Terrain consists of aa flow.
VEGETATION: Koa-haole, klu and Christmas-berry.
CONDITION: Excellent
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 29.00 m by 0.43 m by 0.40 m
DESCRIPTION: The trail is oriented in a SW-NE direction across an aa flow. It consists of thirty pahoehoe slabs placed on the aa surface. The slabs vary in size from 0.41 m by 0.32 m to 0.20 m by 0.18 m and the thickness ranges from 1.3 to 0.40 m. This trail may connect with the Site 13204 trail, located c. 220.00 m to the north.

SITE NO.: State: 13207 PHRI: T-35
SITE TYPE: Complex (5 Features)
TOPOGRAPHY: Gently sloping pahoehoe and aa flows with numerous pahoehoe blisters.
VEGETATION: Kiawe, koa-haole, lantana, fountain grass and ferns.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation-agriculture/poss. habitation
DESCRIPTION: The complex consists of a steppingstone trail (Feature A), a cluster of three terraces (Feature B) and a fourth terrace (Feature C). Overall site area is c. 30.0 m E-W by 26.0 m N-S. The terraces are arranged around the edges of an aa flow, and the steppingstone trail crosses over the aa and approaches the terraces from the north. Waterworn basalt pebbles and a marine shell fragment were observed at Feature B, and at least 3 cm of soil is present at this feature. Soil may be present on Feature C as well. There are many

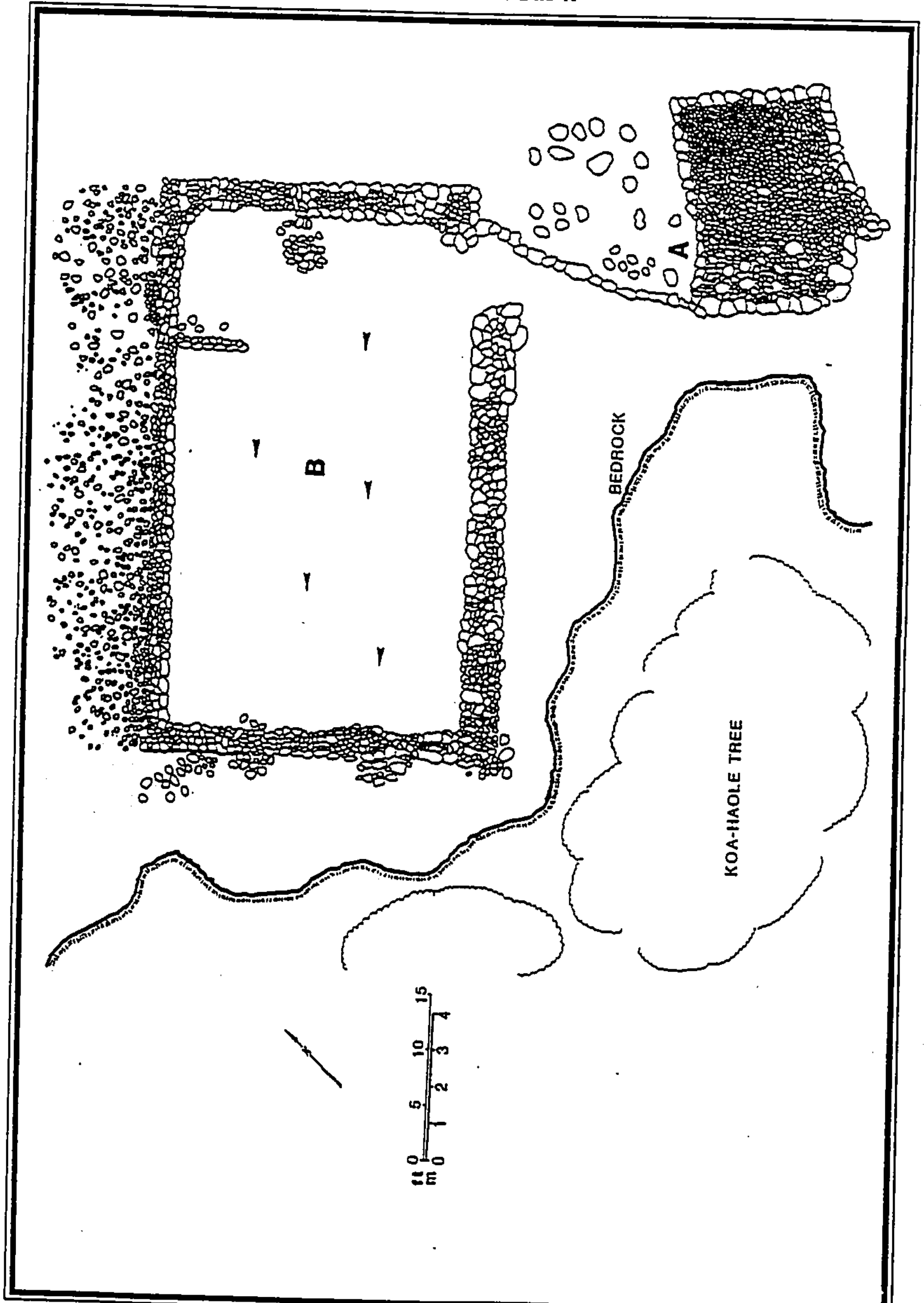

Figure A-7. SITE 13205

collapsed pahoehoe blisters in the area; these have been filled or capped with pahoehoe boulders and cobbles. Their function remains indeterminate at this time.

FEATURE A: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 18.90 m by 0.66 m
DESCRIPTION: The trail consists of a linear pattern of pahoehoe slabs that have been inset level with the aa surface. The trail is oriented generally north-south and the southern end is on the Feature B upper level terrace, 3.0 m west of the terrace wall.

FEATURE B: Terraces (3)
FUNCTION: Agriculture/possible habitation
DIMENSIONS: Overall 17.00 m by 13.50 m by 1.68 m maximum height
DESCRIPTION: This feature consists of three inter-connecting terraces arranged to form an arc around the side of an aa flow. The terraces are bordered by upright and stacked aa and pahoehoe ranging in size from large pebbles to small boulders.

The lower terrace is raised on the south and east sides to a maximum height of 0.74 m. The perimeters consist of stacked pahoehoe and aa boulders with several upright slabs incorporated into the sides. The surface is 3.80 m SW-NE by 3.60 m N-S. A soil deposit at least 0.03 m thick was observed on this terrace.

The upper terrace is divided into two parts by Feature A. It is mostly a natural aa shelf that has been leveled and outlined with aa and pahoehoe boulders, stacked one to two courses high. The stacked perimeters have a maximum height of 0.92 m. The surface area is 13.80 m E-W by 5.8 m N-S, one to two courses high. Two waterworn basalt pebbles and an unidentified marine shell fragment were observed on this terrace surface.

The smallest terrace measures c. 7.90 m (N-S) by 4.10 m (E-W) and is immediately adjacent to Feature A, which is to the west. The surfaces of the terraces are paved with small pebble to small cobble aa, some of which may be natural.

FEATURE C: Terrace
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 3.70 m by 3.50 m by 0.85 m maximum height
DESCRIPTION: This terrace is located along the southwest side of an aa outcrop, 3.00 m west of Feature B. The terrace is raised on the south and west sides, and the perimeter consists of stacked and upright aa with a single pahoehoe upright. The material used ranges from large pebbles to large cobbles. The interior of the terrace is paved with small pebble to medium cobble aa. No soil was observed on the terrace surface; however, it may be present beneath the pavement.

SITE NO.: State: 13208 PHRI: T-36
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: Situated on a high outcrop within a rough irregular pahoehoe flow.
VEGETATION: Koa-haole, grasses, scrub brush, noni and Christmas-berry.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-markers
DESCRIPTION: The site consists of a modified outcrop (Feature A) and three small rock piles that may be collapsed cairns. The overall site area is c. 18.0 m E-W by 6.0 m N-S. No soil or portable remains were observed on the site.

FEATURE A: Modified outcrop
FUNCTION: Agriculture
DIMENSIONS: 7.00 m by 5.00 m by 1.10 m maximum height
DESCRIPTION: The outcrop is a lava bubble which has a smooth and roughly level surface. Pahoehoe cobbles and boulders have been stacked along the west side of the outcrop, to a height level with the top of the blister (three courses). The stacked wall is 2.70 m long and has a maximum width of 1.30 m. Cobble and pebble fill is present to the east side of the wall, forming a terrace-like surface. Near the north edge of the outcrop there is an area of collapsed blister or possibly a pahoehoe excavation. The opening is 1.10 m (N-S) by 0.90 m (E-W). No modifications were noted in the blister, and only cow bones were observed.

FEATURE - : Cairns (3)
FUNCTION: Markers
DIMENSIONS: 1.00 m by 1.50 m by .40 m maximum height
DESCRIPTION: Three small rubble piles interpreted as possible collapsed cairns were located in the vicinity of Feature A. One of the piles is on the Feature A outcrop, 2.5 m southeast of the terrace fill. The largest pile is at the base of the Feature A outcrop, 3.0 m to the west. The third pile is located in a pahoehoe depression 18.0 m from Feature A at 140 degrees Az.

SITE NO.: State: 13209 PHRI: T-37,38
(Figures A-8 and A-9)
SITE TYPE: Complex (56+ Features)
TOPOGRAPHY: The terrain is a medium slope consisting of pahoehoe, aa flows and bedrock outcropping.
VEGETATION: Noni, kiawe, koa-haole, shower trees, fountain grass, lantana and air plants.
CONDITION: Good
INTEGRITY: Partially altered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation-agriculture-possible burial-marker-transportation
DESCRIPTION: Sixteen features were identified and measured within an area 135.00 m NE-SW by 30.00 m SE-NW at this site. An additional 40 pahoehoe excavations were observed, but not individually measured within the site area. Recorded features include a steppingstone trail (Feature A), four cairns (Features B, I, J, and L), three terraces (Features C, D1, and F), two platforms (Features D2 and E), four modified outcrops (Features G and K), a rock mound (Feature D3), and a surface midden deposit (Feature M). In addition to the midden observed at Feature M, thick soil deposits were observed at Feature K, and three waterworn basalt cobbles were observed on Feature D.

FEATURE A: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 15.60 m by 4.00 m by 0.30 m
DESCRIPTION: The identified portion of this trail crosses aa. It consists of randomly spaced pahoehoe slabs that are slightly inset into the aa surface. The trail is oriented generally east-west and appears to head toward Feature J, a cairn. A possible branch trail was identified at the west end of Feature A. This possible trail is a cleared path through the aa (no steppingstones) 0.30 m to 0.60 m wide. It is oriented north-south.

FEATURE B: Cairn
FUNCTION: Marker
DIMENSIONS: 1.27 m by 1.17 m by 0.61 m
DESCRIPTION: This feature is located 24.0 m southwest of Feature A on an aa flow. It consists of loosely stacked aa and pahoehoe chunks, and is conical, with a circular base. There may be some cobble core fill inside the structure.

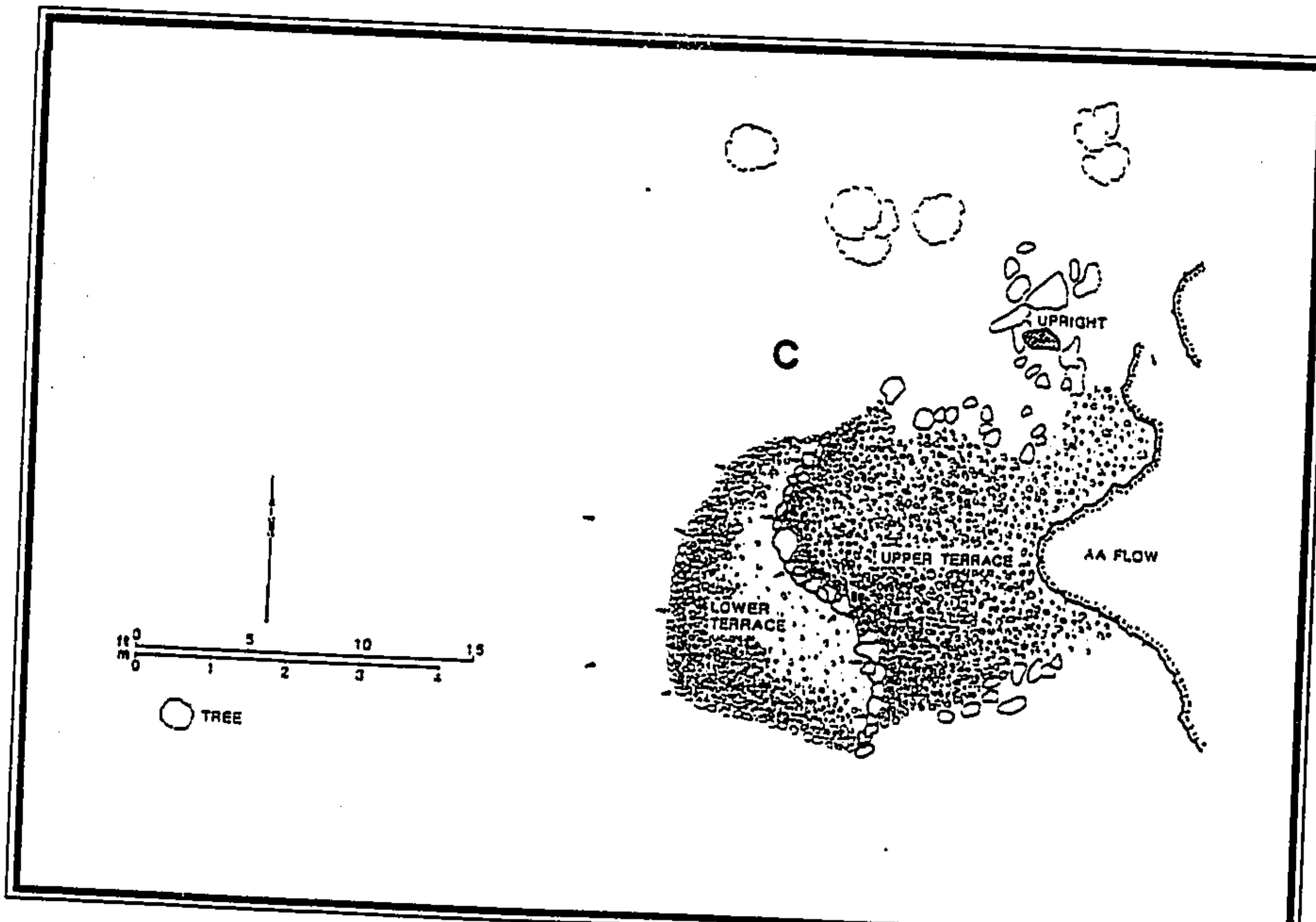

Figure A-8. SITE 13209

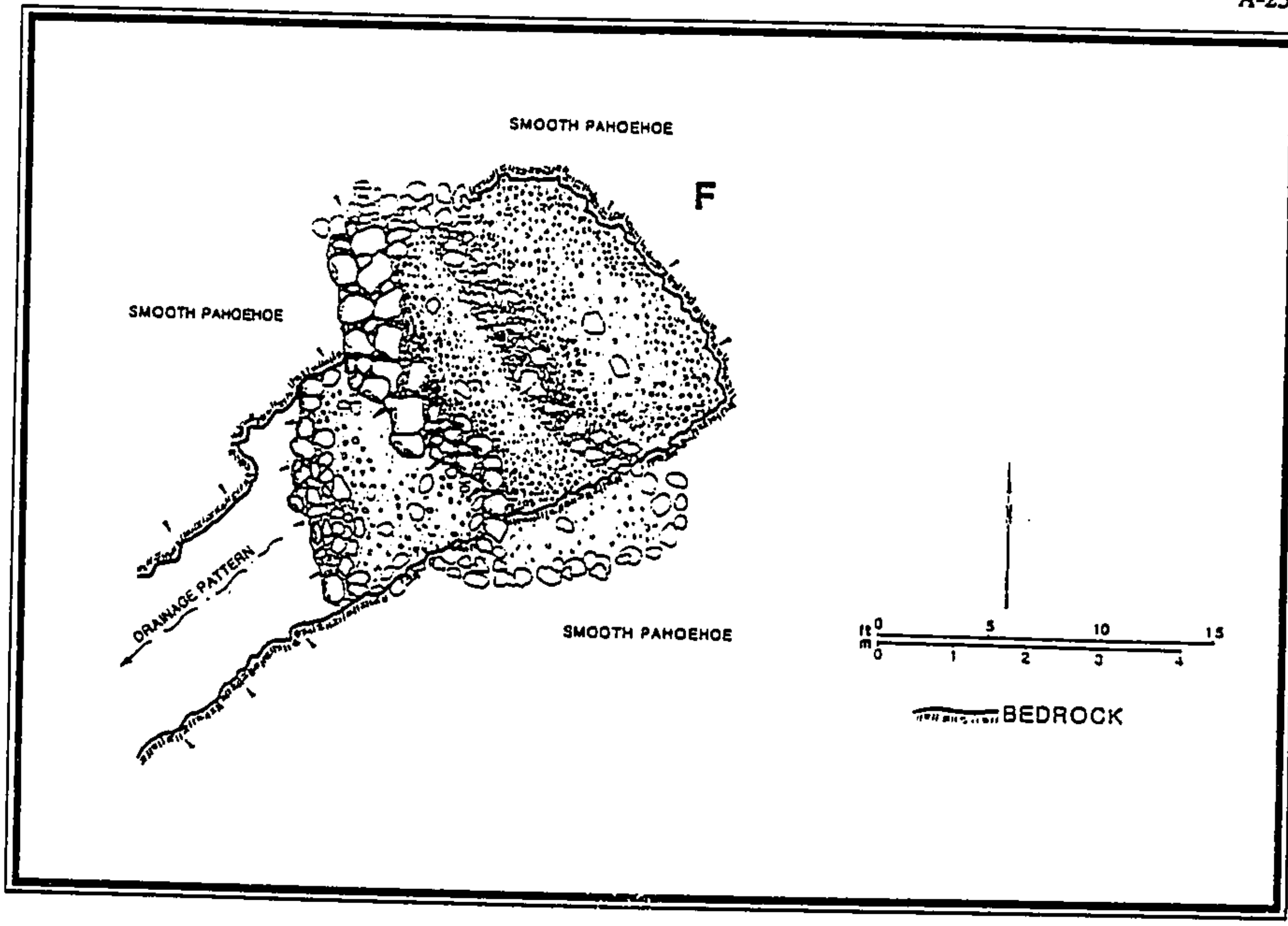

Figure A-9. SITE 13209

FEATURE C: Stepped terrace
FUNCTION: Agriculture
DIMENSIONS: 6.50 m by 5.50 m by 0.30 m maximum height
DESCRIPTION: Feature C is located 3.6 m from Feature B at 335 degrees Az. The terrace has two levels and is stepped with a single course alignment of pahoehoe and aa boulders. The lower level is semicircular and is situated along a sloping aa surface, which was leveled with aa clinkers and cobbles. The upper level is amorphous in shape, and follows the natural configuration of the aa outcrop. The surface is leveled with aa clinkers and cobbles. A pile of aa cobbles is present on the northern corner of the upper level. No soil was observed on the surface of this terrace.

FEATURE D1: Terrace
FUNCTION: Agriculture/habitation/possible burial
DIMENSIONS: 6.00 m by 8.80 m
DESCRIPTION: The Feature D structures are clustered in an area 5.8 m from Feature C at 192 degrees Az. The terrace is oval and consists of loosely piled pahoehoe and aa boulders and cobbles. The terrace is situated along the slope of an outcrop. The surface is leveled, but the sides are not faced. Three water worn basalt cobbles were found in the vicinity.

FEATURE D2: Platform
FUNCTION: Agriculture/habitation/possible burial
DIMENSIONS: 1.44 m by 0.91 m by 0.42 m maximum height
DESCRIPTION: This platform is located on top of the Feature D1 terrace. It is rectangular, and consists of aa and pahoehoe cobbles and boulders. The northeast side of the platform abuts a flow edge; the other three sides are raised one to two courses above the terrace surface.

FEATURE D3: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 2.20 m by 1.20 m by 0.58 m
DESCRIPTION: The mound is rectangular and located on the west corner of the terrace.

FEATURE E: Platform
FUNCTION: Habitation
DIMENSIONS: 8.05 m by 6.10 m by 1.20 m maximum height

DESCRIPTION: Feature E is located 29.5 m east of Feature D and 27.5 m south of Feature A. This platform is roughly rectangular, with a C-shaped notch in the north side. The notch is 2.00 m wide and has a maximum depth of 2.00 m. The platform consists of piled pahoehoe blocks and slabs ranging from small boulders to small cobbles; there is no obvious facing or stacking. Pahoehoe outcrops are scattered in the immediate area, and one is incorporated into the SE corner of the structure. There is a possible cupboard in the SE area of the C-shaped notch. A deposit of sandy loam at least 0.12 m thick is present inside the notch area.

FEATURE F: Stepped terrace
FUNCTION: Agriculture
DIMENSIONS: 6.35 m by 4.95 m by 1.45 m maximum height
DESCRIPTION: Feature F is located c. 60.0 m northeast of Feature E and 42.5 m northeast of Feature A. It is situated in a narrow draw between pahoehoe outcrops, and consists of an upper D-shaped terrace with a smaller step along the southwest side. The terrace perimeter consists of pahoehoe blocks and slabs, and aa cobbles. The sides are stacked and faced, up to four courses high. The terraces are paved in the interior with small aa pebbles and cobbles.

The upper terrace is 4.45 m N-S by 4.15 m E-W, and has an average height of 0.50 m above the lower level terrace. A low linear mound is present across the major axis of the upper level, near the center. The mound is 0.70 m wide and 0.15 m high and consists of piled aa and pahoehoe rock. The lower terrace is 2.55 m N-S by 1.95 E-W, and has a maximum height of 0.80 m above the lowest point of the draw.

A soil deposit at least 0.06 m thick was observed in the draw immediately to the southwest of the lower terrace, and it is likely that soil is present beneath the pavement fill of the terraces.

FEATURE G: Modified outcrop
FUNCTION: Agriculture/habitation
DIMENSIONS: 1.90 m by 1.19 m
DESCRIPTION: Feature G is located 30.0 m from Feature M at 260 degrees Az. It is the westernmost feature at Site 13209, and is c. 50.0 m northeast of Site 13208. It consists of a natural depression in a pahoehoe outcrop that has been filled with pahoehoe cobbles.

FEATURE I: Cairn
FUNCTION: Marker
DIMENSIONS: 0.62 m by 0.56 m by 0.38 m
DESCRIPTION: This cairn is located on aa, 13.5 m from Feature A at 248 degrees Az. It consists of about four aa cobbles and some clinkers, stacked in a roughly circular formation. The largest stone is situated on top of the stack.

FEATURE J: Cairn
FUNCTION: Marker
DIMENSIONS: 0.76 m by 0.74 m by 0.44 m
DESCRIPTION: Feature J is located on aa, c. 7.00 m northeast of Feature I. It consists of about ten small aa boulders and cobbles which are loosely stacked in a conical formation.

FEATURE K: Modified outcrop (3)
FUNCTION: Agriculture/habitation
DIMENSIONS: 13.00 m by 12.50 m by 1.60 m maximum height
DESCRIPTION: A cluster of three modified pahoehoe outcrops is situated near the center of the site, c. 10.00 m southwest of Feature D. The bedrock forms a naturally enclosed and terraced area that was enhanced by modifications. Pahoehoe blocks ranging in size from small boulders to small cobbles were used to fill gaps and extend the size of the enclosed area.

The interior of the enclosed area is an oval-shaped, flat pahoehoe surface 3.50 m N-S by 3.00 m E-W with a soil deposit. It is surrounded on three sides by a high, natural outcrop filled in three places with pahoehoe cobbles. A 1.00 m wide natural entrance into the enclosed area is present at the southeast corner.

About 3.00 m to the east of the enclosed area is a natural flat that has been cleared and modified. This area is 4.00 m NW-SE by 3.50 m NE-SW, and is depressed an average of 0.20 m below the surrounding pahoehoe. A soil deposit is present.

Situated immediately north of the modified flat, a second area has been leveled by the filling of depressions with pahoehoe cobbles. A soil deposit is present on this feature as well.

FEATURE L: Rock pile (collapsed cairn)
FUNCTION: Marker
DIMENSIONS: 1.50 m by 1.35 m by 0.38 m
DESCRIPTION: This small rock pile, or possible disturbed cairn, is located 5.00 m from Feature K at 210 degrees Az. It consists of about 18 small pahoehoe boulders and cobbles loosely clustered on the unbroken surface of a pahoehoe flow.

FEATURE M: Midden deposit
FUNCTION: Habitation
DIMENSIONS: 8.00 m by 5.60 m by 0.03 m maximum depth
DESCRIPTION: This shallow surface midden deposit is located 13.0 m west of Feature L. The deposit is present in a semicircular pahoehoe depression, and consists of marine shell fragments mixed with loamy soil. Thickness of the deposit varies from 0.01 to 0.03 m.

FEATURE - : Pahoehoe excavations (40+)
FUNCTION: Agriculture
DESCRIPTION: There are at least 40 additional pahoehoe excavations with associated rock piles in the area of the recorded features.

SITE NO.: State: 13210 PHRI: T-39
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: The immediate terrain consists of a southwest facing aa flow.
VEGETATION: Christmas-berry, koa-haole, air plants, alahe'e and vines.
CONDITION: Good to poor
INTEGRITY: Fair; Feature C altered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation/agriculture
DESCRIPTION: The overall complex area is c. 25.0 m E-W by 15.0 m N-S. Three features were identified, a platform (Feature A) and two terraces (Features B and C). In addition, small pockets of pebble paving are present between the features. No soil or portable remains were observed.

FEATURE A: Platform
FUNCTION: Agriculture/habitation
DIMENSIONS: 7.00 m by 6.10 m by 1.10 m
DESCRIPTION: The platform is roughly rectangular and is situated on a naturally raised aa outcrop. The perimeters are faced, and consist of aa boulders and cobbles, stacked above the level of the platform surface. The surface is paved with aa pebbles and is built up in the east corner. The remainder of the surface is depressed.

An alignment of aa rocks 1.46 m long extends southeast from the southeast corner of the platform to a paved area 6.0 m long by 4.0 m wide. The area is built beside a natural aa outcrop and paved mostly with aa pebbles. To the southwest of the paved area (2.00 m) is a mounded pavement.

A second alignment of aa boulders extends 5.00 m northwest from the northwest corner of the platform and connects with Feature C.

FEATURE B: Terrace
FUNCTION: Agriculture/habitation
DIMENSIONS: 6.70 m by 5.20 m by 0.30 m maximum height
DESCRIPTION: The terrace is located 5.00 m southeast of Feature A. It is rectangular, with the southeast and northeast sides defined by an aa flow edge. The southwest side of the terrace is raised and faced with aa boulders and cobbles stacked two to three courses high. The terrace surface is paved with aa pebbles and cobbles. The northwest side of the terrace abuts the paved area described above.

FEATURE C: Terrace
FUNCTION: Agriculture/habitation
DIMENSIONS: 3.80 m by 2.00 m by 1.30 m maximum height
DESCRIPTION: Feature C is located c. 5.00 m north of Feature A, along the southwest side of an aa outcrop. The terrace consists of small aa boulders and cobbles, and is raised and faced on the southwest side. Four to seven courses of aa boulders and cobbles are stacked up to 1.30 m high along the southwest face. The surface is paved with small to large cobbles and is roughly flat and level. The terrace has been disturbed on the northeast and southeast sides from bulldozer activity; it was probably larger than current dimensions indicate.

SITE NO.: State: 13211 PHRI: T-40
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: Undulating pahoehoe flow with a southwest slope.
VEGETATION: Kiawe, koa-haole, kukui, fountain grass, air plant and Christmas-berry.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: A rock mound (Feature A) and a terrace (Feature B) were identified within an area 32.00 m N-S by 18.00 m E-W at this site. No portable remains were observed; however, deposits of dark brown loam up to 0.08 m thick are present in and around the features.

FEATURE A: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 11.50 m by 9.25 m by 0.90 m maximum height
DESCRIPTION: This feature is a curved rock mound forming a roughly oval enclosure around a soil deposit. It consists of pahoehoe slabs and cobbles, and has two faced sections along the exterior southeast and southwest sides. Width of the mound ranges from 1.25 to 3.40 m. The area

inside the mound is 9.20 m N-S by 4.8 m E-W and has a soil deposit 0.02 to 0.08 m thick.

FEATURE B: Terrace with walls
FUNCTION: Agriculture
DIMENSIONS: 7.70 m by 6.30 m by 1.50 m
DESCRIPTION: Feature B is located 9.00 m north of Feature A, at the head of a natural pahoehoe channel. The terrace consists of large boulders to small cobbles of basalt. The western side of the terrace lies across the channel, which is c. 6.0 m wide at this point. The west face is stacked seven courses high and is partially collapsed. The top of the terrace is paved with small to medium cobbles.

To the west of the terrace, two walls are located along the sides of the channel. These walls are 3.00 m long and consist of pahoehoe boulders and cobbles stacked up to five courses high.

SITE NO.: State: 13212 PHRI: T-41
SITE TYPE: Complex (8 Features)
TOPOGRAPHY: The terrain is irregular pahoehoe and aa with a general southwestern exposure.
VEGETATION: Kukui, Christmas-berry, koa-haole, airplant, vines and alahe'e.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric - historic
FUNCTIONAL INTERPRETATION: Agriculture-transportation
DESCRIPTION: This complex includes a pahoehoe excavation (Feature A), a cluster of six terraces (Feature B), and a kerbstone trail (Feature C). Overall site area is c. 62.0 m NE-SW by 43.20 m NW-SE. No portable remains were observed on the site; however, a horseshoe was noted c. 15.0 m north of the trail.

FEATURE A: Pahoehoe-aa excavation
FUNCTION: Agriculture
DIMENSIONS: 5.40 m by 3.20 m by 1.00 m maximum depth
DESCRIPTION: This excavation is located in a mixed pahoehoe/aa outcrop, where loose aa clinkers were cleared from the area and pahoehoe blocks were excavated from the face of a collapsed blister. The removed stones were piled in a ring around the edges of the excavation. The piles of stones range from 0.15 to 0.80 m in diameter.

FEATURE B: Terraces (6)
FUNCTION: Agriculture
DIMENSIONS: 18.10 m by 18.00 m by 1.60 m maximum height
DESCRIPTION: This cluster of terraces is located 3.0 m from Feature A, along the southwest slope of a pahoehoe outcrop. Within the cluster is a single faced terrace consisting of pahoehoe cobbles and boulders. This terrace is 3.70 m NW-SE by 2.65 m NE-SW and 1.60 m high along the faced side (SW). A natural hole is present in the southern corner of the terrace which has rocks piled up around it.

The remaining five terraces are located lower on the outcrop slope and consist of aa cobbles. These terraces follow natural outcrop configurations and were formed by filling gaps and depressions to create relatively level surfaces. These terraces are raised on the southwest sides, but are not faced. They are in various stages of deterioration.

FEATURE C: Kerbstone trail
FUNCTION: Transportation
DIMENSIONS: 62.00 m by 2.20 m by 0.95 m maximum kerbstone height
DESCRIPTION: This trail section runs upslope/downslope in a SW-NE orientation. The trail has been graded, and this has resulted in some sections consisting of fill and other sections consisting of bare pahoehoe. The perimeters are defined with aligned pahoehoe cobbles and boulders. Where fill occurs, the trail surface is paved with small to large pahoehoe cobbles. This feature is probably a historic horse or mule path.

SITE NO.: State: 13213 PHRI: T-42
SITE TYPE: Enclosure
TOPOGRAPHY: On irregular aa terrain; southwest-facing slope.
VEGETATION: Christmas-berry, fountain grass, air plants and koa-haole.
CONDITION: Poor
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture/possible habitation
DIMENSIONS: 14.70 m by 11.70 m
DESCRIPTION: The enclosure is roughly trapezoidal, with the long axis oriented 145 degrees Az. The walls are bifaced and consist of aa boulders and cobbles with aa pebble and small cobble core fill. The northwest wall is 14.1 m long; the southeast wall is 12.5 m long; the northeast wall is 11.70 m long and the southwest wall is 9.60 m long (all measurements along exterior sides).

Inside the enclosure are pockets of soil and scattered aa cobbles and pebbles. A pile of aa pebbles which may represent a deteriorated cupboard is present in the northern corner.

To the northeast immediately outside the enclosure is an area of concentrated aa that may represent either wall fall from the enclosure or a deteriorated terrace.

SITE NO.: State: 13214 PHRI: T-43
SITE TYPE: Complex (2 Features)
TOPOGRAPHY: On irregular, mixed pahoehoe and aa terrain with a southwestern exposure.
VEGETATION: Koa-haole, low fern, fountain grass and airplant.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture/possible habitation
DESCRIPTION: This site consists of an enclosure (Feature A) with a platform (Feature B) located inside. Overall site area is the same as Feature A dimensions. No portable remains or deposits were observed.

FEATURE A: Enclosure
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 16.20 m by 10.30 m by 1.20 m maximum height
DESCRIPTION: This roughly rectangular enclosure has double-faced, core-filled walls ranging in width from 1.20 to 1.25 m. The wall perimeters consist of pahoehoe boulders, several of which are uprights. The core fill is pahoehoe cobbles and pebbles. The northeast wall is 16.20 m long; the southwest wall is 15.25 m long; the northwest wall is 8.60 m long and the southeast wall is 10.30 m long (exterior sides).

Within the enclosure and connected to the northeast, northwest and southeast walls is a platform (Feature B). To the south of the platform the interior surface is paved with rubble and raised an average height of 0.35 m above original ground surface. Near the center of the enclosure, against the southeast wall, is a pahoehoe excavation measuring c. 2.7 by 2.0 m.

FEATURE B: Platform
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 8.60 m by 5.50 m by 0.75 m
DESCRIPTION: The platform is situated within and adjacent to the Feature A enclosure wall, in the northeastern corner. It consists of pahoehoe boulders, cobbles and pebbles. Two depressions exist in the surface of the platform, and it was not possible to determine whether pavement was once present on the surface. The feature is in a generally deteriorated condition.

SITE NO.: State: 13215 PHRI: T-44
SITE TYPE: Wall
TOPOGRAPHY: Smooth to rough undulating pahoehoe flow with scattered aa pockets.
VEGETATION: Air plant, koa-haole, kiawe, 'ilima, noni and fountain grass.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Ranching
DIMENSIONS: 18.00 m by 1.10 m by 1.00 m maximum height
DESCRIPTION: This relatively short wall section is double-faced and core-filled, and consists of pahoehoe cobbles and boulders, with some uprights incorporated into the faced sides. It is oriented NW-SE, and the southeastern end stops 9.00 m north of the Kealakehe/Keahuolu ahupuaa boundary wall (Site 13253). The sides of the wall are stacked and faced three to five courses high, at heights from 0.70 to 1.00 m. Portions of both sides of the wall have collapsed.

SITE NO.: State: 13216 PHRI: T-45
SITE TYPE: Wall
TOPOGRAPHY: Gently sloping pahoehoe and aa terrain that has been bulldozed.
VEGETATION: Mango, koa-haole and air plants.
CONDITION: Poor-fair
INTEGRITY: Possibly altered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Land division/agriculture
DIMENSIONS: 49.14 m by 0.99 m by 1.24 m maximum height
DESCRIPTION: This double-faced, core-filled wall is oriented generally east-west. The east end of the wall is at the eastern boundary of the project area, where it terminates at a housing subdivision. The western end of the wall is within the boundaries of Site 13254, where it exhibits formal characteristics of a kuaiwi wall.

The wall consists of aa cobbles and is generally more curved and irregular than boundary walls of historic period construction. A portion of the wall near the western end widens from the average 0.85 m to a range of 2.10-3.90 m. This area consists of small boulders and cobbles of aa, stacked five courses high. The surface here is relatively level but not paved. The north side of the wall is faced, five courses high, 1.0 m high and in some areas collapsed. The south side of the wall has a sloping edge c. 0.50 m high. The northeast corner of this widened area has a built up circular pile of small aa boulders with a depression in the center that may have supported a post at one time.

SITE NO.: State: 13217 PHRI: T-46
SITE TYPE: Enclosure
TOPOGRAPHY: Gently sloping pahoehoe, southwest exposure
VEGETATION: Mango, kiawe, fountain grass, lantana and elephant grass.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Recent historic
FUNCTIONAL INTERPRETATION: Agriculture (recent)
DIMENSIONS: 10.00 m by 4.00 m by 1.30 m maximum height
DESCRIPTION: This oval enclosure is built around a mature mango tree. It consists of pahoehoe boulders and cobbles stacked four to six courses on the exterior side, and an inner ring three courses high (c. 0.30-0.50 m). Overall width of the wall averages 0.80 m. There is no entranceway into the enclosure, which is partially collapsed.

SITE NO.: State: 13218 PHRI: T-47
SITE TYPE: Wall
TOPOGRAPHY: Gently sloping pahoehoe.
VEGETATION: Lantana, lilikoi, day flower, fountain grass and kiawe.
CONDITION: Poor
INTEGRITY: Unaltered
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Land division/ ranching
DIMENSIONS: 80.00 m by 0.85 m by 1.50 m (approx.)
DESCRIPTION: This east-west wall extends from the Site 13184 wall eastward beyond the boundary of the project area. The length given here includes only that portion within the project area. Overall length is c. 640.00 m. The wall is bifaced and core-filled and has fencing wire, concrete slabs, and a salt lick incorporated into the construction.

SITE NO.: State: 13219 PHRI: T-48 ***(Figure A-10)***
SITE TYPE: Kerbstone trail
TOPOGRAPHY: Varies from sloping to level pahoehoe with some aa.
VEGETATION: Grass, koa-haole, Christmas-berry, klu, lantana, guava
CONDITION: Fair-good
INTEGRITY: Portions affected by bulldozing
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 250.00 m by 1.70 m by 1.20 m maximum height
DESCRIPTION: This straight-line, graded kerbstone trail is oriented east-west and consists of both aa and pahoehoe boulders and cobbles, depending upon local terrain. The eastern end of the trail as currently defined is at a large riprap pile near the eastern boundary of the project area. The western end of the intact portion is at the Site 13184 wall. Two short sections were identified to the west of the wall, where extensive bulldozing and chain-dragging has occurred.

The trail perimeters are defined by aligned and/or stacked pahoehoe and aa boulders and cobbles, and the surface varies from a pebble pavement to cleared soil. Some sections of the trail have been filled up to 1.20 m high, and some sections are depressed into aa surfaces, in order to maintain a level grade. There are about four sections of upgrading c. 1.00 m high across low areas within the intact section of the trail. In two to three sections across aa the trail surface is below the surrounding grade.

The location of this trail section seems to correlate with a "3 ft road" plotted on Emerson's Survey Map (1882) of upper Kealakehe.

SITE NO.: State: 13220 PHRI: T-55
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: Irregular pahoehoe, southwestern exposure.
VEGETATION: Dense akia, guava, fountain grass, Christmas-berry, lantana, 'ilima, vines, noni, air plant and koa-haole.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: A linear rock mound (Feature A), a pahoehoe excavation (Feature B), and a circular rock mound (Feature C) were identified within an area c. 12.20 m by 10.0 m at this site. No portable remains or deposits were noted.

FEATURE A: Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 5.00 m by 1.60 m by 0.80 m
DESCRIPTION: The mound consists of pahoehoe boulders and cobbles, and is oriented NE-SW.

FEATURE B: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 7.20 m by 6.00 m
DESCRIPTION: The pahoehoe excavation is located 2.50 m from Feature A at 70 degrees Az. The excavation is rectangular with pahoehoe boulders and cobbles loosely stacked around the outside edges.

Figure A-10. SITE 13219. TRAIL SEGMENT. VIEW TO EAST (PHRI Neg. 1304-11)

FEATURE C: Circular rock mound
FUNCTION: Agriculture
DIMENSIONS: 3.20 m by 1.92 m by 0.56 m
DESCRIPTION: This mound is 1.50 m from Feature A at 288 degrees Az. It consists of loosely piled pahoehoe boulders and cobbles.

SITE NO.: State: 13221 PHRI: T-56,57
SITE TYPE: Complex (80 Features)
TOPOGRAPHY: Undulating pahoehoe flow which slopes to the southwest.
VEGETATION: Christmas-berry, alahe'e, koa-haole, fountain grass and various other grasses, 'ilima, lantana and air plant.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Over 55 linear stone mounds and 25 pahoehoe excavations were counted within an area 60.0 m N-S by 35.0 m E-W at this complex. The features could not be individually measured during this survey. It is likely additional features are present within the site boundaries, which were arbitrarily delineated for purposes of feature enumeration. The site appears to be contiguous with Site 13222, located to the northeast.

FEATURE - : Linear rock mounds (55)
FUNCTION: Agriculture
DESCRIPTION: The mounds range from 2.0 m to 6.0 m in length and 2.0 to 4.50 m in width and 0.80 to 1.50 m in height. They consist of piled to crudely stacked rocks on top of bedrock.

FEATURE - : Pahoehoe excavations (25)
FUNCTION: Agriculture
DESCRIPTION: The quarried materials are piled around the excavations in linear mounds. Soil deposits were observed in several of the excavations.

SITE NO.: State: 13222 PHRI: T-58
SITE TYPE: Complex (19 Features)
TOPOGRAPHY: Irregular pahoehoe, southwestern exposure.
VEGETATION: Dense vegetation of alahe'e, monkey pod, Christmas-berry, lauae, koa-haole, fountain grass and vines.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture-quarry
DESCRIPTION: Four pahoehoe excavations and 15 linear rock mounds were identified within an area 30.0 m E-W by 20.0 m N-S at this site. Measurements were recorded for one of the pahoehoe excavations (Feature A) and one of the linear rock mounds (Feature B).

FEATURE A: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 8.30 m by 9.30 m
DESCRIPTION: This is a filled excavation with a circular alignment around the edges. The pahoehoe flow has been excavated by pahoehoe extracting boulders and cobbles and then building up the edges of the excavation by stacking the rocks along the outer edges. The depression is filled with pahoehoe boulders down to pebbles, with the smaller pieces at the bottom and larger pieces on top. Large boulder size uprights are present along the southern edge of the excavation. Paving is to the east of this in an area which appears to be an opening in the circular pattern of the excavation. The south curve of the circle is paved outside the main circle about 1.00 to 1.50 m wide.

FEATURE B: Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 8.80 m by 2.50 m by 1.00 m maximum height
DESCRIPTION: The mound is oriented NE-SW, and consists of pahoehoe boulders to pebbles. The rocks are piled (not faced) on an unbroken pahoehoe surface.

SITE NO.: State: 13223 PHRI: T-59 *(Figure A-11)*
SITE TYPE: Complex (10 Features)
TOPOGRAPHY: Irregular pahoehoe flows with many bedrock outcrops.
VEGETATION: Dense koa-haole, Christmas-berry, alahe'e, sparse grasses, air plants, 'ilima, guava, and lauae.
CONDITION: Good to poor
INTEGRITY: Unaltered; Feature A altered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture-habitation-possible burial
DESCRIPTION: An enclosure (Feature A), two platforms (Features B and D) and a terrace with six associated cleared depressions (Feature C) were identified at this complex. Overall site area is c. 27.00 m N-S by 25.00 m E-W. Portable remains observed include a waterworn basalt cobble, incorporated into the wall of Feature A, and waterworn basalt cobble fragments, located at Feature C. Pockets of loamy soil are scattered across the site. In addition, an unknown number of rock mounds are present within the site area.

FEATURE A: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 16.00 m by 14.50 m by 0.80 m maximum wall height

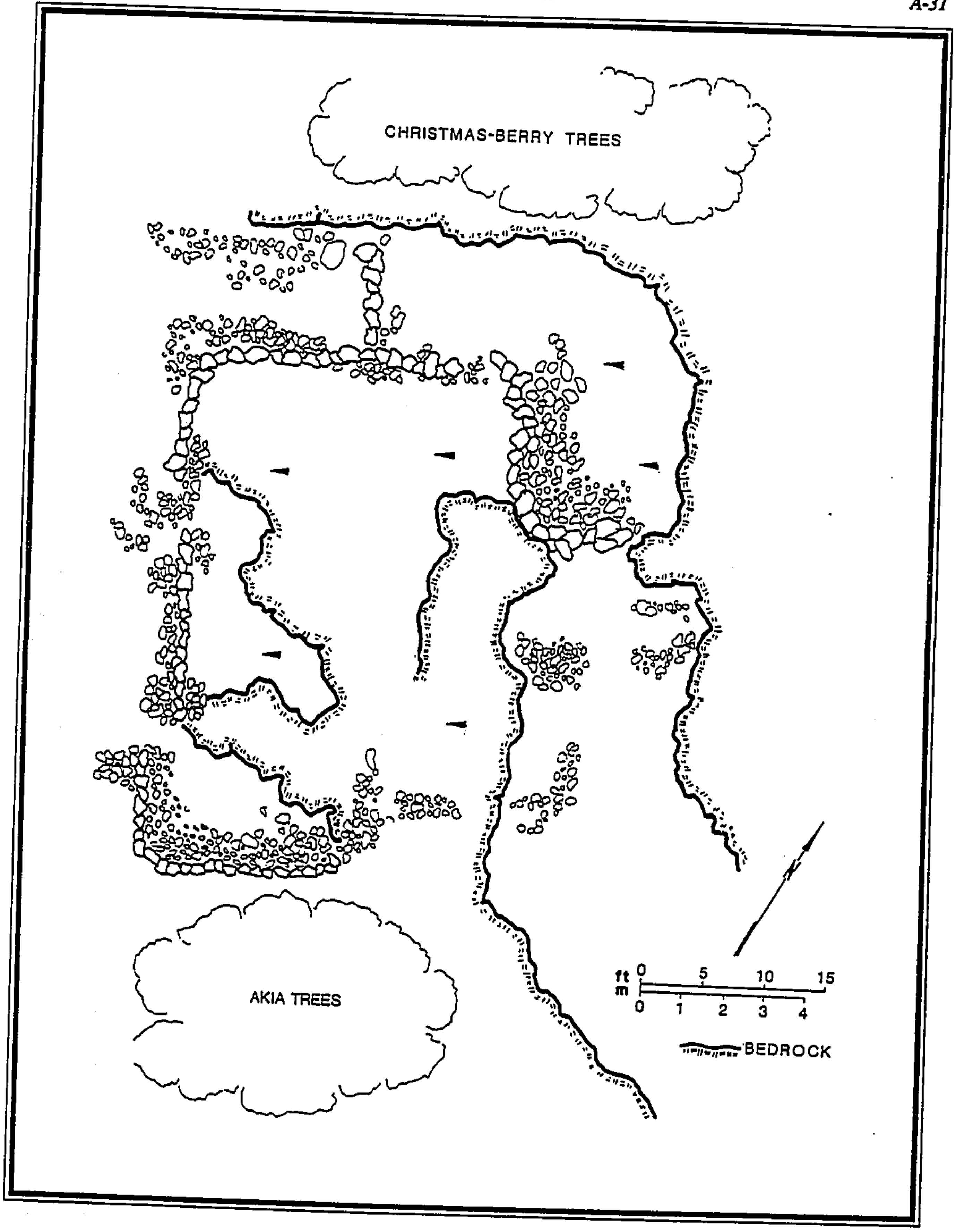

Figure A-11. SITE 13223

The enclosure walls consist of pahoehoe boulders and cobbles, stacked from one to three courses high (0.35 to 0.80 m), and one to two stones wide. No core fill is present in the walls. One waterworn rock was noted at the north end of the enclosure. The southeastern section of the enclosure wall is in very poor preservation; it consists of boulders scattered atop bedrock. Approximately two thirds of the interior area contains a 0.05-0.08 m thick deposit of dark brown loam.

FEATURE B: Platform
FUNCTION: Habitation/possible burial
DIMENSIONS: 3.70 m by 3.60 m by 0.70 m maximum height
DESCRIPTION: This nearly square platform is located 19.0 m from Feature A at 38 degrees Az. It consists of aa boulders and pahoehoe boulders, cobbles and pebbles. The platform base stands up to three courses high and is made mostly of small aa boulders. All four sides are faced, although sections are currently collapsed. The top of the platform is made mostly of pahoehoe cobbles and pebbles, and is slightly mounded. Height of the platform varies from 0.45 m to 0.70 m.

FEATURE C: Terrace with six cleared depressions
FUNCTION: Agriculture
DIMENSIONS: 5.00 m by 4.60 m by 0.80 m maximum height
DESCRIPTION: This cluster of features is located 11.40 m from Feature A. The terrace is situated along the southwest edge of a pahoehoe outcrop, and has a single faced side along the southwest. This side is stacked pahoehoe cobbles, one to two courses high. The top of the terrace is paved with pahoehoe cobbles and pebbles, with some exposed outcrop surfaces protruding. On the southeast corner of the terrace is a circular alignment of pahoehoe cobbles and boulders which forms the perimeter of a soil deposit. The alignment is 1.80 by 1.10 m across the inside.

The pahoehoe outcrop forms a natural edge between the terrace and six circular depressions which are lined with pahoehoe, small boulders and cobbles where the outcrop stops. These depressions are filled with soil and pahoehoe pebbles in the center.

FEATURE D: Platform
FUNCTION: Agriculture/habitation
DIMENSIONS: 2.50 m by 2.20 m by 0.60 m maximum height
DESCRIPTION: The platform is located immediately adjacent to the northeast of the Feature C terrace and modified outcrop area. It consists of pahoehoe boulders and cobbles, stacked and faced on all sides, one to three courses high (0.50 to 0.60 m). The top of the platform was apparently not paved, and near the center is a small depression. The platform is adjacent to a modified outcrop.

SITE NO.: State: 13224 PHRI: T-60
SITE TYPE: Complex (28+ Features)
TOPOGRAPHY: Irregular to hilly pahoehoe terrain; southwest facing slope.
VEGETATION: Heavy vegetation consisting of Christmas-berry, koa-haole, lantana, alah'ee, 'ilima, and grasses.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: A terrace (Feature A), 19+ pahoehoe excavations, and eight+ rock mounds were identified within an area 40.0 m N-S by 40.0 m E-W at this site. No portable remains were observed; however, soil pockets are present across the site.

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 6.30 m by 5.70 m by 0.95 m maximum height
DESCRIPTION: The somewhat circular terrace consists of small pahoehoe boulders and cobbles. The south side is raised and faced with up to three courses of stacked boulders. The surface is not formally paved, and is leveled primarily by filling depressions in the natural outcrop. A pocket of soil at least 0.06 m thick was observed just outside the south wall. Adjacent to the northeast corner of the terrace is a rock mound.

FEATURE - : Pahoehoe excavations (19)
FUNCTION: Agriculture

FEATURE - : Rock mounds (8)
FUNCTION: Agriculture

SITE NO.: State: 13225 PHRI: T-61
SITE TYPE: Complex (7 Features)
TOPOGRAPHY: The site is situated on the S-SW facing slope. The terrain is irregular with pahoehoe outcrops.
VEGETATION: Dense vegetation; air plant, lantana, fountain grass, Christmas-berry, koa-haole, 'akia, monkey pod and grasses.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Three pahoehoe excavations (Feature A), a linear rock mound (Feature B) and three circular rock mounds were identified within an area c. 33.8 m N-S by

10.0 m E-W at this site. Dark brown loam was identified in pockets in and around the pahoehoe excavations.

FEATURE A: Pahoehoe excavations (3)
FUNCTION: Agriculture
DIMENSIONS: 9.00 m by 5.45 m
DESCRIPTION: Three sections along the edges of a pahoehoe blister have blocks knocked from the rock face, forming circular depressions. The depressions are built up along the outer edges with aligned pahoehoe blocks, and the interiors are filled with pahoehoe cobbles. Some flat slabs around the outer edges of the excavations are upright.

FEATURE B: Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 6.60 m by 1.60 m by 0.85 m maximum height
DESCRIPTION: The linear mound is located 19.0 m from Feature A at 292 degrees Az. It consists of pahoehoe boulders and cobbles, with no formalized stacking or facing. The mound is oriented SW-NE. To either side of the mound, the surface has been paved with small pahoehoe cobbles.

FEATURE - : Circular rock mound (3)
FUNCTION: Agriculture
DESCRIPTION: These were found in the immediate area of Features A and B.

SITE NO.: State: 13226 PHRI: T-63,64
SITE TYPE: Complex (13 Features)
TOPOGRAPHY: Undulating pahoehoe flow with a light slope to the southwest.
VEGETATION: Christmas-berry, alahe'e, koa-haole, sparse grass, air plant, ferns and monkey pod.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: An L-shaped rock mound (Feature A), four circular rock mounds, seven pahoehoe excavations, and a terrace were identified within an area c. 33.0 m N-S by 28.0 m E-W at this site. This site is immediately adjacent to and north of Site 13223, and believed to be associated with this agricultural complex. It is also adjacent to and on the southwest edge of Site 13227.

FEATURE A: L-shaped rock mound
FUNCTION: Agriculture
DIMENSIONS: 23.50 m by 3.00 m maximum width by 0.95 m maximum height
DESCRIPTION: The mound is comprised of two linear sections; one 10.00 m long section is oriented NW-SE, and a 13.50 m long section is oriented NW-SW. The mound is composed of mostly small basalt boulders with some large to medium cobbles mixed in. These rocks are stacked roughly with some short areas of facing on the west and south sides. The NW-SE section has an average width of 2.10 m wide and ranges from 0.35 to 0.95 m in height. The NE-SW section widens to 3.0 m at the southwest end of the mound. Height of this section varies from 0.25 to 0.90 m.

FEATURE - : Rock mound (4)
FUNCTION: Agriculture
DESCRIPTION: In the vicinity of Feature A are at least four rock mounds; these are associated with pahoehoe excavations.

FEATURE - : Pahoehoe excavation (7)
FUNCTION: Agriculture
DESCRIPTION: There is a large pahoehoe excavation NW and directly adjacent to the NW corner of Feature A. At least six additional pahoehoe excavations with associated small stacked mounds of quarried material are present in the immediate vicinity of Feature A.

FEATURE - : Terrace
FUNCTION: Agriculture
DIMENSIONS: 2.25 m by 1.30 m
DESCRIPTION: Approximately 6.0 m south of the northern corner of Feature A is a small terrace. This feature is immediately northwest of a pahoehoe excavation and associated rock mound. The terrace consists of pahoehoe cobbles piled in a small quarried blister. The surface is flat and roughly level.

SITE NO.: State: 13227 PHRI: T-65
SITE TYPE: Complex (120 Features)
TOPOGRAPHY: Irregular pahoehoe and aa flows, southwest exposure.
VEGETATION: Dense upper story of Christmas-berry and alahe'e with moderately dense grasses, air plant, lauae, lantana, noni, and monkey pod.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Features enumerated at this site include 59 circular rock mounds, 48 pahoehoe excavations, and 13 linear rock mounds. The area as defined for purposes of enumeration is 70.0 m NE-SW by 55.0 m NW-SE. Dark brown loam was observed in pockets across the site. Site No. 13226 is c. 45.0 m from this site at 185 degrees AZ, and Site 13235 is adjacent to the northeast.

FEATURE - : Circular rock mounds (59)
FUNCTION: Agriculture

DESCRIPTION: The circular mounds identified at this site are generally adjacent to pahoehoe excavations and may be constructed with quarried pahoehoe blocks and cobbles. These mounds have an average size of 2.0 by 2.0 m, and an average height of 0.75 m.

FEATURE - : Pahoehoe excavation (48)
FUNCTION: Agriculture
DESCRIPTION: The excavations present at the site are most commonly collapsed pahoehoe blisters with blocks knocked from the edges. The centers of the excavations are partially filled with pahoehoe pebbles underlying a layer of cobbles.

FEATURE - : Linear rock mound (13)
FUNCTION: Agriculture
DESCRIPTION: The linear rock mounds have an average size of 4.0 m by 2.0 m, and an average maximum height of 1.25 m.

SITE NO.: State: 13228 PHRI: T-66 ***(Figure A-12)***
SITE TYPE: Enclosure
TOPOGRAPHY: Situated on a knoll that consists of a central pahoehoe outcrop surrounded by aa.
VEGETATION: Christmas-berry, alahe'e, 'ilima, lantana and fountain grass.
CONDITION: Poor
INTEGRITY: Partially disturbed by bulldozer
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Indeterminate/ possible ceremonial
DIMENSIONS: 22.40 m by 16.50 m by 1.50 m maximum wall height
DESCRIPTION: This roughly rectangular enclosure consists of aa and pahoehoe boulders and cobbles. The walls are bifaced and stacked up to eight courses high; wall heights range from 0.40 along the interior at the southwest corner to 1.50 m along the exterior of the west wall. Intact wall sections vary in width from 0.80 to 1.20 m.

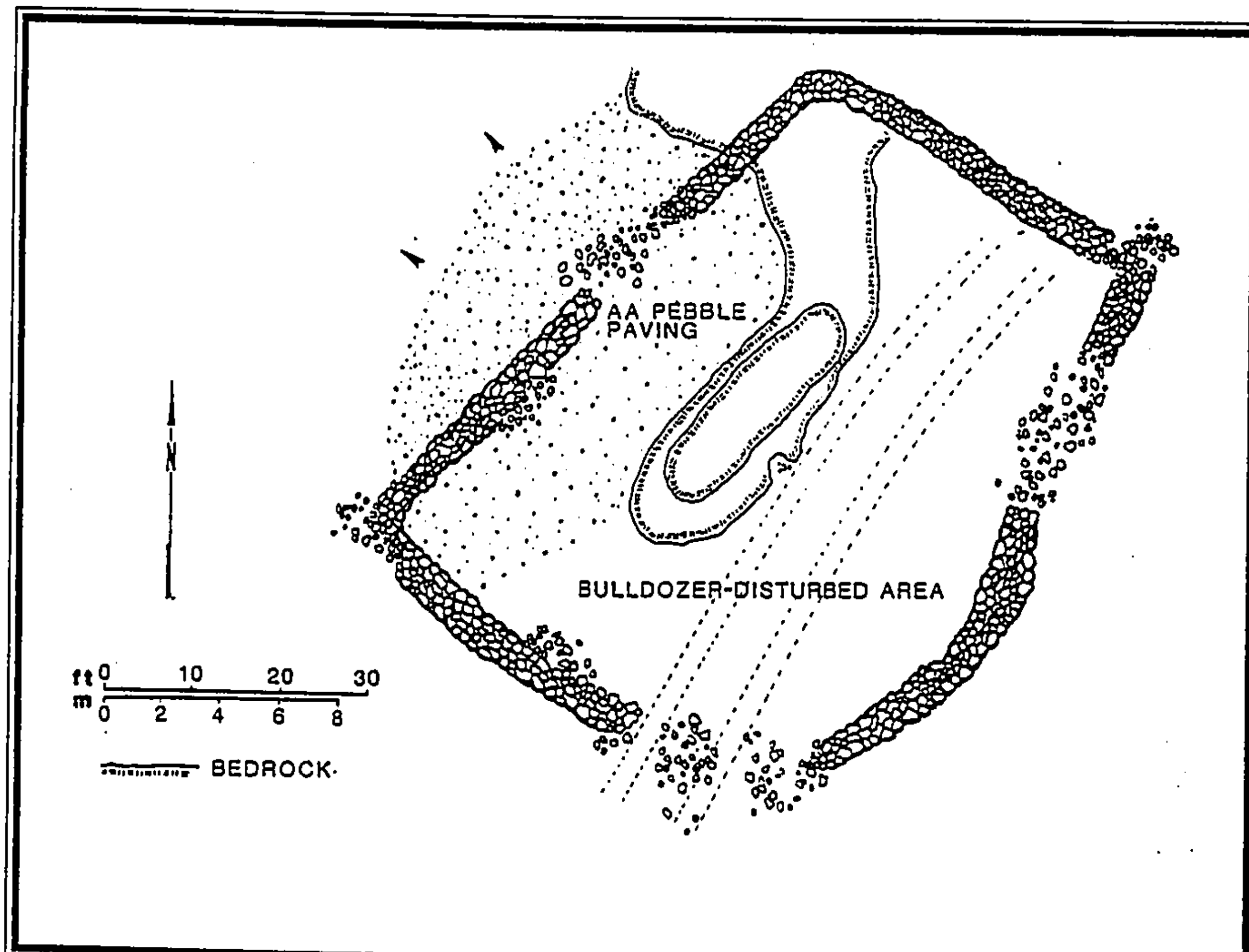

Figure A-12. SITE 13228

The south and eastern portions of the enclosure were affected by a bulldozer which drove through the south wall and into the structure, disturbing approximately half of the interior surface area. The undisturbed portion of the interior consists of a linear pahoehoe rise that may have been excavated along the east face, and a level pavement-like deposit of aa gravel. This pavement continues to the exterior, west side of the enclosure, where it is 15.0 m long and 4.00 m wide. On the north and NE sides of the enclosure, the wall is collapsed.

SITE NO.: State: 13229 PHRI: T-67
SITE TYPE: Complex (10+ Features)
TOPOGRAPHY: On a southwest-facing slope, surrounded by pahoehoe and aa lava flows.
VEGETATION: Dense vegetation of Christmas-berry, koa-haole, fountain grass, lantana, 'ilima, alahe'e, impatiens and vines.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Features identified within this site include four modified pahoehoe excavations, a cairn, and at least five rock mounds. Overall complex area is c. 30.0 m N-S by 20.0 m E-W. Soil deposits are present inside the modified pahoehoe excavations.

Feature A is within a pahoehoe flow naturally suited and culturally adapted for agriculture. The top terracing has Features A1 and A2, a cairn and a circular alignment. The area surrounding it is paved. Dropping down the hill is another circular alignment carved out of a pahoehoe excavation area filled in with soil in the center. At the bottom of this natural terracing is the third circular alignment.

FEATURE A1: Cairn
FUNCTION: Agriculture
DIMENSIONS: 1.50 m by 1.00 m by 0.60 m maximum height
DESCRIPTION: The cairn is located on the upper tier of a naturally terraced pahoehoe outcrop which contains three modified pahoehoe excavations (Features A2-A4). The cairn is immediately adjacent to the northwest end of the Feature A2 alignment, and it consists of small pahoehoe cobbles.

FEATURE A2: Modified pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 2.00 m by 1.50 m by 0.20 m maximum height
DESCRIPTION: This feature consists of a pahoehoe excavation and an encircling alignment/wall. The alignment/wall is made with pahoehoe cobbles excavated from a collapsed area of a pahoehoe outcrop and stacked 1-2 courses high around the outer edges of the excavation. A deposit of dark brown loam is present in the center of the feature.

FEATURE A3: Modified pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 2.50 m by 2.00 m by 0.50 m maximum height
DESCRIPTION: This excavation is located downslope of Features A1 and A2, along the same pahoehoe outcrop. It is identical in construction with Feature A2, and slightly larger. Soil is also present in the center of this feature.

FEATURE A4: Modified pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 3.00 m by 2.50 m by 0.65 m maximum height
DESCRIPTION: Feature A4 is located downslope from Feature A3, on the same pahoehoe outcrop. The circular wall around the excavation at this locale is stacked up to three courses high, and is faced on the northeast side. Soil is present in the center of this feature.

FEATURE B: Modified pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 9.00 m by 5.00 m by 1.00 m maximum depth
DESCRIPTION: Feature B is located to the northeast of Feature A. It consists of a cleared pahoehoe excavation built up around the interior sides with pahoehoe cobbles. At the time of survey, the interior of the feature was damp and contained a lush growth of succulent plants.

FEATURE - : Rock mounds (5)
FUNCTION: Agriculture
DESCRIPTION: Five additional rock mounds are present in the area.

SITE NO.: State: 13230 PHRI: T-68 *(Figure A-13)*
SITE TYPE: Walled cave
TOPOGRAPHY: In a collapsed pahoehoe tube, just south of a major ridgeline.
VEGETATION: Christmas-berry, alahe'e, lantana, fountain grass and air plant.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation
DIMENSIONS: 9.00 m by 2.50 m by 1.50 m average ceiling height

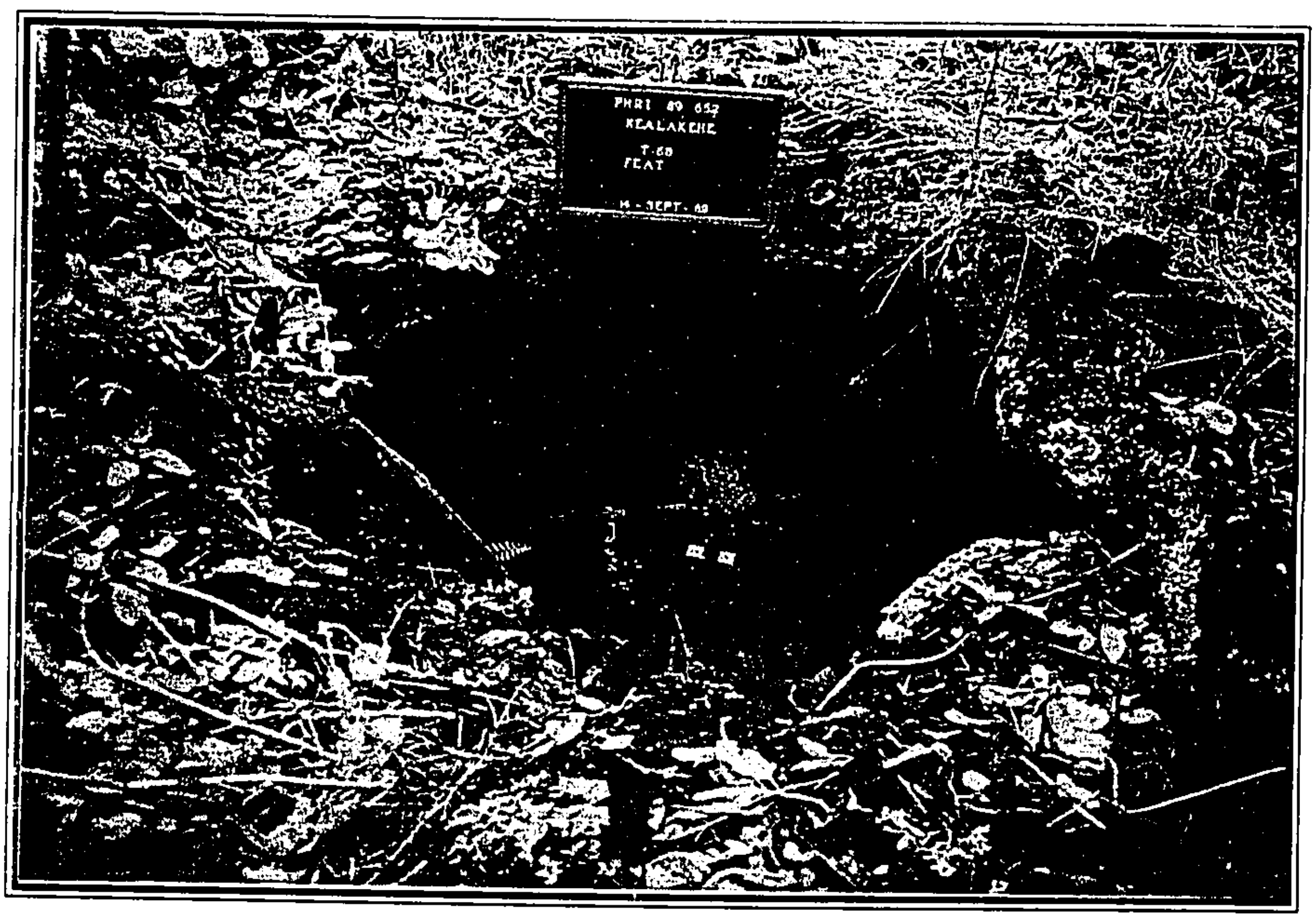

Figure A-13. SITE 13230, CAVE OPENING. VIEW TO WEST (PHRI Neg. 1301-21)

DESCRIPTION: This site is located in a narrow, partially collapsed lava tube oriented NE-SW along the prevailing slope. The floor of the collapsed section has been cleared and leveled and a retaining wall built across the narrow axis of the tube, 1.0 m to the southwest of the cave opening. The wall is 2.00 m long, 1.75 m wide and 1.10 m high. It consists of small boulders to large cobbles, stacked four to six courses high. The area NE of the opening may have been cleared of natural roof-fall, and a skylight northeast of the opening has been filled with some of this rubble. Loose pahoehoe rubble is also stacked within the tube 2.20 m northeast of the opening.

SITE NO.: State: 13231 PHRI: T-69
SITE TYPE: Complex (8 Features)
TOPOGRAPHY: Undulating pahoehoe flow sloping to the southwest.
VEGETATION: Alahe'e, Christmas-berry, koa-haole, noni, fountain grass and air plant.
CONDITION: Fair-good
INTEGRITY: Unaltered-some bulldozer damage
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Eight rock mounds were identified at this site, including seven circular mounds and one linear mound. Overall complex area measures c. 30.0 m N-S by 20.0 m E-W.

FEATURE - : Rock mound (7)
FUNCTION: Agriculture
DESCRIPTION: These mounds consist of stacked basalt boulders and large cobbles. They are generally circular at the base with relatively vertical to collapsed sides. Average sizes range from is 2.00 by 2.00 m to 3.00 by 3.00 m at the base, and 0.60 to 1.25 m in height.

FEATURE - : Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 12.00 m by 4.00 m by 1.25 m maximum height
DESCRIPTION: The mound consists of loosely stacked basalt boulders and large cobbles.

SITE NO.: State: 13232 PHRI: T-70
SITE TYPE: Complex (10 Features)
TOPOGRAPHY: Undulating pahoehoe flow sloping to the southwest.
VEGETATION: Christmas-berry, alahe'e, low ferns, air plant, grasses, kukui nut and koa-haole.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Ten pahoehoe excavations were identified within an area 40.00 m N-S by 30.00 m E-W at this site.

FEATURE - : Pahoehoe excavations (10)
DIMENSIONS: Average excavation is 4.00 m by 5.00 m by 1.25 m deep
DESCRIPTION: The majority of these excavations are into pahoehoe blisters; a few are along the faces of small crevices. In most cases, blocks removed from the depressions are loosely piled along the outer edges of the excavations. There seems to be a higher occurrence of piled stones along the southwestern perimeters of the excavations. Soil deposits were observed inside the excavations.

SITE NO.: State: 13233 PHRI: T-71
SITE TYPE: Complex (6+ Features)
TOPOGRAPHY: Undulating pahoehoe with a slight slope to the southwest.
VEGETATION: Alahe'e, Christmas-berry, guava, kukui nut, grasses and air plant.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Three circular rock mounds and three linear rock mounds were identified within an area 30.0 m N-S by 25.0 m E-W at this site. It is likely additional features are present within the immediate vicinity.

FEATURE - : Rock mounds (3+)
FUNCTION: Agriculture
DESCRIPTION: The mounds consist of small, loosely piled basalt boulders and cobbles. These three mounds are roughly circular at the base, with average dimensions 2.0 m by 2.0 m by 0.75 m high.

FEATURE - : Linear rock mound (3+)
FUNCTION: Agriculture
DESCRIPTION: The linear mounds also consist of small basalt boulders and cobbles. Unlike the circular mounds, the three linear mounds are roughly faced along the east side. Average dimensions are 3.0 m by 2.0 m by 1.00 m.

SITE NO.: State: 13234 PHRI: T-72
SITE TYPE: Kerbstone trail
TOPOGRAPHY: Pahoehoe flow sloping to the southwest.
VEGETATION: Alahe'e, Christmas-berry, koa-haole, lantana, grasses and air plant.
CONDITION: Fair
INTEGRITY: Possible destruction by bulldozer at north end

PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 244.00 m by 3.00 m by 0.10 m (approx.)
DESCRIPTION: The trail was identified primarily on the basis of two parallel kerbstone alignments oriented N-S. The alignments are spaced 2.50 to 3.00 m apart and consist of pahoehoe boulders and cobbles. In some areas the trail is paved with large to medium cobbles on a roughly flat surface. Intermittent areas of the trail are natural bedrock and in some sections the surface is loose rubble. The trail passes beside several agricultural features. It is possible this section once connected with the Site 13244 kerbstone trail, located c. 300.00 m to the north. If these sections connected, the trail would have been nearly parallel with, and about 60.0 m downslope of the existing Palani Road.

SITE NO.: State: 13235 PHRI: T-73,74
SITE TYPE: Complex (33+ Features)
TOPOGRAPHY: Undulating pahoehoe flow sloping gently to the southwest.
VEGETATION: Christmas-berry, alahe'e, fountain grass, air plant, guava, low ferns and 'ilima.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Atleast linear rock mounds, 10 circular rock mounds, and 10 pahoehoe excavations were identified within an area 85.00 m E-W by 50.00 m N-S at this site. The entire area has many pahoehoe blister areas which have been excavated with the quarried material piled or crudely stacked adjacent to the excavations.

FEATURE - : Circular rock mounds (10+)
FUNCTION: Agriculture
DESCRIPTION: The circular rock mounds consist of loosely piled pahoehoe blocks and cobbles. Average size is 3.00 m by 3.00 m at the base by 1.25 m high.

FEATURE - : Linear rock mounds (10+)
FUNCTION: Agriculture
DESCRIPTION: There are at least ten linear mounds on the site; average dimensions are 4.00 to 6.00 m by 1.00 m by .70 m high. Three unusually long mounds were observed and individually measured. These are listed below.

FEATURE - : Linear rock mound
DIMENSIONS: 25.00 m by 1.00 m by 0.75 m

FEATURE - : Linear rock mound
DIMENSIONS: 13.00 m by 1.00 m by 0.70 m

FEATURE - : Linear rock mound
DIMENSIONS: 10.00 m by 1.00 m by 0.75 m

FEATURE - : Pahoehoe excavation (10+)
FUNCTION: Agriculture
DESCRIPTION: There are over ten pahoehoe excavations ranging from 4.0 m by 5.0 m to 0.50 m by 0.50 m with an average depth of 0.60 m. Rubble removed from the excavations is scattered over the site surface between the excavations and the mounds.

SITE NO.: State: 13236 PHRI: T-75,77
SITE TYPE: Complex (6 Features)
TOPOGRAPHY: Pahoehoe flow sloping to the southwest.
VEGETATION: Christmas-berry, alahe'e, sparse fountain grass, air plant and koa-haole.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric/historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Six rock mounds were identified within an area 30.0 m E-W by 25.0 m N-S. Pockets of dark brown loam were observed scattered over the site surface.

FEATURE - : Rock mound (6)
FUNCTION: Agriculture
DESCRIPTION: These mounds consist of loosely piled, small pahoehoe boulders and large cobbles. They average 2.00 m by 3.00 m at the base by 1.25 m in height. One of the mounds is larger and more linear. It measures 5.50 m by 2.25 m by 1.10 m high.

SITE NO.: State: 13237 PHRI: T-76 *(Figure A-14)*
SITE TYPE: Enclosure
TOPOGRAPHY: Undulating pahoehoe flow with a slight slope to the southwest.
VEGETATION: Christmas-berry, alahe'e, 'ilima, fountain grass and koa-haole.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Recent historic
FUNCTIONAL INTERPRETATION: Agriculture (recent)
DIMENSIONS: 4.40 m by 5.30 m by 0.70 m maximum wall height
DESCRIPTION: This is a small, roughly circular structure consisting of pahoehoe slabs, boulders and cobbles. Major portions of the side walls are outlined along the interior with upright slabs. Pahoehoe boulders and cobble chunks are stacked and loosely piled against the exterior sides of the uprights. Wall width varies from 0.60 to 1.50 m.

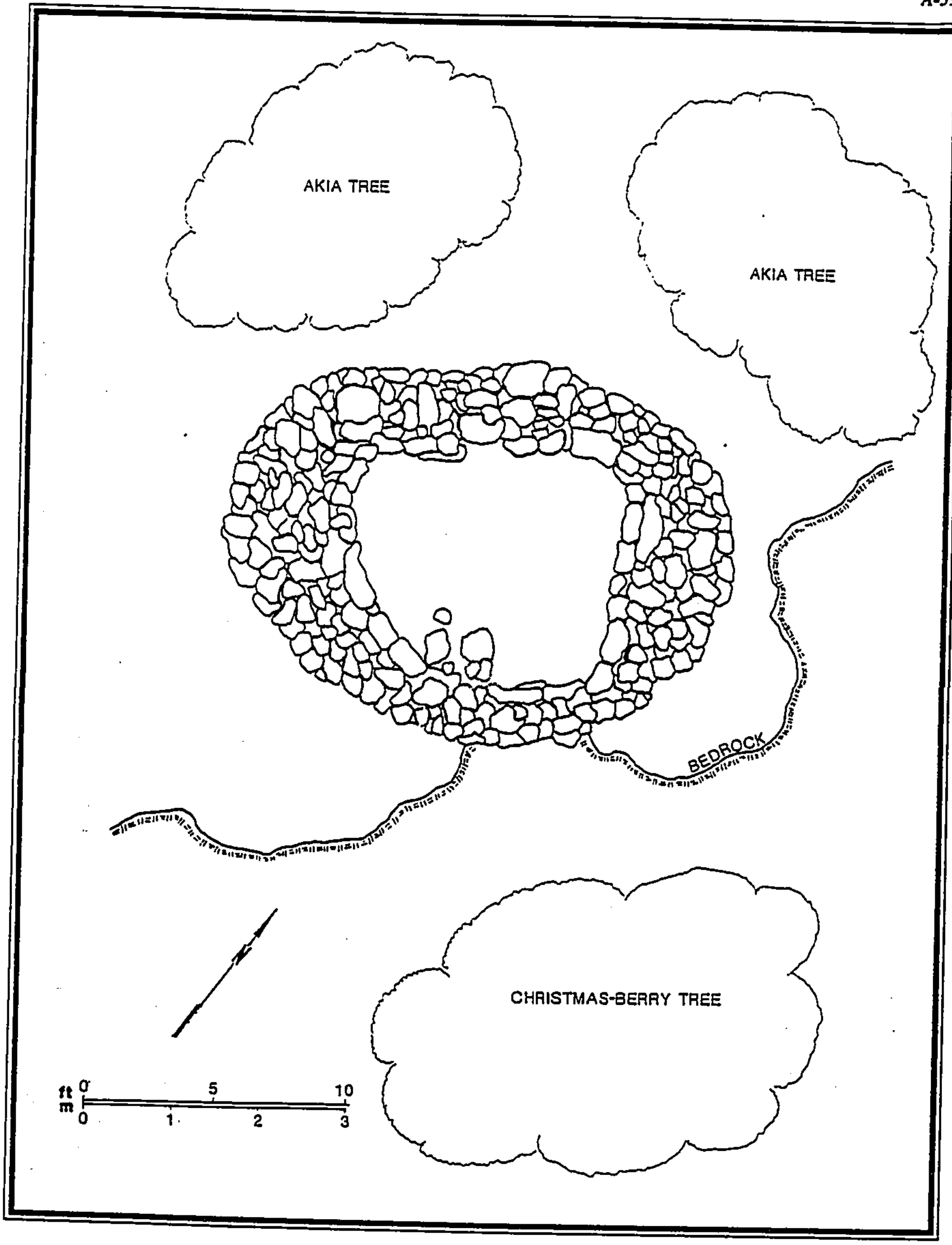

Figure A-14. SITE 13237

The interior area is 3.00 m E-W by 2.5 m N-S. It is cleared and the surface is flat and level, with a 0.10 m thick deposit of soil. The soil contains cinders and hapu fibers. Much of this soil may have been recently deposited and it is likely the enclosure was recently constructed. There are plastic seeding pots at the northeast edge of the enclosure and an old burlap bag on the western edge. Cut branches were also noticed around the perimeter.

SITE NO.: State: 13238 PHRI: T-78
SITE TYPE: Complex (20 Features)
TOPOGRAPHY: Undulating pahoehoe flow sloping gently to the southwest.
VEGETATION: Christmas-berry, alahe'e, guava, lantana, lauae, fountain grass and koa-haole.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Ten pahoehoe excavations and 10 rock mounds were identified within an area 15.0 m N-S by 12.0 m E-W at this site. In general, the rock mounds are spatially associated with excavated pahoehoe blisters and crevices. Individual feature measurements could not be obtained at the time of survey. Pockets of dark brown loam were observed scattered over the site surface.

FEATURE - : Pahoehoe excavations (10)
FUNCTION: Agriculture

FEATURE - : Rock mounds (10)
FUNCTION: Agriculture

SITE NO.: State: 13239 PHRI: T-79 *(Figure A-15)*
SITE TYPE: Complex (33 Features)
TOPOGRAPHY: Gently sloping pahoehoe with scattered upthrusts and blisters.
VEGETATION: 'Ilima, Christmas-berry, koa-haole and alahe'e.
CONDITION: Good
INTEGRITY: Unaltered-possibly altered
PROBABLE AGE: Prehistoric/recent historic
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: A C-shaped wall (Feature A), a cairn (Feature B) and a terrace (Feature C) were identified within an area 13.00 by 13.00 m at this site. In addition, 20 pahoehoe excavations and 10 rock mounds were identified within an area 40.0 m N-S by 30.0 m E-W. The former area of three concentrated structures is within the overall area of feature enumeration. Portable remains observed on the site include a metal machete and a metal pick-axe with a wooden handle. These tools were lying next to Feature A. Soil deposits were observed in pockets across the site surface.

FEATURE A: C-shaped wall
FUNCTION: Agriculture
DIMENSIONS: 8.40 m by 1.50 m by 0.80 m maximum wall height
DESCRIPTION: Feature A consists of pahoehoe slabs loosely stacked and haphazardly piled in a curved, C-shaped arrangement. A small section of the wall is somewhat faced along the interior side, where slabs are piled up to 5 courses high. A single upright slab (1.20 m high) is positioned at the southern end of the wall. The wall is positioned to the west of a prominent pahoehoe outcrop, which has been modified with scattered pahoehoe cobbles. An area 5.40 m N-S by 4.80 m E-W is defined and mostly enclosed by the wall and outcrop. A deposit of very dark, cindery soil is present immediately inside the wall. A metal machete and metal pick-axe with wooden handle are on bedrock, inside the enclosed area.

FEATURE B: Cairn
FUNCTION: Agriculture
DIMENSIONS: 1.90 m by 1.40 m by 0.97 m maximum height
DESCRIPTION: Feature B is located 1.50 m west of Feature A. This is a collapsed cairn and the dimensions given above include both the cairn and the area of scattered rocks. The original shape may have been square with sides c. 0.90 m to 1.00 m long. It consists of pahoehoe slabs, stacked six courses high along the perimeters, with a core filling of cobble to pebble-size rocks. Two sides of the cairn appear to be intact. These sides form a rounded corner on the side facing Feature A.

FEATURE C: Terrace
FUNCTION: Agriculture
DIMENSIONS: 5.80 m by 5.00 m by 0.50 m maximum height
DESCRIPTION: This terrace is located 3.00 m north of Feature A. It consists of cobble and pebble fill built over a depression in pahoehoe. The north side is raised and faced to a maximum height of 0.50 m, with slabs stacked three courses high. The west perimeter of the terrace follows a pahoehoe outcrop and is also built up. The east perimeter is defined by an outcrop as well. Approximately half of the surface area is small boulder and cobble fill that is relatively level. The level portion of the surface is circular (1.90 m in diameter). Along the south edge of the terrace is a loosely stacked rock pile 0.90 m high.

FEATURE - : Pahoehoe excavations (20) and rock mounds (10)

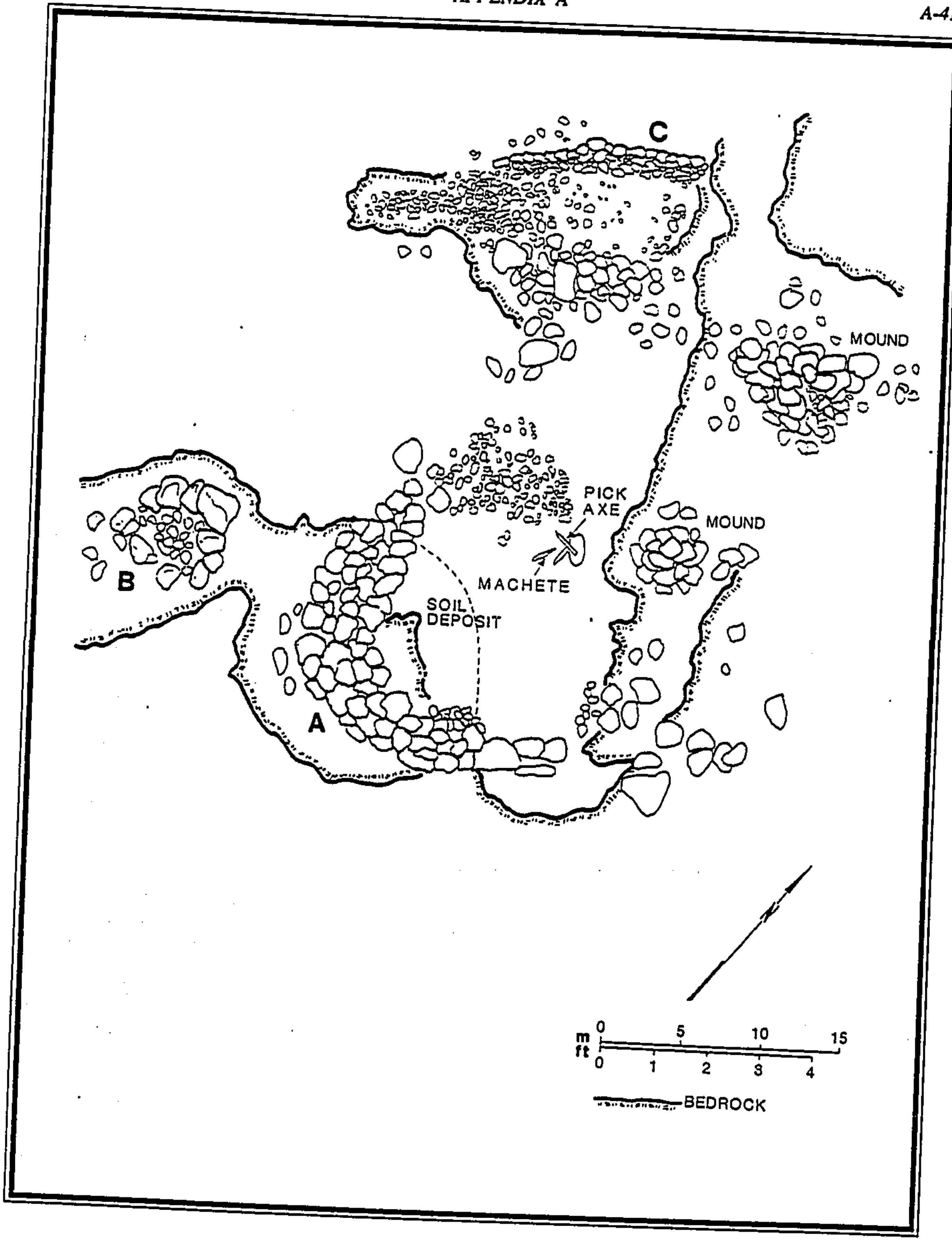

Figure A-15. SITE 13239.

FUNCTION: Agriculture
DESCRIPTION: There are probably additional minor modifications within and adjacent to the area delineated here for feature enumeration.

SITE NO.: State: 13240 PHRI: T-80
SITE TYPE: Complex (33+ Features)
TOPOGRAPHY: Pahoehoe flow sloping to the southwest.
VEGETATION: Christmas-berry, alahe'e, fountain grass, guava trees, lantana and air plant.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Twenty rock mounds, 10 pahoehoe excavations and three faced mounds were identified within an area 50.0 m N-S by 30.0 m E-W. Scattered pahoehoe pieces, apparently removed from excavated areas, are present over most of the site surface.

FEATURE - : Rock mounds (20+)
FUNCTION: Agriculture
DESCRIPTION: The rock mounds at this site are generally circular at the base and somewhat conical. Average size of the mounds is c. 2.00 m by 2.00 m by 1.50 m high.

FEATURE - : Pahoehoe excavation (10+)
FUNCTION: Agriculture
DESCRIPTION: The average size of the pahoehoe excavations is c. 2.0 m by 3.0 m by 0.50 m. deep

FEATURE - : Faced rock mound (3+)
FUNCTION: Agriculture
DESCRIPTION: Three circular mounds exhibit faced sides. These mounds range from 1.00 to 2.00 m in diameter and have an average height of 0.60 m.

SITE NO.: State: 13241 PHRI: T-81
SITE TYPE: Complex (49 Features)
TOPOGRAPHY: Gently sloping pahoehoe with blisters. Major cultural modifications to flow.
VEGETATION: Christmas-berry, lantana, alahe'e, koa-haole, vines and thick grasses on Feature A.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-possible habitation
DESCRIPTION: Two terraces (Features A and C), a modified outcrop (Feature B), an L-shaped mound (Feature C), 24 modified outcrops and 21 rock mounds were identified at this site. Overall area of the site is 69.0 m E-W by 59.5 m N-S. No portable remains were observed on the site. A small pocket of soil was observed at Feature B.

FEATURE A: Terrace
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 7.60 m by 5.40 m by 0.30 m maximum height
DESCRIPTION: This rectangular terrace consists of pahoehoe boulders and cobbles, and incorporates portions of a naturally raised pahoehoe outcrop. The north and west sides are defined with straight alignments, and the north side is raised and stacked two to three courses high. The surface of the terrace is not formally paved, and exposed portions of the underlying outcrop are visible. Small rock piles up to 0.50 m high are present on the terrace surface. Additional linear rock piles extend off to the sides but they are generally distinct from the terrace.

FEATURE B: Cupboard
FUNCTION: Agriculture
DIMENSIONS: 1.10 m deep by 0.45 m wide by 0.30 m ceiling height
DESCRIPTION: This modified outcrop is located c. 10.0 m northwest of Feature A. It consists of a large slab placed on an upright square boulder and an outcrop, forming a protected cupboard. The cupboard is inside an excavated pahoehoe blister that has been cleared of loose rock. The area outside the cupboard and inside the pahoehoe excavation is 1.60 m by 0.67.m, and 0.35 m deep. Small rock piles are present around the perimeters of this cleared area. Very dark, cindery soil was noted inside the cupboard.

FEATURE C: L-shaped rock mound
FUNCTION: Agriculture
DIMENSIONS: 7.00 m by 5.80 m by 0.60 m average height
DESCRIPTION: Feature C is located 2.90 m west of Feature A. It is a loosely piled L-shaped mound of pahoehoe slabs and boulders. The mound incorporates a pahoehoe excavation and some sections are built up in circular perimeters around low spots. The N-S section is 5.80 m long and the E-W section is is 7.0 m long. Average width is 2.20 m and the average height is 0.60 m. There are three circular rock piles between Features A and C. Average size of the rock piles is 2.0 m by 1.8 m and 0.6 m high.

FEATURE D: Terrace
FUNCTION: Agriculture
DIMENSIONS: 4.47 m by 4.40 m by 0.85 m maximum height
DESCRIPTION: This terrace is 22.50 m from Feature C at 145 degrees Az. It consists of loosely stacked pahoehoe

blocks and is raised (but not faced) on the south side. The terrace surface is flat, but is not formally paved. Surface fill is generally loose, large cobbles. Pahoehoe excavations were noted around the perimeter.

FEATURE - : Modified outcrops (24)
FUNCTION: Agriculture

FEATURE - : Rock mounds (21)
FUNCTION: Agriculture

SITE NO.: State: 13242 PHRI: T-82 ***(Figure A-16)***
SITE TYPE: Steppingstone trail
TOPOGRAPHY: Undulating aa flow sloping to the southwest; a pahoehoe ridge is at the southwest side of the site.
VEGETATION: Christmas-berry, alahe'e and fountain grass.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 70.00 m by 0.75 m by 0.10 m (approx.)
DESCRIPTION: The trail is oriented 250-70 degrees Az. It consists of a linear pattern of small pahoehoe slabs placed on an aa surface, forming steppingstones. The NE and SE ends of the trail are paved with tightly spaced slabs while parts of the central section of the trail have loosely spaced small and large slabs. The SW end of the trail segment as currently identified is at a pahoehoe ridge. The NE end is at a depression in the aa flow. Two cairns (Site 13245) are located c. 25.00 m to the east and may be associated with the trail.

SITE NO.: State: 13243 PHRI: T-83
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: Partially set on an old Palani Road bed which is leveled with crushed basalt; on pahoehoe with a southwest slope.
VEGETATION: Christmas-berry, alahe'e and low ferns.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Recent historic
FUNCTIONAL INTERPRETATION: Habitation (recent)
DESCRIPTION: The site consists of a C-shape (Feature A), two hearths (Features B and C) and a wall (Feature D). Overall site area is c. 15.0 m N-S by 6.0 m E-W. These features may be of recent construction.

FEATURE A: C-shape
FUNCTION: Habitation (recent)
DIMENSIONS: 3.00 m by 2.25 m by 0.50 m maximum height
DESCRIPTION: The C-shape partially surrounds a fire pit and may have functioned as seating. It consists of thick pahoehoe slabs and is one to two courses high, with an opening to the east.

FEATURE B: Hearth
FUNCTION: Habitation (recent)
DIMENSIONS: 0.60 m by 0.60 m
DESCRIPTION: The C-shape (Feature A) partially surrounds the fire pit. The hearth appears to have had little use; recent rubbish is located in and around the feature.

FEATURE C: Hearth
FUNCTION: Habitation (recent)
DIMENSIONS: 0.90 m by 0.80 m by 0.40 m (approx.)
DESCRIPTION: A second hearth is present 2.50 m east of Feature A. The hearth appears to have had little use.

FEATURE D: Wall
FUNCTION: Habitation (recent)
DIMENSIONS: 2.25 m long by 0.85 m maximum height
DESCRIPTION: Three meters to the north of the C-shape (Feature A) is a stacked wall of large cobbles. It stands between two small alahe'e trees in a *N-S direction. This* wall lies across a section of the old Palani Road bed, which is oriented E-W.

SITE NO.: State: 13244 PHRI: T-85
SITE TYPE: Kerbstone trail
TOPOGRAPHY: Aa and pahoehoe flows sloping towards the southwest.
VEGETATION: Christmas-berry, alahe'e, fountain grass, low ferns, scrub lantana and koa-haole.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 350.00 m by 3.00 m by 0.75 m maximum height
DESCRIPTION: This is a cleared trail that has been graded to level across low-lying areas. The sides are defined by aligned cobbles and scattered boulders, and are very rough in places with minor construction. The trail is oriented in a generally E-W direction at the south end, then curves to a more N-S direction and continues to the project area boundary near Kealakehe Elementary School.

SITE NO.: State: 13245 PHRI: T-86
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: In a depression between an aa flow to the west and a pahoehoe flow to the east. The aa flow may have been modified by bulldozer.

Figure A-16. SITE 13242. VIEW TO WEST-SOUTHWEST (PHRI Neg. 1301-12)

VEGETATION: Christmas-berry, alahe'e, airplant and guava.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Marker-agriculture
DESCRIPTION: Two cairns (Feature A) and a rock mound (Feature B) were identified within an area 6.00 by 1.00 m at this site. No portable remains or deposits were observed.

FEATURE A1: Cairn
FUNCTION: Marker
DIMENSIONS: 0.90 m by 0.85 m by 0.85 m maximum height
DESCRIPTION: This cairn is the northernmost of two cairns built in a slight depression that is paved with aa clinkers. The cairn consists of small to medium aa boulders and pebbles, and the top of the cairn is piled with three to four pahoehoe slabs. The cairn is pyramid-shaped and circular at the base.

FEATURE A2: Cairn
FUNCTION: Marker
DIMENSIONS: 1.15 m by 1.00 m by 1.10 m maximum height
DESCRIPTION: The cairn is located 5.00 m southeast of Feature A1. It has an identical construction style as Feature A1 and includes aa boulders and pebbles with stacked pahoehoe slabs on top.

FEATURE B: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 1.90 m by 1.10 m by 0.75 m (approx.)

DESCRIPTION: This oval mound is located 1.00 m from Feature A1. It consists of loosely piled basalt boulders and cobbles, with a surface aa clinkers and cobbles.

SITE NO.: State: 13246 PHRI: T-87
SITE TYPE: Complex (6+ Features)
TOPOGRAPHY: Undulating pahoehoe flow sloping to the southwest; c. 15.0 m west of Palani Road.
VEGETATION: Alahe'e, Christmas-berry, guava, low ferns and noni.
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric/historic
FUNCTIONAL INTERPRETATION: Agriculture-transportation
DESCRIPTION: Features identified and recorded at this site include a historic roadbed (Feature A), three linear mounds (Features B, C and F), two alignments (Feature D), and a pahoehoe excavation (Feature E). Additional pahoehoe excavations were observed but not individually measured at the site. Overall site area is 25.00 m N-S by 15.0 m E-W, and it is c. 25.0 m west of Palani Road.

FEATURE A: Roadbed
FUNCTION: Transportation
DIMENSIONS: 30.00 m by 0.00 m by 0.50 m (approx. height)
DESCRIPTION: This machine-made roadbed is probably a former location of Palani Road. Additional sections were noted in other areas along the existing roadway. The section identified at this site was followed for 30.0 m; it connects with the shoulder area of the existing road.

FEATURE B: Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 4.20 m by 1.80 m by 1.05 m maximum height
DESCRIPTION: This is the northernmost of two linear mounds lying along the outer edges of a pahoehoe excavation. The south side of the mound is faced, with pahoehoe slabs stacked up to five courses.

FEATURE C: *Linear rock mound*
FUNCTION: Agriculture
DIMENSIONS: 6.00 m by 2.40 m by 0.90 m maximum height
DESCRIPTION: This mound is located immediately west of Feature A, along the western edge of a pahoehoe excavation. It consists of loosely piled pahoehoe cobbles and slabs.

FEATURE D: Depression with two alignments
FUNCTION: Agriculture
DIMENSIONS: 6.00 m long
DESCRIPTION: There is a linear depression which has two stone alignments running along the north and south top edges and joining at the west end. The north alignment is partial bedrock and the SW alignment is built up on the edge of the Feature A roadbed. The north alignment is 6.0 m long and the south alignment continues with some breaks along the road tract. There is a small rock mound at the south side of the depression connecting with the southwest alignment. It measures c. 3.5 m by 1.75 m and 0.85 m high.

FEATURE E: Pahoehoe excavation with alignment
FUNCTION: Agriculture
DIMENSIONS: 3.50 m by 1.75 m by 0.85 m maximum depth
DESCRIPTION: On the SW side of the site, adjacent to the road tract (Feature A) is another excavated depression with

the quarried material piled in an alignment on the western (downslope) side of the excavation. Some of this material is also piled on the south edge of the excavation.

FEATURE F: Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 3.10 m by 2.35 m by 0.75 m maximum height
DESCRIPTION: This linear mound is located on the north side of the roadbed (Feature A). This mound is possibly push from the road tract but also may be agricultural in nature.

SITE NO.: State: 13247 PHRI: T-88
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: Irregular aa flow sloping to the west.
VEGETATION: Alahe'e, koa-haole, air plant, kukui, wiliwili, Christmas-berry, guava, shower tree, mamaki and scrub bushes.
CONDITION: Poor
INTEGRITY: Altered by bulldozing
PROBABLE AGE: Indeterminate
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Two linear mounds (Feature A), a cleared depression (Feature B) and a stepped terrace (Feature C) were identified within an area c. 75.00 m E-W by 50.00 m N-S. The entire site area has been bulldozed and it is difficult to determine the extent of damage or alteration to the surface features.

FEATURE A: Linear rock mound (2)
FUNCTION: Agriculture
DESCRIPTION: There are many linear mounds in the area, most of which were obviously created by bulldozing. Two of the mounds appear to have been stacked by hand prior to disturbance. Current shape and dimensions are, however, affected by bulldozing.

FEATURE B: Cleared depression
FUNCTION: Agriculture
DIMENSIONS: 5.00 m by 5.00 m
DESCRIPTION: There is one aa depression which may be an excavation. Loose rubble surrounds this depression with no obvious facing. This feature has also been affected by bulldozing.

FEATURE C: Stepped terrace
FUNCTION: Agriculture
DESCRIPTION: One possible stepped terrace is located on the east side of the site, but it is surrounded by bulldozer activity and may be the result of just such an activity. The original dimensions are indeterminate.

SITE NO.: State: 13248 PHRI: T-89
SITE TYPE: Wall
TOPOGRAPHY: On relatively steep pahoehoe slope.
VEGETATION: Alahe'e, Christmas-berry, cactus, lauae, guava, air plants, lantana, low ferns and a'ali'i.
CONDITION: Good
INTEGRITY: Fair
PROBABLE AGE: Probable historic
FUNCTIONAL INTERPRETATION: Land division
DIMENSIONS: 134.00 m by 0.80 m by 1.60 m maximum height
DESCRIPTION: This double-faced, core-filled wall is located immediately west of Palani Road, at the junction of Kealakaa Street. It is oriented 340/160 degrees Az., and both ends have been broken by road construction. The wall is constructed with small pahoehoe boulders and aa rocks, and the core fill consists of small cobbles and pebbles.

SITE NO.: State: 13249 PHRI: T-90 ***(Figure A-17)***
SITE TYPE: Complex (7 Features)
TOPOGRAPHY: Along the crest and south facing slope of a pahoehoe ridge, and in the flat at the base of the slope. Scattered aa pockets on ridge crest.
VEGETATION: Thick air plants, immature koa-haole, lantana.
CONDITION: Poor-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: Four terraces (Features A, B1, C, D), a linear mound (Feature B2) and two rock mounds (Feature E, F) were identified within an area 30.00 m E-W by 17.00 m N-S at this site. No portable remains or cultural deposits were observed, but the surface was generally not visible at the time of survey. Soil was observed intermixed with terrace fill and at the base of the ridge slope.

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 11.50 m by 6.00 m by 1.10 m maximum height
DESCRIPTION: The terrace is built along a naturally stepped slope of a pahoehoe ridge. It is generally elliptical, and follows the natural configuration of the outcrops along the slope. The east, south, and west sides of the terrace are raised and faced; height of the faced sides varies with natural contours. Maximum wall height is at the western corner, where a 1.00 m long section is faced with aa cobbles, stacked five courses high. The east end of the terrace is also nicely faced, stacked four courses high (0.94 m). The southern area of the terrace has aa cobbles piled c. 1.10 m back (north) from the edge of the slope.

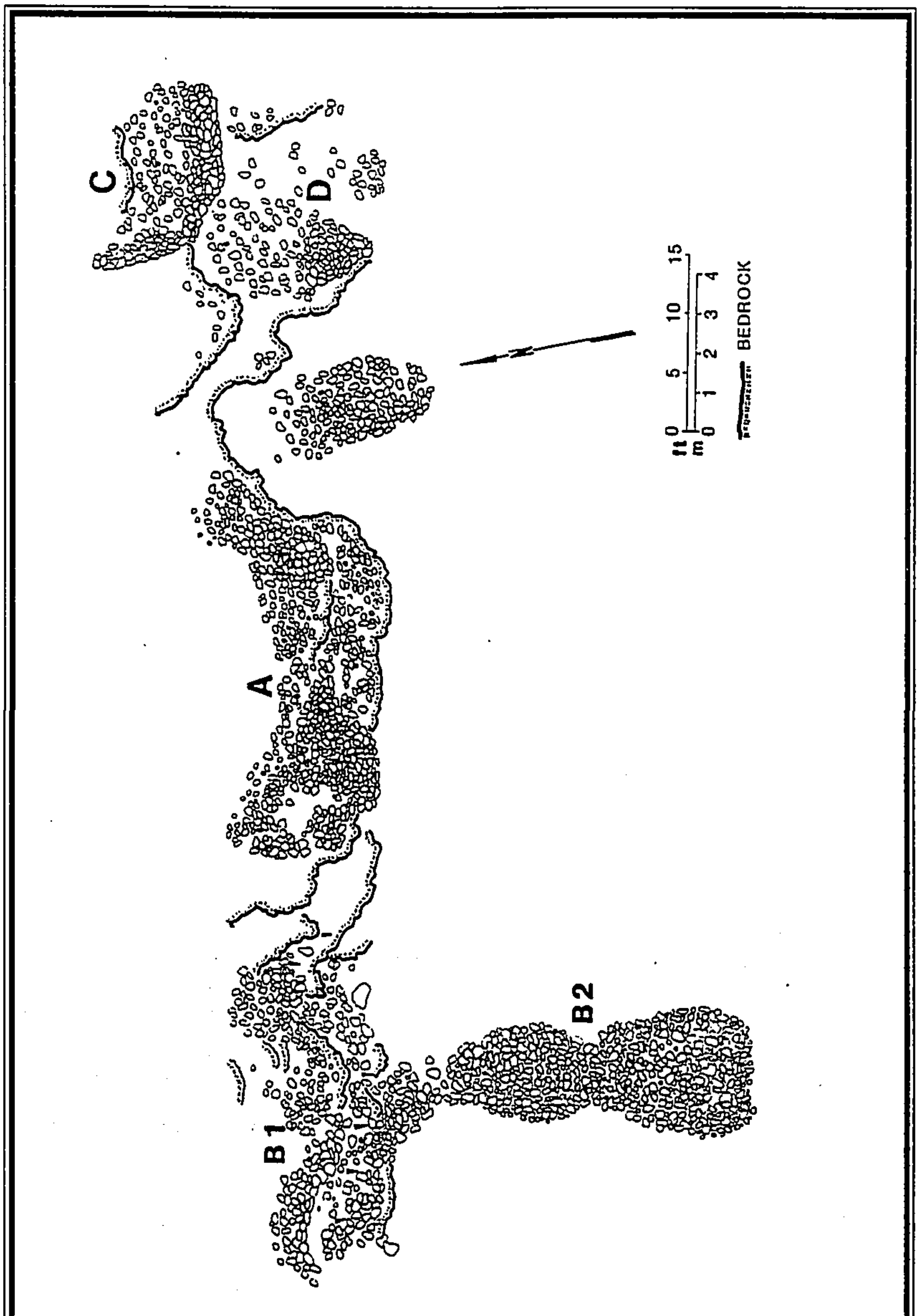

Figure A-17. SITE 13249

Flat, leveled surfaces are present on two levels. The upper level surface is on the edge of the ridge crest, at the western end of the terrace. This flat is c. 2.00 m E-W by 1.50 m N-S and paved with aa pebbles. The lower level is midway along the slope, 0.40 m above the base of the slope. Three relatively small flats are present at this level, the largest of which is 1.50 E-W by 0.80 N-S. These areas are also paved with aa pebbles.

FEATURE B1: Terrace
FUNCTION: Agriculture
DIMENSIONS: 6.20 m by 3.70 m by 0.50 m maximum height
DESCRIPTION: This terrace is located 4.25 m west of Feature A, along the same ridge slope formation. It is semi-circular, and follows the natural configuration of the ridge. The terrace consists of aa cobbles and pebbles, and has filled flat areas at two levels; the south side is raised, but no faced sections are present. Maximum perimeter height is one course. The terrace surface is filled with aa cobbles and pebbles, with portions of the natural outcrop protruding through the fill.

FEATURE B2: Linear rock mound
FUNCTION: Agriculture
DIMENSIONS: 9.50 m by 3.50 m by 0.32 m maximum height
DESCRIPTION: A linear rock mound extends southward from the terrace slope, near the center of the Feature. This mound has a maximum height of 0.32 m, which is at the southern end. Width varies from 1.00 m at the north end to 3.50 m at the south end. The northern end of the mound is incorporated into the lower level of the terrace.

FEATURE C: Terrace
FUNCTION: Agriculture
DIMENSIONS: 4.90 m by 2.50 m by 0.83 m maximum height
DESCRIPTION: Feature C is located 6.00 m east of Feature A, on the edge of the ridge crest. It is semi-circular, and incorporates an outcrop on the upper level of the pahoehoe ridge. It consists of aa cobbles, with the south and west sides crudely stacked three courses high. The raised sides vary from 0.30 to 0.83 m in height. The surface is loosely filled with aa cobbles. The terrace is partially collapsed in several areas.

FEATURE D: Terrace
FUNCTION: Agriculture
DIMENSIONS: 3.00 m by 2.52 m by 0.57 m maximum height
DESCRIPTION: This terrace is situated on a small natural shelf near the base of the ridge slope, 1.70 m south (and downslope) of Feature C. It consists of aa boulders and cobbles stacked two to three courses high along the east, west and south sides.

FEATURE E: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 5.10 m by 3.20 m by 0.80 m maximum height
DESCRIPTION: Feature E is located 8.50 m from Feature C (330 degrees Az.), on a flat area along the ridge crest. The mound consists of loosely piled aa cobbles and pebbles. It is teardrop in plan view and width varies from 3.20 to 2.00 m. A depression is present in the fill at the widest area of the mound. The depression is 0.70 by 0.60 and has a maximum depth of 0.30 m. A slightly lower tier is located off the northwest side of the mound; a short faced section is situated along the side of the mound at this point.

FEATURE F: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 4.00 m by 2.00 m by 0.30 m maximum height
DESCRIPTION: This low rock mound is located at the base of the ridge slope, midway between Features A and D. It consists of loosely piled aa cobbles and pebbles. No formal stacking or facing was observed.

SITE NO.: State: 13250 PHRI: T-91
SITE TYPE: Terraced rock mound
TOPOGRAPHY: Along the south-facing gradual slope of an aa ridge. The mound incorporates a natural face along the aa which is oriented E-W.
VEGETATION: Air plants, koa-haole and immature Christmas-berry.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DIMENSIONS: 14.65 m by 1.30 m by 0.70 m maximum height
DESCRIPTION: This linear mound is oriented N-S along the south-facing slope of a naturally stepped aa ridge. Along the west side of the mound are three partially cleared and leveled terraces that incorporate the natural topography as well as the mound structure.

The mound consists of loosely piled aa boulders, cobbles and pebbles. A short section of the west side below the stepped terraces is somewhat faced. This is also the area of maximum height. The small stepped terraces have less than 1.00 sq m surface area each, and are an average of 0.40 high. The south perimeters of these small flats consist of natural outcrops with some modification.

SITE NO.: State: 13251 PHRI: T-92
SITE TYPE: Enclosure
TOPOGRAPHY: The terrain consists of pahoehoe and aa flows.
VEGETATION: Air plants, lantana, Christmas-berry, kiawe and koa-haole.
CONDITION: Poor
INTEGRITY: Considerable alteration by bulldozing
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture/ ranching
DIMENSIONS: 27.00 m by 28.00 m by 0.90 m maximum height
DESCRIPTION: The enclosure may have been roughly square; it is currently too disturbed to definitely determine original plan view. It consists of pahoehoe cobbles and boulders stacked with no core fill; however, original wall construction cannot be accurately determined. The north, south and west walls have been almost obliterated by bulldozing. The east wall is discernable primarily as a linear rubble pile. The interior area is totally bulldozed.

SITE NO.: State: 13252 PHRI: T-93 ***(Figure A-18)***
SITE TYPE: Complex (17 Features)
TOPOGRAPHY: Western slope of natural aa and pahoehoe outcroppings.
VEGETATION: Dense koa-haole, fountain grass, plants with small red and blue flowers, Christmas-berry, lantana, grass and lilikoi.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-possible habitation
DESCRIPTION: Seventeen features were identified within a 50.00 by 50.00 m area at this site. This count does not represent the total number of features present or the total site area. Features present within the sampled area include three faced mounds (Features A, B, D), an enclosure (Feature C), three paved areas (Features E1, I, J), two cairns (Features E2, E3), a pahoehoe excavation (Feature E4), two rock mounds (Features E5, K), and two walls (Features E6, E7). No portable remains were observed; however, a medium brown, coarse loam deposit up to 0.10 m thick is present over most of the site surface.

FEATURE A: Faced rock mound
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 5.40 m by 2.20 m by 0.70 m maximum height
DESCRIPTION: This rock mound consists of aa and pahoehoe boulders and clinkers, crudely stacked six to seven courses high along the southeast face. The north and west sides are loosely piled and unfaced. At the southeast corner of the mound there is a 2.5 m by 1.0 m paved area that has a deposit of dark brown loam beneath the aa gravel.

FEATURE B: Faced rock mound
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 4.10 m by 2.80 m by 0.80 m maximum height
DESCRIPTION: Feature B is located 2.50 m from Feature A at 110 degrees Az. It consists of aa cobbles and is roughly faced on the western side; all other sides are sloping down to the ground surface. The faced side consists of larger cobbles stacked up to four courses high. Small soil pockets were observed within the mound.

FEATURE C: Enclosure
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 6.20 m by 6.10 m by 0.45 m maximum height
DESCRIPTION: This feature is 4.60 m from Feature B at 148 degrees Az. It consists of a two-compartment enclosure with a faced rock mound along the northwest side. The feature incorporates a natural pahoehoe outcrop that has been modified by excavation along the south side. The southern compartment of the enclosure is defined by the pahoehoe excavation and by a loosely piled rubble wall, which delineates the north and south compartments. The north compartment may have been constructed by clearing loose pahoehoe and aa from a low area and piling the rubble around the edges of the depression.

The interior area of the south compartment is 2.1 m by 1.0 m by 0.45 m deep. The interior is clear except for scattered gravels, and contains a 0.08-0.11 m thick deposit of medium brown loam. The north compartment has an interior area 2.0 m by 2.70 m by 0.40 m deep. The floor has four or five large cobbles atop a layer of small cobbles and a thin (c. 0.01 cm) deposit of soil. A mound, which may be the result of clearing for this compartment, is present along the west side. The mound consists of small cobbles piled on a natural pahoehoe outcrop. It is 3.90 m by 2.60 m by 0.40 m high.

FEATURE D: Faced rock mound
FUNCTION: Agriculture
DIMENSIONS: 2.60 m by 2.20 m by 1.20 m maximum height
DESCRIPTION: This faced rock mound is located 19.0 m from Feature C at 220 degrees Az. It consists of pahoehoe slabs stacked four to six courses high on the north, faced side. Along the south side of the stacked slabs are loosely

Figure A-18. SITE 13252, FEATURE D. VIEW TO SOUTH
(PHRI Neg.1306-30)

piled pahoehoe and aa cobbles. The mound slopes along the south side, with the exception of two possible upright pahoehoe slabs that are incorporated into the mound.

FEATURE E1: Walled pavement
FUNCTION: Agriculture/possible habitation
DIMENSIONS: 20.00 m by 14.60 m by 0.90 m maximum wall height
DESCRIPTION: This cleared paved area is located c. 4.50 m east of Feature C. The area is roughly rectangular, and bounded on two sides by walls (Features E6, E7). The cleared area incorporates natural terracing along the face of a rough pahoehoe outcrop. Pavement consists of aa pebbles and clinkers. Four features are located on the paved surface. These include two cairns (Features E2, E3), a pahoehoe excavation (Feature E4), and a rock mound (Feature E5).

FEATURE E2: Cairn
FUNCTION: Marker
DIMENSIONS: 0.60 m by 0.65 m by 0.50 m maximum height
DESCRIPTION: This cairn in the south portion of the paved area, midway between the two walls. It consists of aa cobbles stacked two to three courses high.

FEATURE E3: Cairn
FUNCTION: Marker
DIMENSIONS: 0.70 m by 0.40 m by 0.45 m maximum height
DESCRIPTION: This cairn is 8.00 m west of Feature E2, on the paved area. It consists of three large aa cobbles stacked two courses high.

FEATURE E4: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 3.00 m by 2.50 m by 0.60 m deep
DESCRIPTION: A semicircular pahoehoe excavation is located at the northwestern end of the Feature E1 paved area. It is partially cleared with some cobbles tossed along the outside on a ledge. Several small cobbles remain inside the excavation.

FEATURE E5: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 4.90 m by 2.50 m by 0.50 m maximum height
DESCRIPTION: The mound is situated in the center of the paved area, between the cairns and the pahoehoe excavation. It consists of loosely piled pahoehoe cobbles. Six pahoehoe boulders are aligned along the northeast side of the mound.

FEATURE E6: Wall
FUNCTION: Agriculture
DIMENSIONS: 9.70 m by 2.70 m by 0.90 m maximum height
DESCRIPTION: This wall is oriented north-south and defines the eastern edge of the paved area. It consists of pahoehoe boulders and cobbles, and is roughly faced on the western side.

FEATURE E7: Wall
FUNCTION: Agriculture
DIMENSIONS: 14.20 m by 1.10 m by 0.45 m maximum height
DESCRIPTION: Feature E7 is oriented east-west and defines the southern edge of the paved area. It consists of large pahoehoe boulders and cobbles, loosely piled one to two courses high. The wall is not faced, and portions of the wall appear to be collapsed.

FEATURE F: Terrace with central depression
FUNCTION: Agriculture
DIMENSIONS: 8.20 m by 6.00 m by 0.70 m (approx.)
DESCRIPTION: This feature is located 2.00 m north of Feature E6. It is oval in plan view and raised on the west side. It consists of pahoehoe and aa cobbles, and paved with aa gravel. A natural depression 2.0 m in diameter is present in the center of the terrace. The depression contains several large pahoehoe cobbles, and a soil deposit. Soil was also observed mixed with the gravel paving fill on top of the terrace.

FEATURE G: Terrace
FUNCTION: Agriculture
DIMENSIONS: 5.30 m by 5.50 m by 0.95 m maximum wall height
DESCRIPTION: Feature G is located just south of Feature F. It consists of pahoehoe and aa cobbles and raised along the southwest side. The terrace incorporates a natural pahoehoe shelf. A stacked perimeter is present along the northwest side of the terrace, following a flow edge. The surface is paved with aa gravel that is intermixed with loamy soil deposits.

FEATURE H: Wall
FUNCTION: Agriculture
DIMENSIONS: 29.00 m by 7.10 m by 1.20 m maximum height
DESCRIPTION: This wall is located c. 7.00 m southwest of Feature E1. It is L-shaped, and is partially faced. The wall is subdivided into three sections, each exhibiting a

different construction technique. The northeastern section is 5.40 m long, 2.00 m wide and 1.20 m high. It is faced on the south side only; the top of this section is flat and triangular. The second section (to the southwest) is 3.10 m long, 1.00 m wide and 0.55 m high. It is also faced on the south side, but is considerably lower and narrower than the adjacent section. Section three is 19.70 m long, 2.00 m wide and an average of 0.50 m high. This section consists of loosely mounded pahoehoe boulders and cobbles.

FEATURE I: Pavement
FUNCTION: Agriculture
DIMENSIONS: 4.30 m by 3.30 m
DESCRIPTION: Feature I is adjacent to the west side of the Feature H wall, in a natural pahoehoe flat. The pavement consists of aa clinkers, intermixed with a loamy soil deposit 0.01 to 0.03 m thick.

FEATURE J: Pavement
FUNCTION: Agriculture
DIMENSIONS: 10.40 m by 6.80 m
DESCRIPTION: This pavement is located on the east side of the Feature H wall, on a natural pahoehoe flat that has been cleared of large pieces of rubble and scattered with aa gravel. The feature is also covered with a deposit of brown, coarse loamy soil 0.01 to 0.05 m thick.

FEATURE K: Rock mound
FUNCTION: Agriculture
DIMENSIONS: 3.00 m by 2.00 m by 0.60 m maximum height
DESCRIPTION: Located 15.00 m from Feature C at 305 degrees Az, this mound consists of loosely piled pahoehoe and aa cobbles, two to four courses high.

SITE NO.: State: 05011 PHRI: T-94
SITE TYPE: Wall
TOPOGRAPHY: Aa and pahoehoe lava flows sloping to the southwest.
VEGETATION: Christmas-berry, koa-haole, lantana, akia, grasses, lauae and scrub brush.
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric/historic
FUNCTIONAL INTERPRETATION: Land division
DIMENSIONS: 2220.00 m by 0.70 m by 1.50 m average height
DESCRIPTION: This wall follows the ahupuaa boundary between Kealakehe and Keahuolu. It consists of aa and pahoehoe, small to medium boulders and small to large cobbles. The wall is bifaced and core-filled. The wall is oriented an average of c. 220/40 degrees Az. and has a few bends in the eastern section. The east and west ends are currently defined by the boundaries of developed areas, and do not represent the original ends of the wall.

SITE NO.: State: 13254 PHRI: T-95 ***(Figure A-19)***
SITE TYPE: Complex (74+ Features)
TOPOGRAPHY: The terrain is irregular pahoehoe with a gentle southwest-facing slope.
VEGETATION: Dense Christmas-berry, noni, air plants, succulents, alahe'e, fountain grass and other varieties of grass, shower tree, koa-haole, 'ilima, vines and lantana.
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation-agriculture-transportation-possible burial
DESCRIPTION: Twenty-nine features were recorded and a total of 74 features were enumerated within an area 140.0 m E-W by 100.0 m N-S at this site. Recorded features include 17 terraces, six faced mounds, three walls, a steppingstone trail, a platform and an enclosure. An additional 30 rock mounds and 15 pahoehoe excavations were counted within the sampled area. There are additional features beyond the boundaries of the sample area, which does not represent the entire site area.

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 2.81 m by 2.77 m by 1.27 m maximum height
DESCRIPTION: Feature A incorporates a pahoehoe outcrop, and is raised and faced along the west side. The terrace consists of small pahoehoe boulders to cobbles. It consists of loosely stacked rocks at the base with the top filled with smaller rocks. The south side of the terrace appears to have four steps leading up to the terrace surface. Two steps are natural rock shelves and two are paved cobble surfaces.

FEATURE B: Terrace
FUNCTION: Agriculture
DIMENSIONS: 6.20 m by 2.60 m by 1.46 m maximum height
DESCRIPTION: The terrace is located 17.0 m from Feature A at 54 degrees Az. It is L-shaped, and is located on the side of a steep outcrop face. It consists of small aa boulders to pebbles, and paved with aa cobbles and pebbles. The feature may have been affected by bulldozer activity.

FEATURE C: Terrace
FUNCTION: Agriculture
DIMENSIONS: 33.50 m by 3.50 m by 1.50 m maximum height

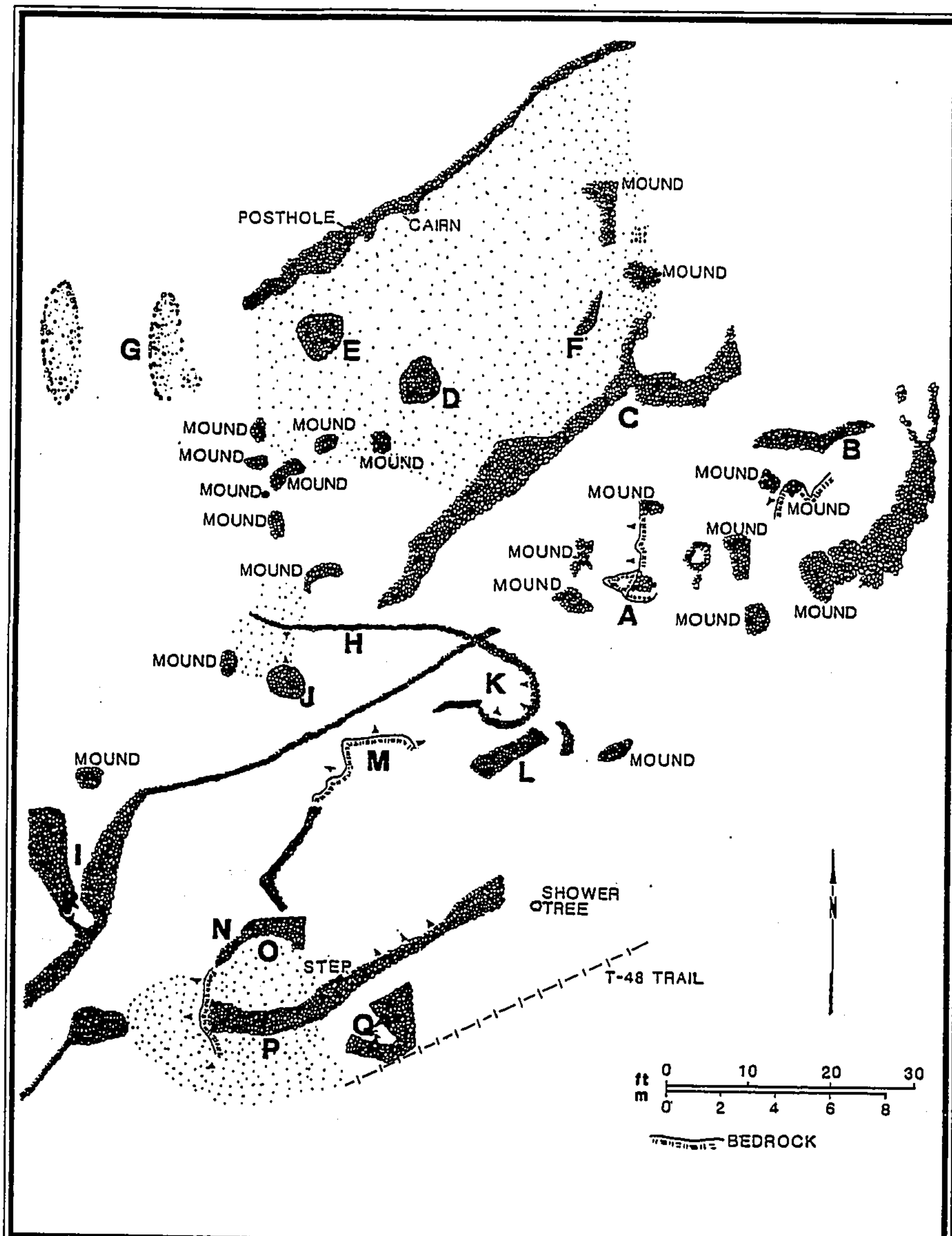

Figure A-19. SITE 13254

DESCRIPTION: Feature C is located 6.5 m west of Feature B. It is a collapsed terrace/retaining wall consisting of small aa boulders to pebbles. It follows the east-facing edge of an aa flow, which is an average of 1.00 m above the surrounding surface to the east.

FEATURE D: Faced mound
FUNCTION: Agriculture/possible burial
DIMENSIONS: 4.68 m by 3.50 m by 0.65 m maximum height
DESCRIPTION: Located 8.0 m from Feature C at 318 degrees Az, Feature D consists of tightly stacked aa boulders, cobbles and pebbles. The northeast and south walls may have been faced, but the remainder of the structure has collapsed.

FEATURE E: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 4.00 m by 3.50 m by 0.85 m maximum height
DESCRIPTION: Feature E is located 8.00 m from Feature D at 286 degrees Az. It is a collapsed mound consisting of small aa boulders to cobbles. The north and east walls are faced with the remaining walls collapsed. The surface is not flat with the center being the highest point. A possible post hole is situated toward the center of the north side.

FEATURE F: Terrace
FUNCTION: Agriculture
DIMENSIONS: 6.00 m by 3.00 m by 0.50 m maximum height
DESCRIPTION: The terrace is located 5.00 m north of Feature C. It consists of small aa boulders to pebbles. The terrace surface is paved and the east side is raised and faced two to three courses high.

FEATURE G1: Terrace
FUNCTION: Agriculture
DIMENSIONS: 10.00 m by 3.10 m by 1.00 m maximum height
DESCRIPTION: Feature G1 is generally oval. It consists of small to large aa boulders stacked three to six courses high. The southeast side of the terrace is partially collapsed. The terrace is oriented in a northerly direction. It is c. 6.0 to 7.0 m away from the widened portion of the Site 13216 wall.

FEATURE G2: Terrace
FUNCTION: Agriculture
DIMENSIONS: 12.00 m by 3.50 m by 0.70 m maximum height
DESCRIPTION: This terrace is located c. 3.5 m west of Feature G1. It is oval and is built with small to medium aa boulders piled c. three courses high. The east side of the terrace is slightly faced. Feature G2 is also oriented in a northerly direction.

FEATURE H: Terrace
FUNCTION: Agriculture
DIMENSIONS: 16.00 m by 3.00 m by 0.40 m maximum height
DEESCRIPTION: Feature H is located 6.00 m from Feature C at 40 degrees Az. It consists of small aa boulders to pebbles. It is raised on the south side and the terrace surface is paved with aa pebbles.

FEATURE I: Wall
FUNCTION: Agriculture
DIMENSIONS: 103.00 m by 1.50 m by 0.60 m average height
DESCRIPTION: The wall connects with the eastern edge of Feature H and is 3.00 m south of Feature J. It is oriented NE-SW and consists of aa rocks. No faced sides or stacked sections were observed.

FEATURE J: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 3.25 m by 3.00 m by 0.92 m maximum height
DESCRIPTION: Feature J is located 3.00 m from Feature H at 172 degrees Az. It consists of small aa boulders to cobbles. There is evidence of facing on all four sides, but it is currently in a deteriorated condition.

FEATURE K: Terrace (3)
FUNCTION: Agriculture
DIMENSIONS: 7.00 m by 4.50 m
DESCRIPTION: These terraces are located at the north end of Feature I, 6.00 m southwest of Feature A. They are interconnected and incorporate naturally terraced features along exposed pahoehoe outcrops. They consist principally of aa cobbles and pebbles. The upper level terrace is oriented east-west and is 7.00 m long. The second terrace is on a slightly lower level; it is C-shaped, 4.50 m wide and 1.00 m long. This terrace connects with a rectangular terrace which is mostly natural, 4.00 m long by 3.5 m wide. Additional modifications may be present along the face of this natural terrace, which continues to the south.

FEATURE L: Terrace
FUNCTION: Agriculture
DIMENSIONS: 7.00 m by 6.00 m by 0.30 m maximum height
DESCRIPTION: This terrace is located 1.00 m south of Feature K. It is rectangular and consists of small aa boulders and cobbles. The northwest side is raised one to two courses high.

FEATURE M: Terrace
FUNCTION: Agriculture
DIMENSIONS: 5.60 m by 2.90 m by 0.20 m maximum height
DESCRIPTION: Feature M is located 3.00 m west of Feature L. It consists of small aa boulders to pebbles. It is raised on the west side, and the north side of the terrace is a bedrock outcrop.

FEATURE N: Terrace wall
FUNCTION: Agriculture
DIMENSIONS: 12.00 m by 1.00 m by 0.95 m maximum height
DESCRIPTION: This terrace wall extends southwest from the southwestern edge of Feature M, and connects with the northern edge of Feature O. It consists of aa boulders and cobbles stacked 3-4 courses high. The north side of the wall is faced. The south side is soil and paving, which is filled level with the top of the wall.

FEATURE O: Terrace
FUNCTION: Habitation
DIMENSIONS: 10.00 m by 4.60 m by 1.10 m maximum height
DESCRIPTION: The terrace consists of small to medium boulders and cobbles. It is faced on both the north and east sides. The central portion of the terrace contains a depression. The terrace abuts bedrock on the west side.

FEATURE P: Wall
FUNCTION: Possible agriculture
DIMENSIONS: 44.00 m by 1.05 m by 1.05 m maximum height
DESCRIPTION: Feature P is located along the southern perimeter of Feature N, and is oriented NE-SW. It consists of aa boulders and cobbles, stacked 2-3 courses high. Portions of the north side of the wall are faced but mostly it is collapsing. The southwest end of Feature P joins with and abuts the Feature N terrace wall.

FEATURE Q: Terrace
FUNCTION: Agriculture
DIMENSIONS: 8.00 m by 1.60 m by 0.85 m maximum height
DESCRIPTION: The terrace is located 1.00 m south of Feature P, near the center of the wall alignment. It is C-shaped, and opens to the northwest. The interior side of the wall is faced with large aa cobbles and varies in height from 0.10 m to 0.85 m. The area inside the wall is paved with level, tightly compacted aa pebbles. The top of the wall is level with the ground surface on the exterior side. Some collapse is shown in the facing but overall the terrace is in good shape.

FEATURE R: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 20.00 m by 1.50 m (approx.)
DESCRIPTION: The trail is oriented E-W and located 15.00 m northeast of Feature S. It consists of a linear pattern of pahoehoe slabs placed on the aa flow. There are at least four mounds present in the area around the trail.

FEATURE S: Wall with associated terrace
FUNCTION: Agriculture
DIMENSIONS: 38.00 m by 2.00 m by 0.60 m average height
DESCRIPTION: The wall passes within 15.00 m to the southwest of Feature R. It consists of medium to small aa boulders stacked three to five courses high, and has a core filling of small, compacted cobbles and pebbles. The eastern end of the wall forms a U-shaped curve, in which is located a terrace. The terrace is 11.90 m long and 5.40 m wide at the western (widest) end. The terrace is raised and faced along the western side with 4-5 courses of medium to small boulders. The surface of the terrace slopes downhill toward the southwest.

FEATURE T: Faced mound
FUNCTION: Agriculture/possible burial
DIMENSIONS: 3.00 m by 2.30 m by 1.00 m maximum height
DESCRIPTION: The mound is located at the southern end of Feature S. It consists of aa cobbles and occasionally small to large aa boulders, and may have been built on a small level area of soil. The southeastern side is faced; all other sides are currently sloping, which may be due to collapse. The surface is paved and leveled. and facing is evident on the southeast portion.

FEATURE U: Faced mound
FUNCTION: Agriculture/possible burial
DIMENSIONS: 4.00 m by 4.00 m by 1.50 m maximum height
DESCRIPTION: Feature U is located 10.00 m from Feature T at 160 degrees Az. The mound consists of aa boulders and cobbles and is faced on the southwest side, where boulders are stacked four courses high. The southeast wall is partially collapsed. The surface of the feature is mounded with aa cobbles.

FEATURE V: Platform
FUNCTION: Habitation/ceremonial/agriculture
DIMENSIONS: 4.00 m by 3.90 m by 1.20 m maximum height
DESCRIPTION: This platform is located 2.00 m west of Feature T. The roughly rectangular platform is faced on all

sides. The east and west walls are partially collapsed. It consists of small aa boulders to cobbles, crudely stacked five to six courses high. The platform fill is aa cobbles to pebbles and the surface is roughly level.

FEATURE W: Terrace
FUNCTION: Agriculture
DIMENSIONS: 6.00 m by 2.80 m by 0.80 m average height
DESCRIPTION: The terrace is located 1.00 m south of Feature S. It consists of large aa cobbles and pebbles, and is raised on the east side. This side is faced with large cobbles, crudely stacked four to five courses high. The terrace surface is level and paved with aa pebbles. No soil was observed here.

FEATURE X: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 7.50 m by 7.50 m by 0.40 m average wall height
DESCRIPTION: The circular enclosure is located 5.00 m north of Feature U. It consists of aa cobbles and boulders, stacked three to four courses high. Maximum wall width is 2.30 m. The interior of the enclosure wall was probably faced, but it is presently collapsed. The interior floor may have been paved with aa cobbles and pebbles. The interior area is 2.90 m in diameter.

Along the SW edge of the enclosure is a small C-shaped structure consisting of medium to small aa boulders. There may have been a paved interior floor but there is presently a lot of loose rubble. It measures c. 2.3 m (N-S) by 2.4 m (E-W) by 0.75 m in height. There is also a pahoehoe excavation and a rock mound in the immediate area.

FEATURE Y: Faced mound
FUNCTION: Possible burial/agriculture
DIMENSIONS: 3.70 m by 1.80 m by 0.60 m (approx.)
DESCRIPTION: Feature Y is located 5.00 m from Feature X at 170 degrees Az. It is rectangular, and may be a collapsed platform. It consists of large aa cobbles, small boulders, and slabs of aa, and is faced on four sides. The south and east faces incorporate upright stone slabs. The surface is slightly mounded. The south side lies on exposed bedrock that may extend under the feature.

SITE NO.: State: 13253 PHRI: T-96
SITE TYPE: Complex (11 Features)
TOPOGRAPHY: In a shallow ravine, at the base of a major aa flow to the south; a high pahoehoe slope to the north.
VEGETATION: Christmas-berry, fountain grass and other varieties of grass, koa-haole, and 'ilima
CONDITION: Fair-good
INTEGRITY: Minor alteration to Feature A; Feature K bulldozed
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Burial-transportation
DESCRIPTION: Three platforms (Features A,B,J), seven terraces (Features C-I), and a steppingstone trail (Feature K) were identified at this site, within an area 35.00 m N-S by 43.00 m E-W. The complex was previously identified as a burial site (Site 1) by Soehren (1977) during a survey in the adjacent parcel at Honokohau 2. Soehren located the northern portion of the trail in Honokohau and mapped the location of the complex, but did not record descriptive data on individual features, since the complex was beyond his study area.

Immediately east of the site is an area that has been filled and leveled by bulldozing. The portion of the trail that crossed this area from the north is obliterated. If additional features were present to the west of the existing features, they would also now be destroyed.

The intact features are patterned in a linear arrangement along the base of a high aa flow. The north face of the flow is nearly vertical and raises an average of 2.00 m above the level of the features. The steppingstone trail follows the upper edge of the flow and has branch trails winding down the face of the flow to various features. To the north of the site is a high, relatively steep pahoehoe hill.

FEATURE A: Platform
FUNCTION: Burial
DIMENSIONS: 4.80 m by 4.80 m by 0.73 m maximum height
DESCRIPTION: This platform is the westernmost of the complex as it is currently identified. It is 32.50 m south of the Kealakehe/Honokohau 2 boundary, and 1.00 m north of the vertical face of the aa flow. The platform is five-sided, and length of the sides ranges from 2.60 to 2.95 m. Height of the sides ranges from 0.42 along the south face to 0.73 along the north face. It has a faced perimeter consisting of aa boulders and a few pahoehoe slabs. The platform is filled with small aa boulders and cobbles and paved with aa pebbles and small cobbles.

The surface of the platform is level and compacted, except where disturbed by a pothole. The pothole is 1.70 m from the east side of the platform. It is 0.90 by 0.50 m at the top and is excavated to a maximum depth of 0.45 m. Rocks removed from the hole are scattered over the platform surface. Portable remains observed on the feature consist of a deflated balloon on a string, apparently left quite recently.

FEATURE B: Platform
FUNCTION: Burial
DIMENSIONS: 3.46 m by 2.50 m by 0.50 m maximum height
DESCRIPTION: This small platform is located 5.60 m from Feature A at 115 degrees Az, and 6.00 m north of the vertical face of the aa flow. It is amorphous, determined primarily by natural rock features on which it is located. The perimeter of the platform consists of aa and pahoehoe boulders, stacked up to three courses high. Fill is aa and pahoehoe cobbles, with some pebbles on the surface. The surface is not formally paved or leveled by compaction. A 2.20 m long section of the platform abuts an outcrop shelf.

FEATURE C: Terrace
FUNCTION: Burial
DIMENSIONS: 5.00 m by 3.00 m by 1.00 m maximum height
DESCRIPTION: This D-shaped terrace is located 3.00 m from Feature B at 155 degrees Az, and abuts the vertical face of the aa flow. It looks like it has been constructed on a natural pahoehoe shelf. The north side is curved and raised, with a stacked aa boulder perimeter 0.80 to 1.00 m high. The surface is filled with aa cobbles and boulders. The southern side of the surface has been cleared of loose aa rubble, which is arranged in an alignment along the southern perimeter.

FEATURE D: Terrace
FUNCTION: Burial
DIMENSIONS: 3.50 m by 2.50 m by 0.70 m maximum height
DESCRIPTION: Feature D is a roughly rectangular terrace located 3.60 m from Feature C at 85 degrees Az. It incorporates a natural aa outcrop and is raised and faced on the south and west sides. The faced perimeter consists of aa cobbles, and fill is small cobbles and pebbles. The northern side of the feature is defined by an alignment, which delineates the terrace surface from an area which may have been artificially cleared of large aa rubble. This area is 2.00 m E-W by 0.92 m N-S.

FEATURE E: Terrace
FUNCTION: Burial
DIMENSIONS: 5.00 m by 3.50 m by 0.60 m maximum height
DESCRIPTION: This terrace abuts the vertical face of the aa flow, 14.50 m from Feature D at 90 degrees Az. It is rectangular and raised and faced on the north side. All other sides grade into the surrounding aa surface. The northern perimeter consists of aa cobbles stacked up to three courses high. This side follows the edge of a natural outcrop shelf. The surface is paved with somewhat compacted aa pebbles. Although it was not examined further, in general, the fill appears to be shallow. A small, recently constructed (?) cairn is located on the terrace, near the center. It consists of four small aa cobbles and is 0.32 m high.

FEATURE F: Terrace
FUNCTION: Burial
DIMENSIONS: 3.90 m by 3.90 m by 0.75 m maximum height
DESCRIPTION: Feature F abuts the vertical face of the aa flow, 3.50 m from Feature E at 70 degrees Az. It is circular and is built on the same natural outcrop shelf occupied by Feature E. The perimeter is faced along approximately 80% of the terrace circumference; the remaining 20% grades into surrounding aa surfaces. Height along the raised sides varies from 0.10 m on the west side to 0.75 m on the southeast side, where the perimeter is stacked to five courses. The terrace surface is nicely paved with packed and leveled aa pebbles. Exposed portions of the underlying bedrock surface can be seen through the pavement in places.

To the southeast of the terrace is a small cleared area against the aa scarp. It is 1.65 m N-S by 0.90 m E-W and is paved with aa pebbles.

FEATURE G: Terrace
FUNCTION: Burial
DIMENSIONS: 2.70 m by 2.64 m by 0.80 m maximum height
DESCRIPTION: This terrace is situated near the center of the ravine, 15.00 m north of the vertical face of the aa flow, and 6.20 m from Feature F at 65 degrees Az. It stands on a natural bedrock shelf which is mixed aa and pahoehoe. The north, west and south sides are raised and faced; the east side grades into the natural outcrop. Overall plan of the surface is oblong, but there are no squared corners. The perimeter consists of pahoehoe and aa boulders and cobbles. Fill is primarily aa with a surface paving of slightly packed aa pebbles and small cobbles. Portions of underlying bedrock are exposed through the pavement in places.

FEATURE H: Terrace
FUNCTION: Burial
DIMENSIONS: 1.90 m by 1.14 m by 0.25 m maximum height
DESCRIPTION: This small D-shaped terrace is built on a natural bedrock shelf at the base of the aa flow. It is 11.70 m from Feature G at 135 degrees Az. The ravine is quite narrow here and begins to slope uphill immediately north of the terrace. The northern, curved side of the terrace is raised and faced with aa cobbles stacked up to two courses high.

The fill is aa pebbles and the surface has no formal leveling or packing. Portions of natural bedrock are exposed through the fill. Present on the terrace is a fragment of a double-knit polyester shirt.

FEATURE I: Terrace
FUNCTION: Burial
DIMENSIONS: 5.70 m by 4.50 m by 0.65 m maximum height
DESCRIPTION: Feature I is situated on a natural shelf along the face of the aa flow, 5.5 m from Feature H at 140 degrees Az. It is raised and faced on the northeast, northwest and southeast sides. The perimeter consists of aa boulders and cobbles, and fill is aa pebbles and small cobbles. The terrace surface is nicely leveled and packed, and is recessed slightly lower than the perimeter walls.

Immediately to the south of the terrace, along the aa cliff, is a small overhang which may have been cleared and paved with aa pebbles. The floor area is 1.90 m E-W by 1.10 m N-S. The Feature K trail approaches this feature from the west along the aa scarp, and appears to terminate at this feature.

FEATURE J: Platform
FUNCTION: Burial
DIMENSIONS: 2.54 m by 2.40 m by 0.30 m maximum height
DESCRIPTION: This small oval platform is at the base of the aa flow, 3.70 m from Feature I at 120 degrees Az. It is the easternmost of the identified features. The platform incorporates a natural bedrock shelf. The perimeter consists of large aa cobbles and some pahoehoe pieces. Fill is small aa cobbles with no formal paving. Portions of natural bedrock are exposed through the fill in places. The feature has been affected by large Christmas-berry trees, growing immediately to the south.

FEATURE K: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 38.00 m by 0.8 maximum width
DESCRIPTION: The trail consists of a narrow corridor of crushed and packed aa clinkers with variously-spaced, inset pahoehoe slabs. The slabs average 0.30 m in diameter and are spaced from 0.40 to 2.00 m apart along the intact section of the trail. The western end of the trail is currently at the eastern edge of an extensive bulldozed area, 35.00 m from Feature A at 310 degrees Az. At the time of Soehren's survey (1975), the trail continued west to the coastal ponds at Honokohau (Soehren 1977:2).

The intact portion of the trail follows a generally east-west orientation, while following the upper, northern edge of the aa flow. At the west end, orientation is c. 50 degrees Az., then shifts to 80 degrees near the eastern end, at Feature I. Along the course of the trail, there are two branches that cut north, down the face of the flow to Features E, F and G. These branches do not have steppingstones. There is an unmarked survey datum pipe in the center of the trail, above Feature E.

APPENDIX B

HISTORICAL DOCUMENTARY RESEARCH

by Helen Wong Smith, B.A.
Historical Researcher

Most of the project area lies in the ahupua'a of Kealakehe, District of North Kona. Kealakehe means literally "the winding path" (Pukui and Elbert 1986). A small portion of the project area is in the ahupua'a of Keahuolu. Pukui et al. (1974:101) translates Keahuolu literally as "the heap of Lu." Although there is no explanation, we can assume "Lu" is a person's name. Emerson surveyed Keahuolu in the 1880s, and his map (Reg. Map 1280) denotes "rough pahoehoe, little vegetation" in the ahupua'a. Perhaps "the heap of Lu" refers to one of the many rock piles scattered throughout the region.

Few legends refer specifically to Kealakehe. Handy and Handy write of the Kona district in general:

> The most interesting mythological and legendary materials relating to Kona have to do directly or indirectly with Lono....The story of the origin of the Makahiki rain and harvest festival...bring Lono from Kahiki, whither he returns....From Kona we have the written record of a myth of Kumuhonua, whose writer says that Lono was a fisherman and yet ends his story by stating that the events related occurred before men peopled the earth....Disregarding the inconsistencies in orally transmitted lore, the point of interest with respect to Lono is that he is plainly identified with Kona, Hawaii, and is said to have introduced the main food plants, taro, sweet potato, yams, sugar cane and bananas to Hawaii, and also 'awa. Hogs were likewise identified with Lono, but there is no mention of his having brought them to Hawaii (Handy and Handy 1972:522).

Legends concerning Keahuolu are also scant. In his report of a reconnaissance survey of the Old Kona Airport area, which is now a state park in Keahuolu, Neller cites one:

> The area around the old Kona airport may also have some connection with the legendary Hawaiian chief Kuali'i. He was said to have been born at Kalapawai in Kailua, and defied the oppression of Lono-ikaika during the dedication of the heiau at Kawaluna. He is associated with Ku-kaili-moku, the god of victory in battle. Perhaps by coincidence, all of these place names are found in the beach park area (Neller 1980).

Two archaeological surveys conducted in the earlier part of the century describe several prehistoric sites in and around the project area. During a reconnaissance survey of Keahuolu, J.F.G. Stokes described the following religious structure:

> Heiau of Palihiolo, at Waikilohi, at or near the boundary of Keahuolu and Lanihau, North Kona; on the beach in an old coco-palm grove; this is an insignificant pen, 25 by 29 feet in size with small, thin walls built on the upper slopes of the beach. Coral has been spread over the floor as a paving. The only interest attaching to the place is the account given by a very old native living in the grove. He said that Palihiolo was formerly a heiau for human sacrifice, and that it was rebuilt by Kalakaua's orders before the latter left for the United States (about 1890). The old native also said that Kalakaua promised to have a sacrifice at Palihiolo on his return from America, but that he died in that country. The old native was very insistent on the truth of his statements. It might be mentioned that the surrounding grove of palms is where Kalakaua's grandfather was hanged for murder. Other information from the old native is given here for convenience, that this king ordered the rebuilding of the two heiaus of Kawaluna and Palihiolo where human sacrifices were formerly offered, and the ko'as of Halepa'u and Maka'eo....It might be remarked that these four structures have the appearance of having been rebuilt in recent times (Stokes 1919).

In reference to heiau committed to human sacrifice, Kamakau (1976) writes that these 'ohi'a ko "would...cause holding the breath (in fear)."

Reinecke's survey of Hawaiian sites on the Big Island (1930) gives this notation for Keahuolu: "Site 4. A group of masonry platform graves on the sand beach." Neller (1980) notes that this is referred to as "graves of chiefs" in Jackson's 1883 Field Notes, p.32.

Reinecke describes Hale o Lono Heiau in Kealakehe. He writes:

> Site 33. Hale o Lono Heiau, Kealakehe Homesteads. A plain platform originally about 4' high, sloping decidedly makai (north) perhaps 4' in 40'; length east and west 3-1/2-38', north and south 40'. It is built largely of water-rounded boulders of a size convenient for one man to carry. It may have been built in a double terrace, accounting for the slope, but it is hard to tell now. There is a slight terrace on the eastern side, 3 1/2' wide (1930:9-10).

Hale o Lono Heiau is depicted on a USGS map (1959), in addition to Hale o Mano Heiau. Although Reinecke does not locate the following sites, it is assumed that they are nearby, and Site 35 may be Hale o Mano:

> **Site 34.** A small shallow bay with an excellent canoe landing on the sand. At the west side is a platform with a great pile of boulders. There are a number of sites in the sand at the head of the bay, ending at the east in a platform; exact number cannot be told, [but it] is about six (ibid:10).
>
> **Site 35.** A heiau, name unknown, situated between the bay and a group of brackish pools. It is remarkable for the size of the stones used in its facing and for two great stone slabs, -kuula- fixed in the west or makai side. One slab is 7' x 3 1/4' x 12-15", the other 8' x 4 3/4' x 12-15". But one of the larger stones in the wall is no less than 5 x 4 x 1. The heiau is very carefully constructed the stones being joined with care, and only the S.E. corner being broken down.
>
> The length north and south is 53' with a slight slope to the south. It is built against the lava slope at the north. The width at the north is 25 1/2 x 9', there being a drop of 2 1/2' on the east; the width at the south is 35' — the identity being planned at 6', tho it is slightly less on the makai side. On the N.E. it is 4 1/4 x 2 1/2', the terrace being only about 16' long and merging into the main platform.
>
> At the north end is a house site or more probably a grave, marked by lava and coral pebbles, c. 13 x 10.
>
> Stretching back of the heiau in two directions are pools of brackish water, which have been rather carefully walled into compartments. Between the two arms is a house site, or platform resembling one. A well-built pen about 50 x 50 cuts across the southern arm. There is an entrance, and it must have been used as a stock pen close to a water supply (ibid).

Thrum, who reported on heiau on all the islands, has no entry for Hale o Mano, and the only Haleolono he lists is in the ahupua'a of Kahaluu, south of the project ahupua'a.

Bonk recently conducted a walk-through survey of the approximate locale of the present project area. His notes include the following:

> ...Makaopi'o Heiau with its pools and terraces, Hale o Kane Heiau, lines of water-worn stones set on pahoehoe lava, burials and platforms house sites, pens and perhaps shrines.
>
> ...mauka of the highway and running parallel to it is the important Mamalahoa trail or "King's Highway." This is the historic horse trail that can be followed from North Kona to South Kohala. Inland of this trail Soehren (1075) mentions an ancient foot trail with stepping stones terminating at eight graves at the north end of the ahupua'a 500 ft mauka of the present highway.
>
> There are some historic walls, rough roadways, one water tank and some fencing in the area between the 240' elevation and the mauka boundary of the study area (Bonk 1987).

An island-wide description of sites was published by Henry Kinney in the earlier part of this century. He describes the shoreline in the vicinity of Keahuolu and Kealakehe as follows:

> From the trail running north towards Makalawaena a side trail runs makai to the Honokahau village, which consists of about a dozen houses by the beach. Here is a large cement pan, formerly used for the manufacture of salt from the sea water, north of which are some rock drawings. Makai thereof, by a couple of cocoanut stumps, are the scant remains of a heiau, "Hale o Kane." Directly in front of the houses are some excellent specimens of the papa konane, or checker boards used by the ancient Hawaiians. This was quite a complicated game, played with black and white pebbles on a board carved on flat pahoehoe rocks (Kinney 1913:57).

Little has been written describing the landscape in this area. Owing to the inhospitable conditions of much of the terrain, most travel among foreigners between Kawaihae and Kailua was conducted by ship or by canoe, with short stops along the coast as needed (Silva 1987:7). Reverend William Ellis, who toured the island in 1823, wrote of the North Kona District:

> The northern part, including Kairua, Kearake'kua and Honaunau, contains a dense population, and the sides of the mountain are cultivated to a considerable extent; but the south part presents a most inhospitable aspect. Its population is thin, consisting principally of fishermen, who cultivate but little land, and that at the distance of from five to seven miles from the shore (1963:95).

Additional information on the North Kona area comes from modern writers and historians. Handy and Handy comment:

> In North Kona dry taro flourishes only in the uplands, which are now largely given over to ranching, though some Hawaiians still have taro plantations above Kalaoa....
>
> The walls (pa aina), seen today in Kona lowlands running across old boundary lines, were built to keep cattle out of the planting areas after they became a pest early in the 19th century.
>
> Kona, like eastern Maui, with its decomposing lava mixed with humus and with intermittent rainfall which soaks away quickly in the porous soil and rock, is ideal for sweet potato cultivation...
>
> Today sweet potatoes are planted by many Hawaiians living along the coast of Kona, either in the sandy soil near the shore at places like Hookena, Kealia, and Honaunau, or in spots where there is sufficient soil in the midst of the dry lava. Two sizable plantations were visited in 1935 on the dry slopes half to a mile inland in the Kailua section. Sweet potato flourished at the government experiment station at Kainaliu, at an altitude of 1,500 feet in North Kona; and patches were seen at various points both above and below the "Belt Road," in North and South Kona at altitudes of 1,800 feet. On the plantation zone up to altitudes of more than 2,000 feet, no sweet potatoes were seen (Handy and Handy 1972:523-4, 526-8).

At the time of the Mahele, the ahupua'a of Kealakehe was set aside as government land, while preserving the rights of native tenants. It is from the testimony of these tenants that we obtain data on land use during the mid-1800s. As government land, Kealakehe was constantly being appraised and re-appraised when petitions for lease or purchase were received by the Interior Department (Silva 1987). Excerpts from Land Commission Award (LCA) testimonies and descriptions of letters addressed to the Minister of the Interior follow (NT denotes Native Testimony):

> **LCA 8608 to Kaahui, for 3.90 acres; NT 4:540, Jan. 2, 1849** - Mioi sworn He has seen the ili at Kaohia of Kealakehu [sic] ahupuaa, 4 taro kihapais, 3 potato kihapai and 2 house lots. (Boundaries of six sections given) Old time resident since Kamehameha I., land from Kapau now, no one has objected.
>
> **LCA 7897 to Kahuenui, for 4.9 acre; NT 4:546** - Kaahui sworn, (Kahuenui is in error in claiming a whole ili.) Kaahui has seen the land Kahuenui has cultivated in Kukuiomino of Kealakehe ahupuaa, four sections in Kauluulu 1, Kaoki 2, Kealaloa 3, and 2 places in Kukuiominonui. He does not know the boundaries but the surveyor will determine the true boundaries. The land is partially cultivated and there is a house for Kahuenui. This old land had been from Kahuenui's grandparents to his parents and now it is for him, no one has objected to him.
>
> **LCA 10322 to Nuhi, for 4.75 acres; NT 4:543** - Kaahui sworn (the whole ili claim is in error) the true claim is the area on which Nuhi has worked with his hands, Kaahui has seen in the ili land of Makakiloia of Kealakehe ahupuaa, 5 areas of which he has cultivated—1 in Kaluulu, 2 in Kaaki, 3 in Kealoha, 4 in Kumau and 5 in Kaeamaia. The boundaries are doubtful, but the surveyor will establish the correct boundaries. These kihapais and enclosures are partially completed. One house is for Nuhi. The land is from Kaahui in 1844, Nuhi is living there and no one has objected to him.
>
> **LCA 10306 to Nuole, for 5.25 acres; NT 4:542** - Kaahui sworn (error in claiming a whole ili from upland to sea) Nuole's true claim is the area he has cultivated with hiw own hands. Kaahui [has seen] in the ili of Kaniohale of Kealakehe ahupuaa four places he had cultivated of which the boundaries

are in doubt. This has been partially cultivated and it had been for his grandparents since Kamehameha I, now it is for Nuole and no one has objected to him.

LCA 10671 to Pepe, for 4.96 acres; NT 4:544 - Kaahui sworn he has seen the place Pepe had cultivated, in the ili land Iliioa, 2 kihapais, Haleolono ili, 2 kihapais, Kamohale ili, 2 kihapais and in Kukuuimino, 1 kihapai. These have all been cultivated and the surveyor will establish their true boundaries. Keawe had given this land in 1844, no one has objected to Pepe.

Keawe sworn they both have known in the same way for the land of Pepe. House lot section....Two houses for Pepe and enclosed, house lot from Kaahui in 1846, no one has objected to him again.

LCA 10692 to Paai, for 2.80 acres; NT 4:545 - Kauhai, sworn he has seen in the ili land of Puohe, 10 kihapais, in Iliioa, 1 kihapai and in Kaohia, 2 kihapais. Kauhai does not know for certain, the boundaries. The surveyor will establish the true boundaries. These lands have been cultivated. Kaahui had given this interest in 1843, altho he had been a resident there since Kamehameha I, and no one has objected to him.

LCA 10597 to Puou, for 4.12 acres; NT 4:452 - Mioi sworn, He has seen in the ili land of Kukuioninonui in Kealakehe ahupuaa 6 kihapais, 4 kihapais, are in Kukuiominoike ili. The surveyor will determine clearly the boundaries. One house is for Puou and the kihapais have been partially cultivated. Kaahui has given him the land now altho he has lived there since Kamehameha I. No one has ever objected to him.

LCA 10950 to Waiwaiole, for 2 acres; NT 4:545 - Kahuenui 2, sworn (there is an error in the ili land claim), Waiwaiole had cultivated 4 sections in Kaohia ili of Kealakehe ahupuaa and this is the true claim although Kahuenui does not know the boundaries. The surveyor will establish the boundaries of Waiwaiole's kihapais, not all of them have been cultivated.

A house site is in Puohe with no fence, but there is a house for Waiwaiole, where he is now living. They are old-time residents since Kamehameha I, no one has objected.

LCA 9252 to Kauhai, for 5.78 acres; NT 4:545 - Kaahui sworn He has seen in Puohu ili of Kealakehe ahupuaa, 7 kihapais and in Kaohia ili, 2 kihapais....Kauahi's kihapais have been cultivated. There also is a house lot in Kaniohale ili land....

LCA 7483 to Kulua, for 2.6 acres; NT 4:541, Jan. 2, 1849 - 3 cultivated kihapai, one house lot

LCA 10070 to Mioi, for 4.40 acres; NT 4:547, Jan. 2, 1849 - cultivated kihapai but does not say in what.

From the testimonies it was determined by Silva (1987) that:

> ...claimants listed numerous cultivated parcels (kihapai) planted in taro and sweet potatoes. At least 10 houses, some enclosed with fencing, others not....A fair-sized banana patch was situated in the uplands; two claimants mention this patch (Kaeamai'a) as mauka boundaries.
>
> Eight of these natives trace their use and occupancy of the land from their grandparents during the time of Kamehameha I, making them at least third-generation residents and farmers. Only three claimants acquired their lands since—all three receiving parcels in the early 1840's.
>
> Thus, it can be said that Kealakehe supported a fairly stable native population that extended back in time probably to the late 1700's and possibly earlier.

Correspondence to the Minister of the Interior often provides additional background on land use and related transactions:

Int Dept. - Aug. 3, 1853
In letter from Governor of Hawaii (Kapeau) to the Land Commission giving a list of names of persons who have paid their Land Claims...In Statement of land sales showing that Kaahui had paid $15 as part payment for his land in Kealakehe, containing 153 acres (April 1854)

Int Dept. - Sept. 5, 1865
In letter from S.C. Wiltse to the Minister of Interior giving a list of names & description of Government lands which is attached, stating that the above land contains about 2000 acres in all, mauka of the

government road some 400 acres covered with auki, fern & scattering Ohia. 2nd rate soil for this part of Kona. Makai of Government Road, 200 acres of same had been surveyed & sold to Kahenui &c. Within this 200 acres are 10 kuleanas containing in all 43 acres. Makai of this, approximately 1400 acres, 300 acres of which will do for a goat pasture, balance nothing but rocks.

Int. Dept. - April 25, 1866
In letter by J.H. Kalaiheana showing that Kealakehe ahupuaa belongs to the government, excepting the mauka portion which has been sold.

Int. Dept. - July 22, 1874
In letter from H.N. Greenwell to the Minister of Interior enclosing his yearly rental account of Government lands in Kona, Hawaii to June 30, 1874 which is attached, showing that $51 had been received from Keelikolani for 1 year's lease of a piece of land in Kealakehe.

Int. Dept. - MISC, Aug. 7, 1878
Receipt for $76.35, refund for land purchased by him in 1862, on which no patent had been issued him, Nakaukuaana.

Int. Dept. - Bk.35.p.604, July 2, 1888
Acknowledging receipt of his favor of the 30th of June, inquiring as to who owns the coffee growing on the above Government land. Informing him that said land is under lease to His Majesty the King.

Int. Dept. - Dec. 29, 1894
W.P. Fennell to Minister of the Interior. To purchase Government land in Kealakehe, lying between Keahuolu & Honokohau, containing from 400 to 500 acres at $1.50 an acre, &c. Report to Government Survey Office attached.

Int. Dept. - April 3, 1895
J. H. Waipuilani to Min. of Int. Acknowledging receipt of letter of Mar. 22, 1895, regarding Land Claim 10306 to Nuole & Land Claim 10671 to Pepe in the above place. A dispute has arisen amongst the heirs of Nuole; Mrs. Waipuilani claims she is the heir of Nuole, but the children of Pepe claim they are the heirs too, &c.

While conducting a routine survey of the North Kona lands for the Government in 1882, J.S. Emerson noted the following:

/Honokohau/-iki is bounded on the South by the ahupuaa of Kealakehe of comparatively small value owned by Gov't. & rented by S. Kaai (Silva 1987).

Homesteading was seen as a way to provide a diversified and therefore less vulnerable agricultural economy in Hawaii. The Homestead Act of 1884 directed the Minister of the Interior to lay out portions of available and suitable government lands in lots of not over twenty acres, and to offer them as homesteads. Persons taking the lots were allowed five years in which to comply with the conditions for obtaining fee simple titles (Kuykendall and Day 1948:204-205). Silva (1987) presents the following parlay between the King and the Minister of the Interior for such lands. In August of 1886, King Kalakaua entered into a lease agreement with the Minister of the Interior for North Kona lands, including Kealakehe. His lease, No. 364, was limited by a special proviso:

> Each and every of the above mentioned lands are let subject to the express condition that at any time during the term of this lease /20 years/, the Minister of the Interior may at his discretion peaceably enter upon, take possession, and dispose of such piece or pieces of land included in the lands hereby devised, as may be required for the purpose of carrying out the terms and intent of the Homestead Laws now in force, or that may hereafter by enacted during the term of this lease.

Consequently, on Jan. 17, 1889 the Minister of the Interior informed Kalakaua:

> ...that as the Government proposes to utilize the lands described in Government Lease #364 for Homestead purposes, the Minister of the Interior desires to take possession of said lands under the terms of the lease and therefore requests that the same may be surrendered to him.

Kalakaua's Chamberlain replied:

> His Majesty the King, is willing, for the purpose of assisting in carrying out the Homestead Act, to accede to the terms of the lease, so far, as to give up only such portions of the lands, as are suitable to be apportioned off, for Homestead purposes.
>
> It has come to the knowledge of His Majesty, that several of the applicants for portions of the above lands, are already in possession of lands elsewhere, and living in comfortable homes. They are not

poor people, nor are they entitled to the privilege of obtaining lands, under the Homestead Act, but are desirous of obtaining more of such property, for the purpose of selling or leasing to the Chinese, which class is beginning to outnumber the native in nearly every district.

This is the most objectionable feature, to the fair working of this Act, and, were the policy, of promiscuously disposing of lands to anybody applying for the same, more especially to those who are already large land owners, without considering the intent of the Homestead Law, carried out, it would be treating unjustly those who are entitled to protection under that Act. A number of applications were refused by the late administration, for that reason.

The policy of allowing native or persons of other nationalities, who are really in need of Homestead lots, to obtain land for that purpose, is a correct and good one.

To ask his Majesty the King, the present lessee of the lands, described in the above lease, to surrender the whole of them, when only a portion of them are suitable for Homestead purposes, is rather an unjust request.

At the time the lease was made out, it was understood, between His Majesty, and the then Minister of the Interior, that only such portions of the lands required for Homestead purposes, were to be surrendered, should the Government, at any time require them, for the purpose of carrying out the terms and intent of the Homestead Act and a clause to that effect was inserted in the lease.

His Majesty is desirous of retaining the balance of lands, that may be left after the apportionment has been completed; and also desires to lease the remnants of other Government lands in that section of the Island.

Despite Kalakaua's protestations, his lease was cancelled on Aug. 2, 1889 (Int. Dept. 1/22/1889).

George McDougall submitted several applications for the purchase of Kealakehe. His request of March 9, 1893 stated:

There is a remnant of Government land of Kealakehe, left unsold - Kealakehe lies north of Kailua about 3 miles in North Kona, Hawaii. The unsold part that I refer to above, extends from the homesteads to the seashore and contains an area of 15 or 16 hundred acres, fully one half of that is pure pahoehoe, almost without a crack, and is worthless. The mauka half consists of large beds of black aa, with a few bushes between and is of very little value, but what makes it valuable to me, my land is on both sides of it. I pay rent by the quarter at present to the Government agent.

I beg to offer $300 - as an upset price if the Government will put it up for Sale - more on account of its situation than its real value, as it would take more than all it is worth to fence it in (Int. Dept. 3/9/1893).

The Government Surveyor recommended in response that the land not be sold unless $500 be offered for it. The description stated, "There is much barren lava on this tract and some rocky pasture" (Int. Dept. 3/15/1893).

The <u>ahupua'a</u> of Keahuolu was awarded to Ane Keohokalole (d. 1857), who numbered among her offspring King David Kalakaua, Queen Lydia Liliuokalani, and William Pitt Leleiohoku (who was adopted by Ruth Keelikolani). Her youngest daughter, Miriam Likeleke, was the mother of Kaiulani, who was proclaimed heir apparent in 1891 after her aunt, Liliuokalani, took the throne following the death of Kalakaua. Keohokalole was the great-granddaughter of Kameeiamoku, one of the most important of the chiefs supporting Kamehameha I. Approximately half of the lands that Keohokalole received in the mahele were on the island of Hawaii, and two-thirds of those were lands in Kona District (Kelly 1983:31).

Ane Keohokalole's award in Keahuolu was LCA 8452, Apana 12 (Royal Patent 6851). This parcel was 4,071 acres. Keohokalole commuted some of her holdings in order to keep certain lands, including Keahuolu. Excerpts to the Minister of the Interior provide us with this information:

To Highness, John Young
Minister of Interior
Greetings:

This is to inform you and the Privy Council of my desire to convey some of my lands for the Governments one third in the land which remain as mine. Grant me this, of course, with the approval of the Privy council. Below is a list of the lands I wish to convey to the government. (Native Test. 10:326)

To Your Highness, John Young
Minister of Interior
Greetings:

Here is a list of names of my lands which has been left for me pending for an approval of its distribution.

...Keahuolu ahupuaa, Kona, Hawaii...

With appreciation,
A. Keohokalole (Native Test. 10:327)

The following testimony was given by Awahua, to verify Keohokalole's holdings for this LCA in Kona:

Awahua, sworn, says he knows the house lots claimed by Keohokalole at Kaawaloa, Hawaii. The first one is fenced all round with a stone wall. It is bounded makai by the sea shore, on Kailua side by the Government land, mauka by the land of Nahaku, and Awahua, and on the other side by the road. Claimant derived this lot from her ancestors, who held it from very ancient times. There is a stone house and several grass houses in it belonging to claimant, besides a tomb.

The second lot is called "Awili," and is fenced all round. It is bounded makai by government road, on Kailua side by the same, mauka the same, on the side next the pali by the road.

Claimant derived this lot from her ancestors, who held it from older times.

Witness knows the three house lots in Kealakekua, claimed by Keohokaloie. The first lot is called "Kulou" and is fenced in. It is bounded Makai by the sea beach, Kaawaloa side by government land, mauka by the road, south Kona side by a lot belonging to T. Cummings.

The second lot is called "Kaahaloa" it is enclosed all round, and bounded on Kona Hema by a lot belonging to T. Cummings, mauka by the lot of Nakoko, North Kona by an old heiau, makai by the road.

The third lot is called "Wailokoalii" and is bounded on the South Kona side by an old Heiau, mauka by a Government lot and the lot of Ialua, makai by the sea beach, on the other side by a pali.

Claimant inherited these lots from her ancestors by the mother's side, who possessed them from ancient times. Kekaalua, sworn, says he knows these lots perfectly and confirms in full the testimony by Awahua (Foreign Test. 3:573).

Whenever ali'i procured an entire ahupua'a, they were bound to respect the rights of the existing tenants. These tenants, if they filed a claim to The Board of Commissioners to Quiet Land Titles, could continue to cultivate and reside on their parcels. The following testimonies are for awards that were granted within Keahuolu:

LCA 11071 to Aki, for 0.6 acres; NT 4:527 - Kuia sworn He has seen Aki's land that which he had cultivated himself, it is in the ili land of Pauaaiki of Keohoeolu [sic] ahupua'a in Hawaii. Section 1, 5 cultivated kihapais. Section 2, 1 kihapai not cultivated. Section 6, 4 cultivated kihapai. Section 7, 1 cultivated kihapai. These interests have been made from Kaea, Nahaalualu and Kalekahi at the time of Kamehameha I.

LCA 10303 to Maa, for 2.25 acres; NT 4:526 - *Mahu sworn, He has seen a whole section of land,* however, it is just as he has indicated in his claim in that there are 11 taro kihapais, and 10 potato kihapais in the ili land at Maili of Keahuolu ahupuaa. The land is not cultivated completely, but, Maa had planted 7 palm trees. The fruit is for Samuela, both Maa and Samuela have joint interest in the 7 fan palm trees. There is also a coconut grove which had been planted by Maa's grandparents for the Chings who owned the land, they were the caretakers. The same had applied to Maa's parents and to him at the present time. The coconuts went to Keohokalole upon the death of Keoua and it has been that way to the present time.

One whole section is salt land and it is still yielding salt...Land passed down to Maa's parents, these to him now. Maa's grandparents received the ili land Maili of Keahuolu during the time of Kamehameha I. Kamauoha had given to Maa the land sections of Lanihau ahupuaa in 1848, no one had objected to him.

LCA 10345 to Nahaalualu (Naalualu), for 2 acres; NT 4:527 - Kuia sworn, He has seen (Naalualu) place that he had cultivated himself in the ili land of Puuokaliu of Keahuolu ahupuaa in Hawaii.

Section 1 (boundaries given) 1 section cultivated. Section 2, 4 cultivated kihapais, Section 3, 1 cultivated kihapai, Section 4, 4 cultivated kihapais....

LCA 10198 to Hailewalewa (Kailewalewa), for 1.30 acres, NT 4:525 - Mahu swom He has seen the place on which Hailewalewa had cultivated with his own hands, it is in Ulelele ili of keahuolu ahupuaa. Section 1 Taro. Section 2, Kaluulu. Land has been cultivated, 1 land section. On land from Haeilewalewa's parents to him. Uncertainty for 1 section.

LCA 8012 to Apiki, for 1.10 acres; Foreign Testimony [FT] 8:676 - Mahu, sworn, says he knows the kuleaña of Claimant in Kailua, Kona. It consists of 5 patches of Kalo and a lot of patches of potatoes. The kalo patches form 1 piece, bounded on Kau side by Lanihau, Makai by Papaula's land, Kohala side the same, mauka by Hai's land. The potato land is bounded mauka by Haino's land, Kau side by Lanihau, makai by Kahili's land, Kohala side the same. Claimant derived the land from the *Konohiki*, before the death of Kuakini, and has held it ever since without disputes.

LCA 7351 to Kahuanui, for 2.9 acres; FT 8:682 - Papaula, swom says I know the claim of Kahuanui. It is in the ahupuaa of Keahuolu, Kona. It consists of one piece of kalo land, 5 patches - all lying together. One of these patches is planted with coffee. It is bounded mauka by the land of Kahookohukaneole, Kau by Lanihau, Makai by the land Nahaalualu, Kohala by the konohiki. Claimant received this land from his brother in 1846, and his title has never been disputed.

In a report by J.H. Kalaiheana, dated April 25, 1866, Keahuolu is documented as belonging to Keohokaloie. A letter dated July 8, 1869 from David K. Kalakaua to his sister, Liliuokalani, contains a detailed description of Keahuolu:

> "This land is situated in the District of North Kona, bounded by the ahupuaa of Lanihau (in Kailua) belonging to Prince Lunalilo on the Ka'u side, and on the Kohala side, by Kealakehe, a government land and Honokohaniki belonging to Keelikolani. Keahuolu runs clear up to the mountains and includes a portion of nearly one half of Hualalai mountains. On the mountains the koa, kukui and ohia abounds in vast quantities. The upper land or inland is arable, and suitable for growing coffee, oranges, taro, potatoes, bananas &c. Breadfruit trees grow wild as well as the Koli oil seed. The lower land is adopted for grazing cattle, sheep, goat, &c. The fishery is very extensive and a fine grove of cocoanut trees of about 200 to 300 grows on the beach. The flat land near the sea beach is composed chiefly of lava, but herbs and shrubbery grow on it and [it is] suitable for feed of sheep and goats. It is estimated at 15,000 to 20,000 acres or more.

A letter from Liliuokalani to the Minister of the Interior dated Oct. 6, 1894 gives permission to build a road through Keahuolu, to be fenced on both sides.

On a map drafted by J.S. Emerson in the 1880s (Reg. Map 1280), a narrow band of shading that runs in a north-south direction crosses through Keahuolu. This band is at an approximate distance of 6,250 to 7,250 feet inland of the coast. In Emerson's Field Notebook sketches, this line is identified as the "Commencement of the Forest." The notebook notes that ma uka of the forest line, the land is "lava covered with scattering forest and dense masses of ki [ti] root" (Kelly, 1983:58).

The Honokohau Small Boat Harbor is located in the ahupua'a of Kealakehe. The following history of the harbor is taken from Clark's Beaches of the Big Island:

> Honokohau Small Boat Harbor was authorized by the River and Harbor Act of 1965, but the actual construction of the complex was not completed until March 1970. During the summer of 1978 an expansion project was initiated to enlarge the harbor basins and to provide additional boat ramps, loading docks, and moorings. The excess excavated material was deposited in a large depression in a state-owned lava field 1,000 yards south of the harbor. Contractors completed the expansion project in 1980.

On the southern side of the entrance to Honokohau Harbor, behind a small, protected cove, are several brackish-water ponds and a number of archaeological sites that are known as the 'Alua Bay Complex. The cove shelters a crescent of white sand speckled with fragments of black lava - a secluded spot for sunbathing and for viewing the boat traffic moving in and out of the harbor. With its shallow ocean bottom of sand and rock, the cove is also a good place for swimming. Snorkeling and nearshore scuba diving are excellent along the rocks bordering the beach. A small stand of keawe [kiawe] and ekoa in the backshore provide a little shade. Places of fresh water intrusion are frequently encountered in the deeper waters offshore in Honokohau Bay. Most local residents know this little cove as 'Alula Beach (Clark 1985:114).

During the present research, a question was posed concerning the possibility that the project area may fall under the classification of ceded land. Ceded lands are those lands that the Provisional Government acquired from the Monarchy of Hawaii, including Crown and Government lands. These lands were ceded to the United States when Hawaii achieved territorial status. Upon statehood, it became Hawaii State lands. The Land Inventory printout, courtesy of the Land Management Department, confirms that the Title Status of the project area is ceded land.

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Report 652-051090

Addendum Report: 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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BACKGROUND

This addendum report, prepared at the request of Belt, Collins & Associates, on behalf of their client, the Housing Finance and Development Corporation - State of Hawaii, presents findings and conclusions regarding archaeological sites within an area added to the original proposed Kealakehe Planned Community project area. The original project area was reported on in Donham (1990a). The area that has been added (see Figure 1) is a portion of a project area that has already been surveyed (inventory-level) (Queen Liliuokalani Trust Property project area [Donham 1990b]). This report, therefore, consists primarily of findings and conclusions taken from Donham 1990b. The background information (scope of work, project area description, documentary and research, previous work, etc.) relevant to the added project area has already been presented in Donham 1990a and is not repeated here. Specifically, this report only thoroughly describes and summarizes sites, includes general significance assessments and recommended treatments for each site, and discusses sites in terms of the conclusions reached in Donham 1990a.

FINDINGS

SURFACE FINDINGS

Within the area that has been added, Donham (1990b) identified 24 sites. The sites are summarized in Table 1 in terms of State Inventory of Historic Places (SIHP) site number, formal type, functional interpretation, PHRI CRM (Cultural Resource Management) value mode assessment, and recommended field work tasks. Detailed descriptions for individual sites are presented in the following Site Descriptions section, which includes for each site:

(a) site number - PHRI temporary site number or SIHP number;

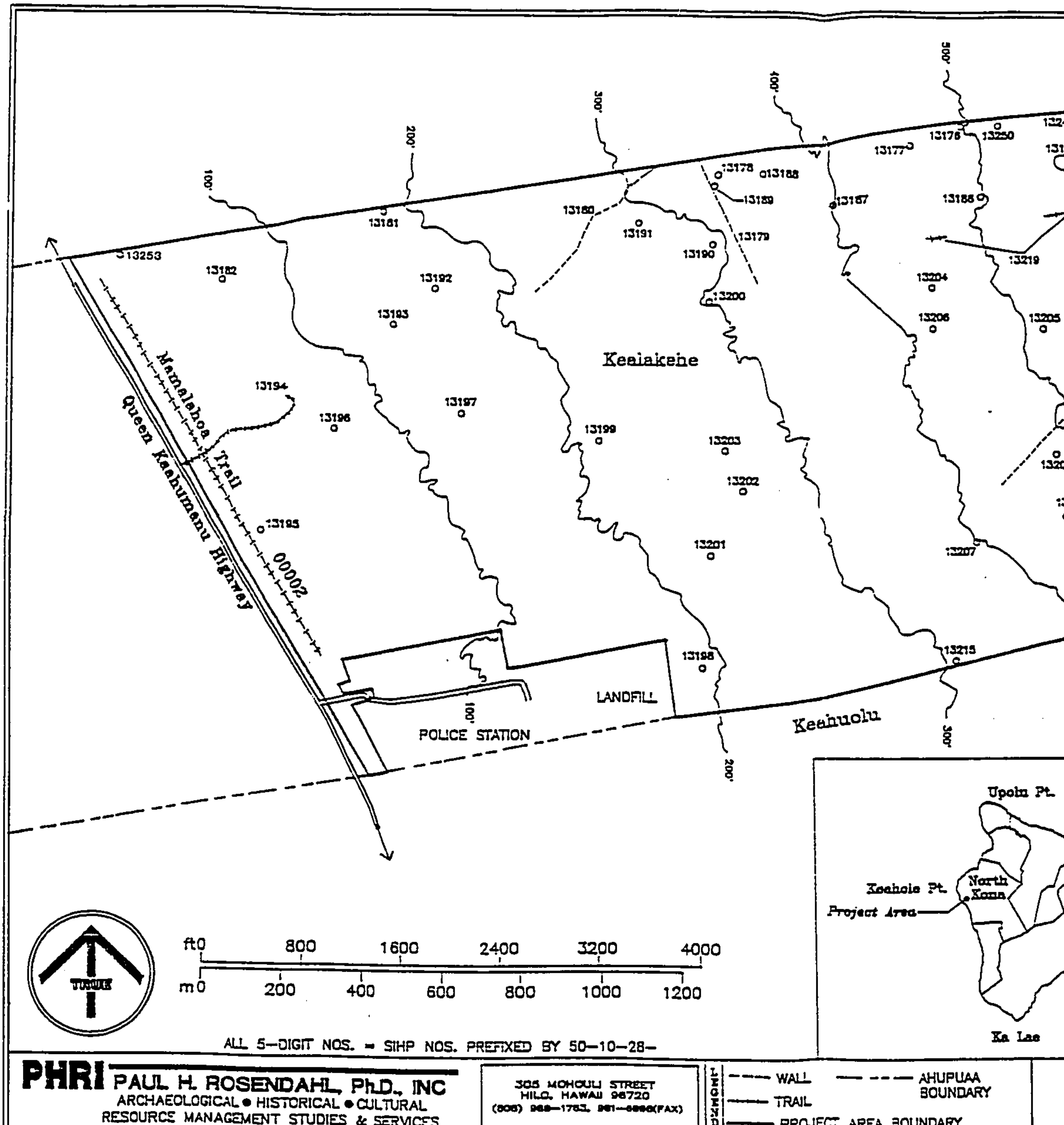
(b) a site type designation - provides formal feature type for sites consisting of a single feature, or designates the site as a complex if site is comprised of more than one feature. Also lists total number of features present;

(c) a description of site topography - a brief description of the terrain in the area of the site;

(d) a listing of site vegetation - lists principal components of the vegetation within and in the vicinity of the site;

(e) a statement of site condition - overall state of preservation of the site (poor, fair, good, or excellent);

652-051090


Keaiakehe
Keahuolu
Mamalahoa Trail
Queen Kaahumanu Highway
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LANDFILL
POLICE STATION
13253
13182
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100'
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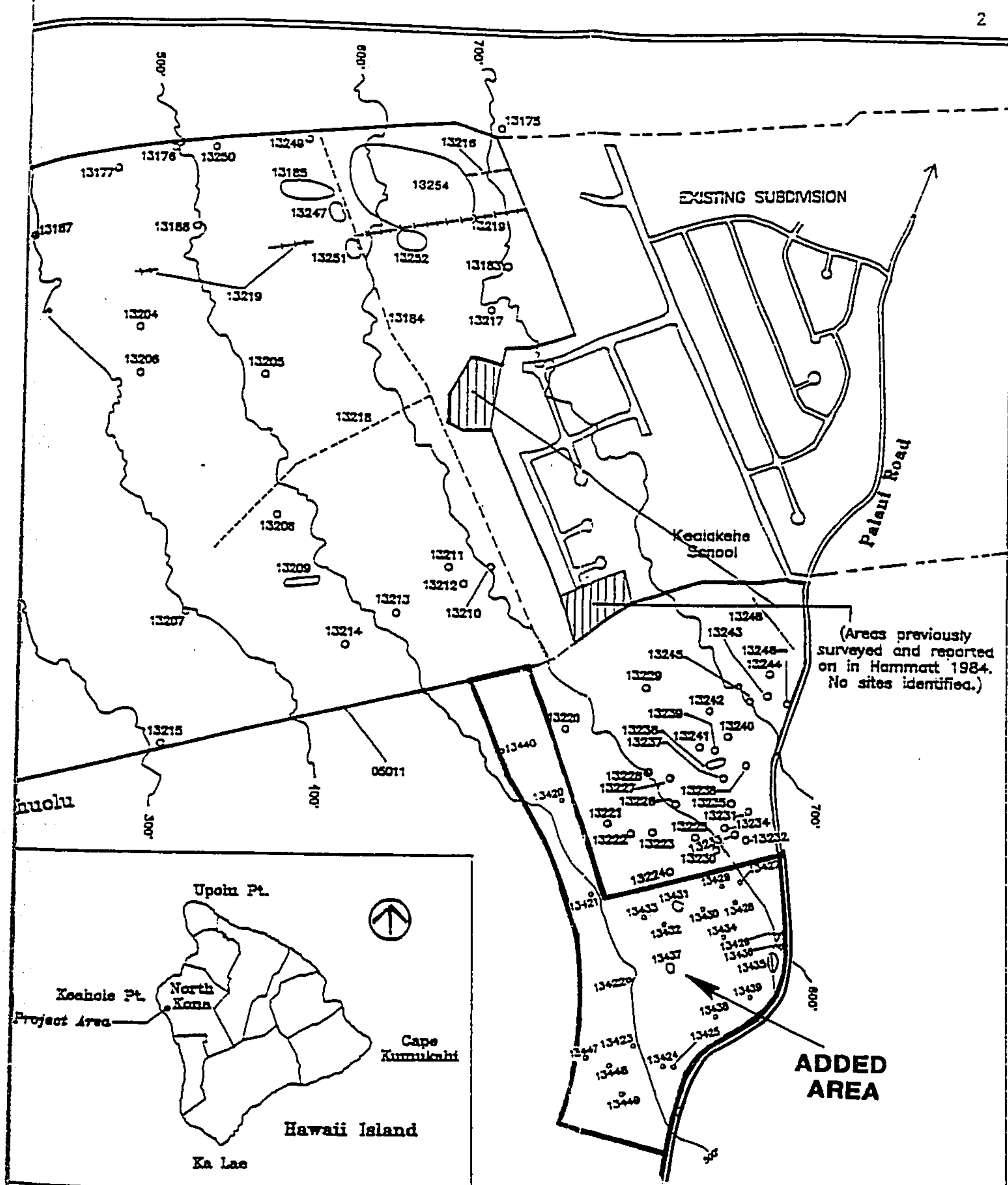
PHRI PAUL H. ROSENDAHL, Ph.D., INC
ARCHAEOLOGICAL • HISTORICAL • CULTURAL RESOURCE MANAGEMENT STUDIES & SERVICES
305 MOHOULI STREET
HILO, HAWAII 96720
LEGEND
WALL
TRAIL
PROJECT AREA BOUNDARY
AHUPUAA BOUNDARY



AHUPUAA BOUNDARY
CT AREA BOUNDARY

Addendum Report: Archaeological Inventory Survey
Kealakehe Planned Community Project Area
PHRI Project No. 89-652

FIGURE 1.
Project Area and Site Location Map

Table 1.

SUMMARY OF IDENTIFIED SITES AND FEATURES

*SIHP Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	#CRM Value Mode Assess. R	I	C	+Field Work Tasks DR	SC	EX
13420	Complex (8)	Agriculture	M	L	L	+	-	-
-	Rock mound							
13421	Complex (18+)	Agriculture-habitation	M	L	L	+	-	-
A-C	Cairn (3)							
D	Cave							
-	Pahoehoe excavation (10+)							
-	Paved area (4)							
13422	Complex (8+)	Agriculture	M	L	L	+	-	-
-	Pahoehoe excavation (7+)							
-	Cairn							
13423	Complex (80)	Agriculture-temporary habitation	H	M	M	+	+	+
-	Mound (59)							
-	Pahoehoe excavation (8)							
-	Modified outcrop (8)							
-	Alignment (2)							
-	Overhang							
-	Modified cave							
-	Modified pahoehoe blister							

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

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

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

(#) Number of component features within complex.

Table 1. (Cont.)

SIHP Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13424	Complex (3)	Agriculture	L	L	L	-	-	-
A	Pahoehoe excavation							
B	Modified outcrop							
C	Cairn							
13425	Complex (4)	Agriculture-habitation	M	L	L	+	-	+
A	Modified blister							
B	Modified outcrop							
C	Cave							
D	Mound							
13426	Roadbed	Transportation	L	L	L	-	-	-
13427	Complex (17)	Agriculture	M	L	L	+	-	-
A-C	Mound (3)							
-	Pahoehoe excavation (10)							
-	Mound (4)							
13428	Complex (43)	Agriculture	M	L	L	+	-	-
A-E	Faced mound (5)							
F	Alignment							
G	Platform							
H	Terrace							
-	Pahoehoe excavation (25)							
-	Mound (10)							
13429	Complex (9)	Agriculture	M	L	L	+	-	+
A	Terrace							
B	Terrace							
C	Modified blister							
D-I	Mound (6)							
13430	Complex (15)	Agriculture-habitation	M	L	L	+	-	+
A	Platform							
B	Mound							
C	Mound							
-	Pahoehoe excavation (5)							
-	Mound (6)							
-	Collapsed blister							

Table 1. (Cont.)

SIHP Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13431	Complex (6)	Agriculture-habitation	M/H	M	M	+	+	+
A	Cave							
B	Enclosure							
C	Enclosure							
D	Pahoehoe excavation							
E	Pahoehoe excavation							
F	Terrace and alignment							
13432	Mound	Agriculture	L	L	L	-	-	-
13433	Cairn	Indeterminate marker	L	L	L	-	-	-
13434	Complex (4)	Agriculture	M	L	L	-	-	-
A	Faced mound							
B	Faced mound							
C	Pahoehoe excavation							
D	Faced mound							
13435	Complex (10)	Agriculture	M	M	M	+	-	+
A-F	Enclosure (6)							
G	L-shape wall							
H	Modified outcrop							
I	Modified outcrop							
J	Enclosure							
13436	Wall	Land division	M	M	M	+	-	-
13437	Complex (7)	Agriculture-marker	M	M	M	+	-	+
A	Stepped terrace							
B	Pavement							
C	Faced outcrop							
D	Terrace							
E-G	Cairn (3)							

Table 1. (Cont.)

SIHP Site No.	Formal Site/Feature Type	Tentative Functional Interpretation	CRM Value Mode Assess. R	I	C	Field Work Tasks DR	SC	EX
13438	Complex (10)	Agriculture-transportation	M	M	M	+	–	+
A	Terrace							
B	Mound							
C	Terrace							
D	Terrace							
E	Pahoehoe excavation							
F	Terrace							
G	Trail							
H	Roadbed							
I	Mound							
J	Cairn							
13439	Cairn	Indeterminate marker	L	L	L	–	–	–
13440	Complex (3)	Agriculture	M	L	L	+	–	–
A	Terrace							
B	Filled crevice							
C	Pahoehoe excavation							
13447	Complex (19)	Agriculture-possible habitation	M	L	L	+	–	+
A	Platform							
–	Filled blister (9)							
–	Pahoehoe excavation (6)							
–	Modified blister (3)							
13448	Complex (7)	Agriculture	M	L	L	+	–	+
–	Pahoehoe excavation							
13449	Complex (3)	Habitation-transportation-possible ceremonial	M	L	M	+	–	+
A	Lava tube cave							
B	Cairn							
C	Steppingstone trail							

(f) an assessment of site integrity - degree of historic modification by human agencies (unaltered, partially altered, and completely altered) and nature of modifications, if any;

(g) a probable age - indicates probable/possible (?) age of the site (i.e., historic or prehistoric);

(h) a functional interpretation - probable or possible (?) functions for each site; or, if function cannot be determined, assigns indeterminate function. For sites with multiple functions, functions separated by "/";

(i) feature dimensions - maximum length, width, and height or depth; and

(j) a site description - a brief overall description of the site listing types of constituent features, portable remains present, if any, and other site data.

SITE DESCRIPTIONS

SITE NO.: State: 13420 **PHRI:** T-203
SITE TYPE: Complex (8 Features)
ELEVATION: c. 515 feet
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: This complex consists of eight rock mounds

SITE NO.: State: 13421 **PHRI:** T-204
SITE TYPE: Complex (18+ Features)
TOPOGRAPHY: Pahoehoe and aa flows on gentle sloping terrain.
VEGETATION: Christmas-berry, lantana, and fountain grass.
ELEVATION: c. 496 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-habitation
DESCRIPTION: The overall complex area measures 30.0 m (E-W) by 15.0 m (N-S). It is located 50.0 m at 350 degrees from Site 13422.

The site consists of three rock cairns (Features A through C) one cave shelter (Feature D), ten pahoehoe excavations three of which are filled with pahoehoe cobbles, and four small paved areas. Also, several naturally collapsed blisters are in the area.

FEATURE A: Cairn
FUNCTION: Indeterminate
DIMENSIONS: 0.80 m by 0.73 m by 0.45 m

Two pahoehoe boulders and eight pahoehoe cobbles are stacked, two courses high, on a pahoehoe flow. The largest boulder is on top.

FEATURE B: Cairn
FUNCTION: Indeterminate
DIMENSIONS: 1.05 m by 0.75 m by 0.45 m

This cairn is located c. 12.00 m southeast from Feature A. It consists of three courses high of pahoehoe boulders with one pahoehoe slab on top. It is built atop a pahoehoe excavation.

FEATURE C: Cairn
FUNCTION: Indeterminate
DIMENSIONS: 0.60 m by 0.45 m by 0.43 m

Feature C is built on the edge of a pahoehoe ledge excavation, 11.00 m northwest from Feature B. It is constructed with three pahoehoe blocks measuring c. 30x40x14 cm stacked two courses high.

FEATURE D: Cave
FUNCTION: Agriculture/habitation
DIMENSIONS: 60.00 m by 1.90 m by 1.10 m

Feature D is a lava tube adjacent to Feature A, oriented at 260 degrees Az. The entrance measures 3.2 m wide and 1.1 m high. Portable remains observed include Cellana shell, *feral goat* bones, and wood.

SITE NO.: State: 13422 **PHRI:** T-205
SITE TYPE: Complex (8+ Features)
ELEVATION: c. 500 feet
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The site consists of at least seven pahoehoe excavations and a cairn. The cairn is collapsed.

SITE NO.: State: 13423 **PHRI:** T-206
SITE TYPE: Complex (80 Features)
TOPOGRAPHY: Gently sloping pahoehoe with areas of natural disturbance.
VEGETATION: Thick Christmas-berry, small koa-haole, and scattered lantana.
ELEVATION: c. 498 feet
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture-habitation
DESCRIPTION: This site is located c. 67.00 to 70.00 m from Site 13422 at 315 degrees Az. The overall complex area measures 133.25 m at 180 degrees Az. by 78.0 m at 255 degrees Az. It consists of 36 small rock mounds/piles, 23 large rock mounds, eight pahoehoe excavations, eight modified outcrops/depressions, two alignments, one overhang shelter, one modified cave and one modified blister with a few pieces of Cypraeidae shell and small pockets of soil.

The modifications are made with pahoehoe blocks with no formally faced walls. The construction is mostly of loose stacks and loosely piled mounds of rocks.

The features may continue beyond the present identified boundaries. The vegetation makes it very difficult to determine accurately.

SITE NO.: State: 13424 **PHRI:** T-207
SITE TYPE: Complex (3 Features)
TOPOGRAPHY:
VEGETATION: Christmas-berry, air plants, guava, koa-haole and fountain grass.
ELEVATION: c. 511 feet
CONDITION: Poor-fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture/possible ceremonial
DESCRIPTION: The overall complex area measures c. 23.0 m at 350 degrees by 17.3 m at 80 degrees.

FEATURE A: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 10.75 m by 3.52 m by 0.54 m

A blister type of pahoehoe excavation in which the excavated area has been filled in with angular pahoehoe pebbles, cobbles and boulders and with an alignment of possible steppingstone slabs of pahoehoe. Roughly rectangular shape in plan, cobbles and pebbles have been placed on the northern corner, 1-2 courses high, and measures 2.1 m by 0.72 m and 0.2 m high.

The SE corner of the entire excavated area has cobbles strewn haphazardly about. The excavated area at the SE corner, also blister type has been filled in with large boulders, cobbles and pebbles. This excavated blister measures 3.0 m by 2.48 m. A Christmas-berry tree is growing out of this excavation.

A pahoehoe finger divides the blister into two excavations and measures 1.75 m by 0.57 m. Approximately 1.58 m apart, pahoehoe slabs and cobbles have been placed oriented south in a linear direction, but slabs are laying flat on top of the pahoehoe finger. The largest slab is 0.57 m and the smallest is 0.34 m in length.

FEATURE B: Modified outcrop Figure 2
FUNCTION: Agriculture
DIMENSIONS: 9.00 m by 3.90 m by 0.35 m

This feature is a shallow excavated blister that has been filled with pahoehoe blocks and cobbles. The surface of the filled area is relatively level and contains three areas of pebble pavement, outlined with larger cobbles. Two of the pebble areas are adjacent to one another in the western half of the blister. They are roughly circular

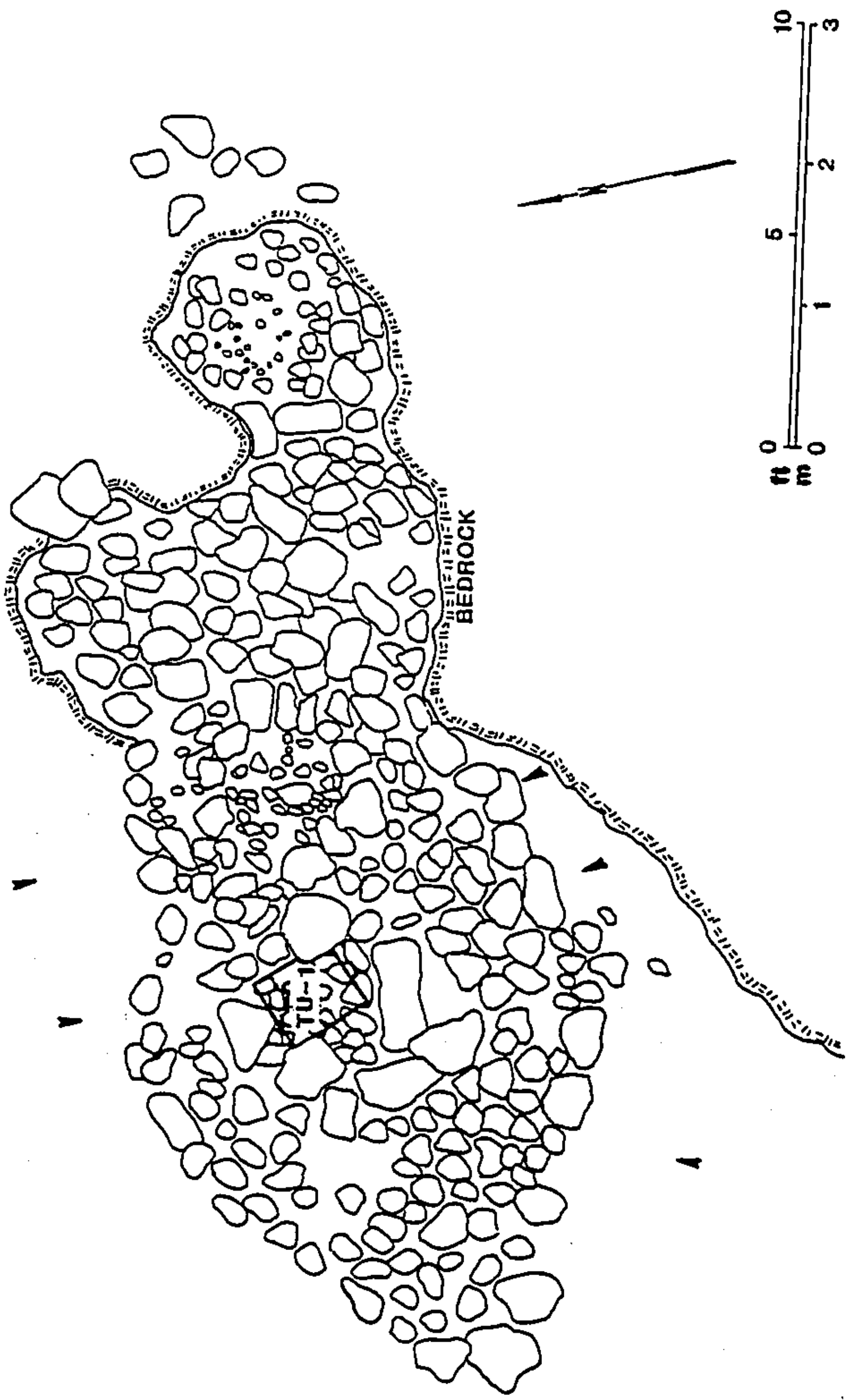


Figure 2. SITE 13424, FEATURE B

in plan, with interior areas 0.75 m in diameter. The third pebble area is at the eastern end of the blister, in a deeper section (0.27 m below surface). The surface area of this pebble plot is 1.50 by 1.40 m.

A 0.50 by 0.50 m sq test unit was excavated into the westernmost pebble-paved plot, in order to determine the nature of the fill, and if subsurface features were present. The pebble fill was found to be 0.26 m thick and overlying a 0.05 m thick deposit of silty loam. No cultural deposits or portable remains were located in the test unit. The soil deposit was sampled for further analysis (see subsurface findings).

FEATURE C: Cairn
FUNCTION: Indeterminate marker
DIMENSIONS: 0.85 m by 0.80 m by 0.47 m

The cairn is located 15.00 m northwest from Feature B. It is generally circular shape in plan, and constructed with pahoehoe cobbles and slabs stacked two courses high. It is built on ropy pahoehoe with large cobbles at the base of the structure and smaller cobbles on top. The cairn is presently collapsed.

SITE NO.: State: 13425 **PHRI:** T-208
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: Terrain consists of a gentle westward slope, irregular and disturbed pahoehoe flow with a northwestern exposure.
VEGETATION: Christmas-berry, lantana, noni, and sparse grass.
ELEVATION: c. 521 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture-habitation
DESCRIPTION: The overall complex area measures 38.50 m at 225 degrees Az. by 23.90 m Identified features include two modified outcrops (Features A and B), a cave (Feature C), and a rock mound (Feature D).

FEATURE A: Modified blister
FUNCTION: Agriculture
DIMENSIONS: 9.25 m by 6.90 m by 0.87 m

This feature is a collapsed blister that was modified to form boulder alignments and pavement fill. In the eastern portion of the blister is a pavement of pebble size pahoehoe pieces. Abutting the eastern wall of the outcrop, boulder alignments surround the western edge and divide the pavement into two areas. The pavement measures 3.50 m (E-W) by 2.00 m on the north side of the boulder alignment. On the south side of the alignment the pavement measures 3.20 m E-W by 3.0 m N-S at its widest point. It is a C-shape with a wall of boulders and cobbles on the northwest edge of the terrace and a circular alignment. The rock wall measures 0.62 m from the outcrop to the north. It is 1.00 m at its widest point and 0.61 m at its highest. The circular alignment is 1.20 m wide on the interior.

FEATURE B: Modified outcrop
FUNCTION: Agriculture
DIMENSIONS: 8.50 m by 5.50 m by 1.15 m

Feature B is 6.00 m from Feature A at 310 degrees Az. It is an oval-shaped depression in pahoehoe that has been cleared of loose cobble and boulder size rubble. The cleared area measures 4.80 m by 2.20 m. Cleared stones are placed in various haphazard alignments along the base perimeter of the broken pahoehoe, some are along the rim slope and more are in piles.

The most formal arrangement is a small wall at the southwest corner between a small cave opening and at the base of the depression. It measures 1.50 m long, 0.50 m wide and 0.40 m high. The sides of the depression are sloping uphill.

There are three cave openings along the west side. The cave openings were examined and no portable remains were visible except for Feature C which has its opening along the southwest side of the Feature B blister rim. Most of the cleared blocks are along the eastern side of the slopes.

A soil area at the base of the depression measures 4.60 by 2.10 m. Average thickness is 0.06-0.08 m; it is black to dark brown granular loam.

FEATURE C: Cave
FUNCTION: Habitation
DIMENSIONS: 8.30 m by 3.00 m by 1.20 m

It is situated along the southern rim of Feature B (modified outcrop) 2.00 m from the cleared area. The cave entrance is vertical with the chamber tube extending to the northwest at 220 degrees. The opening measures 1.25 m by 0.70 m with a height of 0.94 m.

The cave is generally unmodified with some evidence of moving large pieces of roof fall towards the edges of the chamber, along a shelf that defines the crawlspace. Four to six large blocks are in loose alignment at the east side of the chamber.

Portable remains consists of kukui nut, a waterworn basalt slab with one side possibly used for grinding, a possible coral abrader, a piece of coral and a large piece of charcoal. Dark brown, granular soil is present in pockets.

FEATURE D: Mound
FUNCTION: Indeterminate/possible agriculture
DIMENSIONS: 3.60 m by 3.20 m by 0.65 m

Feature D is 12.00 m northeast from Feature A. It is constructed with aa and pahoehoe cobbles that range in size from 0.03 by 0.04 m to 0.20 by 0.30 m.

SITE NO.: State: 13426 **PHRI:** T-209
SITE TYPE: Roadbed
TOPOGRAPHY: Gently to steeply sloping irregular pahoehoe and aa.
VEGETATION: Thick lantana, agave, guava, grasses, koa-haole, and kiawe.
ELEVATION: c. 600 feet
CONDITION: Good
INTEGRITY: Unaltered except by present roadway.
PROBABLE AGE: Historic
FUNCTIONAL INTERPRETATION: Transportation
DIMENSIONS: 220.00 m by 6.20 m by 2.00 m
DESCRIPTION: The roadbed is stacked and faced along both sides, up to three courses high in places. The road surface is on a relatively level grade with retaining walls filling in the low places. The west side is also built up to maintain the grade. Most of the roadbed looks like rock fill covered with gravel size pieces of aa and some soil. The height of the roadbed ranges from 0.7 m to 2.0 m. This section of the road goes through the center of Site 13435, Possible Agriculture Complex. The feature appears to be an abandoned section of Palani Road.

SITE NO.: State: 13427 **PHRI:** T-210
SITE TYPE: Complex (17 Features)
TOPOGRAPHY: The terrain consists of pahoehoe lava flow with large boulders scatters on the surface, many of which appear to be quarried material.
VEGETATION: Christmas-berry, koa-haole, lantana, and fountain grass.
ELEVATION: c. 590 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall complex area is 50.0 m by 50.0 m. Three rock mounds were individually recorded (Features A-C) and four additional mounds and ten pahoehoe excavations were identified. There are additional agriculture features in the area consisting of rock mounds, pahoehoe excavations and rock alignments. The area is covered with thick vegetation and extensive clearing is required before an accurate count of features can be obtained.

FEATURE A: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.36 m by 1.40 m by 0.88 m

The mound is constructed with large boulders stacked three courses high on top of smooth pahoehoe.

FEATURE B: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.00 m by 1.90 m by 0.95 m

This mound is c. 30.00 m northwest from Feature A. It is constructed with large boulders (some upright) around the base and is filled with small cobbles, piled four courses high.

FEATURE C: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.30 m by 1.40 m by 1.30 m

Semicircular shape in plan, it is constructed with stacked boulders and cobbles. Large boulders are used along the perimeter and faced with cobbles on the interior. This mound is adjacent to Feature B.

SITE NO.: State: 13428 **PHRI:** T-211
SITE TYPE: Complex (43 Features)
TOPOGRAPHY: The terrain consists of irregular pahoehoe.
VEGETATION: Christmas-berry, lantana, and grass.
ELEVATION: c. 575 feet
CONDITION: Poor-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall complex area measures 48.0 m at 250 degrees Az. by 20.0 m. Eight features were individually recorded at the site, including five faced mounds (Features A-E), an alignment (Feature F), a platform (Feature G), and a terrace (Feature H). In addition, 25 pahoehoe excavations and 10 rock mounds were enumerated.

FEATURE A: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.55 m by 1.50 m by 1.20 m

Generally circular shaped in plan, it is constructed with stacked and faced boulders with smaller cobbles as fill. A cleared pahoehoe excavation is present 0.70 m at 60 degrees from Feature A. The excavation may have been a quarry source for building material.

FEATURE B: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.80 m by 1.60 m by 0.95 m

Feature B is c. 4.4 m at 190 degrees to Feature E and 6.9 m at 280 degrees to Feature B. Generally circular shape in plan, it is constructed with stacked boulders along the perimeter and filled with pahoehoe cobbles. Feature B is bounded on all sides by pahoehoe excavations.

FEATURE C: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.85 m by 1.80 m by 1.27 m

Circular shape in plan, it is constructed with stacked pahoehoe boulders along the perimeter and cobble filled. Several boulders have fallen, but for the most part this mound appears to be in good condition. A pahoehoe excavation is adjacent to the east side of the mound.

The center fill of the mound was removed in order to determine if subsurface features were present. The fill was found to consist of undifferentiated cobbles and pebbles, with a slightly higher proportion of pebbles toward the base of the mound. A 0.10 m thick deposit of silty clay loam was encountered beneath the core fill. The soil was directly on unbroken bedrock and contained no portable remains or indications of a cultural deposit. A sample of the soil was collected for further analysis (see subsurface findings).

FEATURE D: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.25 m by 1.20 m by 0.45 m

Circular shape in plan, it is constructed with large boulders along the perimeter and filled with cobbles and pebbles. The mound is 7.40 m northwest from Feature B.

FEATURE E: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.80 m by 1.80 m by 0.95 m

Generally circular shape in plan, the perimeter is built up with boulders and the interior is filled with cobbles. Feature E has collapsed along the eastern side with other fallen boulders surrounding the mound. It is located 4.2 m east from Feature A.

It is constructed on the very edge of a pahoehoe excavation located on the northern side of the mound. This excavation may have been a quarry source for building material.

The center core filling of the mound was removed in order to determine if subsurface features or deposits were present. The fill was found to be an undifferentiated mixture of pebbles and small cobbles, with slightly more small pebbles toward the base of fill. The bedrock surface under the mound was broken and a soil deposit up to 0.30 m thick was present in the surface hole. No cultural materials or portable remains were located in the soil, however, a single <u>kukui</u> nut was located at the base of the pebble fill, 0.57 m below the present top of the mound. A sample of the soil was collected for further analysis (see subsurface findings).

FEATURE F: Alignment
FUNCTION: Indeterminate
DIMENSIONS: 16.00 m by 1.00 m by 0.50 m

Feature F is a boulder alignment that connects and incorporates adjacent mounds. The alignment begins at the eastern end with a rock mound that measures 3.00 m by 3.00 m. It continues 5.10 m to a second mound that measures 1.90 m in diameter. The alignment continues 6.00 m to the Feature G platform. It continues along the western edge of the platform for 10.00 m to the Feature H terrace. Feature F varies from a single boulder alignment to stacked boulders, two high and three wide, with smaller cobbles used as fill.

FEATURE G: Platform
FUNCTION: Agriculture
DIMENSIONS: 3.50 m by 3.25 m by 0.85 m

Figure 3

The platform is roughly rectangular in plan, with convex sides. It is constructed with a stacked pahoehoe boulder perimeter and with pahoehoe boulder and cobble fill. The platform surface was apparently leveled at one time and covered with a pavement of small cobbles and pebbles. Presently, the northern portion is covered with a deposit of large pahoehoe cobbles and slabs, piled to 0.40 m above the exposed portion of the original pavement.

Adjacent to the east side of the platform is a D-shaped terrace, constructed from large cobbles and boulders. The terrace is 2.50 m N-S by 1.50 m E-W and is connected to the Feature F alignment. Large cobbles and boulders are scattered to the east and north of this feature. The terrace surface is very irregular and it resembles a truncated mound.

A 1.00 by 1.00 m square test unit was excavated into the center of the platform in order to determine if subsurface features, such as a human interment, were present. The test unit confirmed that the original paved surface had covered the platform, and that the larger cobbles and slabs had been added later, possibly reflecting a different use phase of the feature. The small pavement fill consisted of only 1-2 layers of pebbles overlying larger cobble and boulder fill. The cobble/boulder fill varied in thickness from 0.30 to 0.70 m, depending on the underlying bedrock, which was a sloping blister formation. At the base of the large fill layer was a layer of small pebbles and fragments of rock, some of which apparently filtered down through the larger matrix. A layer of silty loam occurred directly on the bedrock surface; it varied in thickness for less than 0.01 m to 0.06 m. A single kukui nut (complete but fragmented) was located in the soil zone. No other portable remains were observed. A soil sample was collected for further analysis (see subsurface findings).

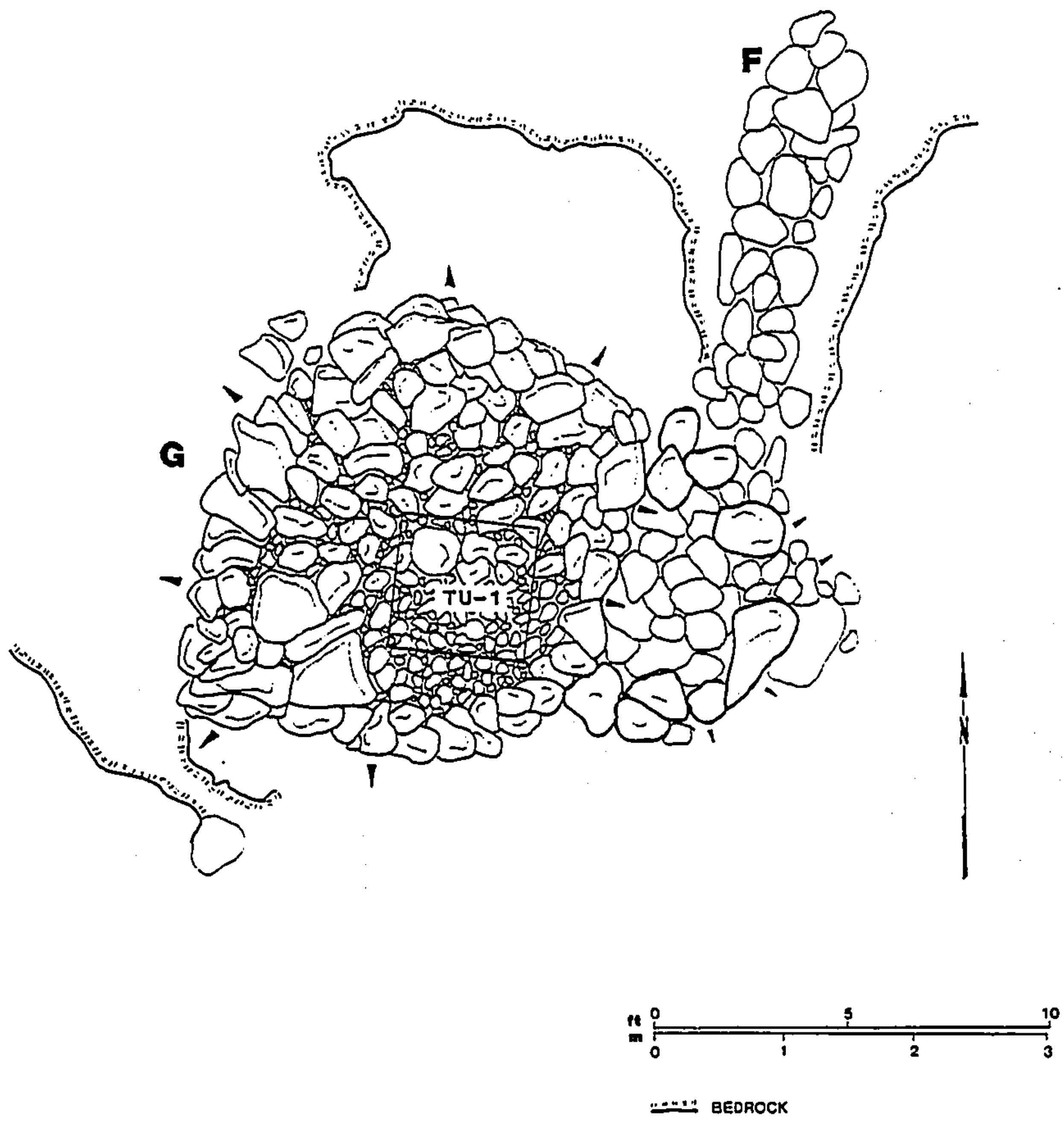


Figure 3. SITE 13428, FEATURE G

FEATURE H: Terrace
FUNCTION: Agriculture
DIMENSIONS: 7.00 m by 5.10 m by 0.80 m

The terrace is located 13.60 m southwest from Feature G. It is constructed with a stacked boulder perimeter and loose boulder and cobble fill. A cleared pahoehoe excavation is located 2.20 m west of the northeast corner of the terrace.

SITE NO.: State: 13429 **PHRI:** T-212
SITE TYPE: Complex (9 Features)
TOPOGRAPHY: Natural smooth pahoehoe flow with many rock mounds and pahoehoe blister excavations.
VEGETATION: Lantana, Christmas-berry, impatiens, koa-haole, and wild 'ilima.
ELEVATION: c. 575 feet
CONDITION: Fair-good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall complex area measures 35.00 m at 45 degrees Az. by 16.00 m. The site consists of two terraces (Features A and B), a modified blister (Feature C) and six mounds (Features D-I). All individual features are oriented in a NE-SW pattern.

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 3.37 m by 2.61 m by 0.70 m

Feature A is a low paved terrace that is rectangular shape in plan. It is built on a bedrock outcrop and faced on the east side. The paved area is 1.88 m by 1.2 m with a semicircular retainer built around the paved area. The retaining wall is stacked three courses high. Large boulder and cobble fill make up the terrace interior.

Excavated blocks have been strewn haphazardly on the southeast side. Another terrace (Feature B) is located to the southeast.

FEATURE B: Terrace
FUNCTION: Agriculture
DIMENSIONS: 2.55 m by 1.40 m by 0.48 m

The terrace is semicircular shape in plan. Cobbles outline the semicircle with larger cobbles and boulders on top. It is faced and stacked three courses high with boulders and cobbles. The interior is paved with pahoehoe slabs and cobble fill; it measures 1.81 by 1.0 m.

FEATURE C: Modified blister
FUNCTION: Agriculture
DIMENSIONS: 5.57 m by 2.90 m by 0.57 m

The northeast corner of a pahoehoe blister area is paved and filled with small cobbles. This paved area measures 1.79 m by 0.95 m.

An alignment built with large boulder size slabs is 1.50 m to the southwest. It is oriented NE-SW and measures 2.84 m by 0.61. In the center of the alignment along the exterior is an upright that measures 0.55 m by 0.43 m. The other slabs vary slightly in dimensions. Ten pahoehoe slabs make up this linear alignment.

In the center of the blister and the alignment is an excavated area with cobbles haphazardly placed. It contains soil with lantana bushes and measures 1.93 by 1.72 m.

FEATURE D: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.20 m by 2.00 m by 0.70 m

Feature D is 5.0 m at 215 degrees Az. from Feature A. It consists of a rock mound constructed along an excavated blister. The mound is built with stacked cobbles two to three courses high. The cobbles appear to derive from the pahoehoe excavation.

FEATURE E: Mound
FUNCTION: Agriculture
DIMENSIONS: 3.00 m by 2.60 m by 0.80 m

Feature E is 3.0 m at 215 degrees Az. from Feature D. It is a rock mound consisting of irregular stacked cobbles. Boulders are at the base of Feature E with smaller cobbles stacked on top.

FEATURE F: Mound
FUNCTION: Agriculture
DIMENSIONS: 1.60 m by 1.40 m by 0.65 m

Feature F is situated 2.00 m at 215 degrees Az. from Feature E. It is faced with large upright boulders with cobble fill, three to four courses high.

FEATURE G: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.30 m by 2.00 m by 1.00 m

Feature G is 6.0 m at 40 degrees Az. from Feature H. It is semicircular shape in plan and is constructed with large boulders, some upright, surrounding the base. Cobbles are used as interior fill.

FEATURE H: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.30 m by 1.60 m by 0.45 m

Semicircular shape in plan, it is constructed with stacked boulders and cobbles one to two courses high.

FEATURE I: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.24 m by 1.40 m by 0.80 m

Circular in shape at the base, it narrows at the top. Large boulders are at the base with cobbles piled and stacked on top, two courses high. Feature I is built on top of a natural pahoehoe flow.

SITE NO.: State: 13430 **PHRI:** T-213
SITE TYPE: Complex (15 Features)
TOPOGRAPHY: The terrain consists of a smooth pahoehoe flow.
VEGETATION: Christmas-berry, lantana, wild 'ilima, and koa-haole.
ELEVATION: c. 549-550 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-habitation
DESCRIPTION: The overall complex area measures 24.5 m at 245 degrees Az. by 6.50 m. Three structures were given feature designations. They consist of a platform (Feature A) and two mounds (Features B and C). In addition to the measured features, six mounds, a collapsed blister and five pahoehoe excavations were enumerated. The features are patterned in a linear formation, oriented NE-SW.

FEATURE A: Platform
FUNCTION: Possible habitation/agriculture
DIMENSIONS: 4.90 m by 4.30 m by 0.60 m

Rectangular shape in plan, it is outlined with large boulders and filled with cobbles and pebbles. A soil deposit is visible in the center of the platform. On the southwest edge are pahoehoe slabs extending the length of the feature.

FEATURE B: Mound
FUNCTION: Indeterminate/agriculture
DIMENSIONS: 1.60 m by 1.35 m by 0.70 m

Feature B consists of slab boulders and large cobbles, stacked three to four courses high in an irregular fashion. To the south of the mound (1.50 m) is a small rock pile that measures 1.30 by 1.10 m. Another rock pile or possible alignment is 3.00 m to the southwest; it measures 2.10 m (N-S) by 1.0 m (E-W). A collapsed blister with some piled rock is 6.00 m southwest. Surrounding this collapsed blister are several pahoehoe excavations.

FEATURE C: Mound
FUNCTION: Possible agriculture
DIMENSIONS: 2.00 m by 1.90 m by 0.95 m

The mound is roughly faced on the southeast side. It is constructed with boulders and cobbles stacked five courses high. Large boulders (some upright) surround the base; cobbles are used as interior fill.

Within a 10.0 m range are additional features consisting of five pahoehoe excavations and four rock mounds.

SITE NO.: State: 13431 **PHRI:** T-214
SITE TYPE: Complex (6 Features)
TOPOGRAPHY: The terrain consists of a pahoehoe flow that has been extensively altered by agricultural activities
VEGETATION: Christmas-berry, koa-haole, lantana, and kiawe.
ELEVATION: c. 540 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-habitation
DESCRIPTION: The overall complex area measures 20.0 m at 65 degrees Az. by 24.40 m. This site consists of a blister type cave with modifications (Feature A), two enclosures (Features B and C), a pahoehoe excavation (Feature E) and a terrace (Feature F). Portable remains consisting of Cypraeidae, Isognomonidae, kukui nut shell fragments, coral and charcoal were observed in Feature A. In addition there are c. 5-7 pahoehoe excavations within a 10.0 m range around the complex.

FEATURE A: Cave
FUNCTION: Habitation
DIMENSIONS: 4.40 m by 3.30 m by 1.08 m

The overall feature measures 8.00 by 3.30 m. The interior dimensions are 4.4 m (N-S) by 3.3 m (E-W) with an average ceiling height of 0.95 m.

Preceding the entry of the cave is a paved area that measures 3.60 m by 3.00 m. The entry is partially closed with stacked pahoehoe boulders. It is 0.90 m wide, 1.00 m high and faces 250 degrees Az. Immediately to the right of the entry is a small shelf constructed of pahoehoe boulders and paved with small cobbles.

The rear of the cave has been modified with large pahoehoe boulders and small cobbles. To the right rear of the cave is a small enclosure measuring 1.13 m by 0.70 m. It is constructed with large boulders and small cobbles with the floor covered with large cobbles. At the left rear of the cave is a collapsed enclosure of pahoehoe cobbles. The floor of this enclosure is covered with a sandy gravelly loam with kukui nuts. This area measures 1.20 m by 0.85 m.

Portable remains observed in the cave include Cypraeidae and Isognomonidae shells, coral and a partially burned piece of wood, in addition to the kukui nut shell.

FEATURE B: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 11.00 m by 5.40 m by 0.60 m

The enclosure is adjacent to Features A and C. It is oval to rectangular shape in plan. The wall of the enclosure is built with stacked pahoehoe boulders for an average width of 0.20 m. The interior of the enclosure is covered with a gravelly loam and scattered cobbles. The southern end of the enclosure wall rests on top of Feature A entrance. The western wall is shared with the Feature C enclosure. This shared wall is presently higher and in better condition compared with the remaining walls.

FEATURE C: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 12.50 m by 10.00 m by 0.80 m

Oval shape in plan, it is constructed with large pahoehoe boulders and slabs with cobble fill. It is two to three courses high and the wall is approximately 0.40 m wide. The floor interior contains a 0.03 to 0.04 m thick deposit of sandy, gravelly loam with scattered pahoehoe boulders and cobbles.

The northwest section of this enclosure seems to be leveled with smaller cobbles and gravel. Within this area are 5 to 6 filled depressions/possible pahoehoe excavations ranging in size from 0.70 m to 1.50 m across.

FEATURE D: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 3.30 m by 2.85 m by 0.55 m

A cleared blister type pahoehoe excavation. It is bordered on the north by the Feature C enclosure wall. The quarried boulders have been removed from the excavation, with several remaining around the perimeter. Small cobbles remain in the bottom of the excavation.

Directly west at 0.60 m is another blister type pahoehoe excavation. It is 1.40 m wide and 0.50 m deep.

FEATURE E: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 4.80 m by 4.00 m by 0.57 m

A blister type pahoehoe excavation. The excavated boulders and cobbles have been haphazardly strewn in the immediate excavated area. An upright is present next to the excavation.

FEATURE F: Terrace and alignment
FUNCTION: Agriculture
DIMENSIONS: 11.05 m by 38.00 m by 0.42 m

Feature F consists of a circular aligned paved terrace. It measures 4.28 m at 115 degrees Az. by 1.20 m. The paved area is filled with cobbles and gravels and may be a filled blister. An alignment made up of large pahoehoe boulders and aa cobbles, stacked two courses high, is connected to the terrace. It is oriented N-S and collapsed along sections.

SITE NO.: State: 13432 **PHRI:** T-215
SITE TYPE: Mound
TOPOGRAPHY: Pahoehoe finger flows.
VEGETATION: Christmas-berry, fountain grass, and koa-haole.
ELEVATION: c. 227 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DIMENSIONS: 1.60 m by 1.60 m by 0.70 m
DESCRIPTION: This site consists of a rock mound with an associated pahoehoe excavation. The rock mound is constructed with loosely piled pahoehoe boulders and is situated 6.00 m east of the excavation.

SITE NO.: State: 13433 **PHRI:** T-216
SITE TYPE: Cairn
TOPOGRAPHY: Smooth pahoehoe flow and an aa flow southeast of the site.
VEGETATION: Fountain grass, air plants, and Christmas-berry.
ELEVATION: c. 520 feet
CONDITION: Fair
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Indeterminate marker
DIMENSIONS: 0.66 m by 0.54 m by 0.48 m
DESCRIPTION: An oval shaped cairn that is stacked two courses high. Large pahoehoe boulders and cobbles make up the structure. It is collapsing along the north side. The total area of scattered rocks measures 1.69 by 0.92 m.

SITE NO.: State: 13434 **PHRI:** T-217
SITE TYPE: Complex (4 Features)
TOPOGRAPHY: The terrain consists of aa flows surrounding the complex area with large mounds of aa and large aa boulders.
VEGETATION: Christmas-berry, laua'e fern, air plant, lantana, and koa-haole.
ELEVATION: c. 552 feet
CONDITION: Good

INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall complex area measures 46.40 m at 170 degrees Az. by 18.0 m. The site consists of three circular faced mounds (Features A, B and D) and a pahoehoe excavation (Feature C).

FEATURE A: Faced Mound
FUNCTION: Agriculture
DIMENSIONS: 1.50 m by 1.30 m by 0.80 m

It is constructed with a stacked and faced perimeter of pahoehoe boulders, two to three courses high. Cobbles are used as interior fill.

The northern quarter of the mound was disassembled in order to determine if subsurface features were present. The fill was determined to be undifferentiated cobbles, placed directly on an artificially built-up surface of aa pebbles and cobbles. This surface was penetrated and found to be 0.68 m thick, overlying a 0.02 m thick deposit of loamy soil with aa pebbles intermixed. A 0.10 m thick layer of coarse soil and disintegrating pahoehoe bedrock was beneath this soil/pebble layer. No portable remains or cultural deposits were observed. A sample of the soil was collected for further analysis (see subsurface findings).

FEATURE B: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.00 m by 1.00 m by 0.70 m

Feature B is located 8.00 m at 105 degrees Az. from Feature A. It is constructed with large pahoehoe boulders stacked two to three courses high in a circular fashion. Smaller cobbles are used as interior fill.

FEATURE C: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 4.40 m by 3.10 m by 0.35 m

Oval shaped in plan, it contains aa cobbles on the floor and in the surrounding area. Portions of the excavation look natural.

A mound is located 2.40 m north of the excavation. It measures 4.30 m by 3.8 m and 1.13 m in height. The mound is loosely constructed with large aa and some pahoehoe cobbles. The northern portion of the mound is collapsing.

FEATURE D: Faced mound
FUNCTION: Agriculture
DIMENSIONS: 1.20 m by 1.00 m by 0.69 m

Circular shape in plan, it is constructed with aa boulders at the base and aa cobbles as interior fill. The mound is stacked three courses high.

SITE NO.: State: 13435 **PHRI:** T-218
SITE TYPE: Complex (10 Features)
TOPOGRAPHY: The terrain consists of gently sloping to irregular pahoehoe and aa flows.
VEGETATION: Lantana, Christmas-berry, agave, guava, koa-haole, kolu, grass, and numerous sisal plants.
ELEVATION: c. 580-600 feet
CONDITION: Good
INTEGRITY: Unaltered to possibly altered by road construction
PROBABLE AGE: Historic/possibly prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The overall complex area measures 147.90 m N-S by 36.00 m E-W. The site consists of seven enclosures (Features A-F and Feature J), a L-shape wall (Feature G), and modified outcrops (Features H and I). The enclosures are all built using a similar construction technique. Features A-F abut the retaining wall of the Site 13426 roadbed which defines either the east or west side of each enclosure. Some (or all) of these features appear to have been constructed after the roadway was built. There may be additional features in the area; vegetation is extremely thick.

The location of this site is c. 500 m east (upslope from) the mapped location of a commercial sisal mill which operated during the late nineteenth and early twentieth centuries. The enclosures may be associated with this mill.

FEATURE A: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 4.80 m by 3.80 m by 0.70 m

This enclosure is east and adjacent to the old Palani Roadbed (Site 13426). The wall is constructed with loosely stacked boulders and cobbles, two to three courses high and two to three wide. Feature B is directly west on the other side of the roadbed. Inside the enclosure is a deposit of reddish brown silty loam mixed with aa pebbles.

FEATURE B: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 16.50 m by 7.20 m by 1.70 m maximum height

The enclosure is built abutting the west side of the old Palani Roadbed. It is keyhole shape in plan, with the narrow section at the southern end. This portion measures 5.20 m long by 2.20 m wide. The walls at the narrow end are 0.85 m high and 1.10 m wide. At the wider section, the enclosure is 7.20 m wide and 1.70 m high. At the northern end is another narrow section 7.00 m long. Near the center of the northern narrow section is an oval hole with the perimeter outlined with boulders. The hole measures 2.50 m across by 1.20 m deep. The construction of all walls are loosely stacked. The roadbed retaining wall here is 1.70 m high. The enclosure walls here are intact up to and against the retaining wall.

FEATURE C: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 24.00 m by 6.20 m by 1.40 m

Feature C also abuts the western side of the old roadbed, and is immediately south of Feature B. It is similar in plan to Feature B, with minor variation. There is a wide central section and narrow extensions to the north and south. The extensions are 5.00 m long, 1.20 m wide with 1.00 m wide walls. At the northern end of the northern extension is an area of rock fill, which extends nearly to the edge of Feature B. The wall is open at the south end. with a c. 1.00 m wide gap between the end of the wall and the roadbed retaining wall.

The main section of the enclosure is 14.00 m long, 6.20 m wide and averages 1.40 m high. The wall in this section includes some massive boulders, and wall width is up to 2.38 m in places. The interior surface of the enclosure is 2.00 m below the level of the roadbed.

FEATURE D: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 9.50 m by 2.40 m by 1.30 m

Feature D is located 20.00 m south of Feature C, along the west side of the old Palani Roadbed. It consists of a sectioned enclosure that connects with a larger enclosure (Feature E) immediately to the south. The northernmost section is 4.50 m long and 2.40 m wide, with an average wall width of 0.60 m, and an exterior wall height of 0.90 m. The south section is 5.00 m long and 1.80 m wide with an interior wall height of 1.30 m. the northern end of the enclosure is intact up to and against the roadbed retaining wall; the south end is open. The area between the Feature D and E enclosures is filled with cobbles and boulders, as is the opening in the enclosure D wall.

FEATURE E: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 11.30 m by 7.10 m by 0.70 m

Feature E abuts the west side of the old roadbed, and is situated between Features D and F. Overall shape of the enclosure is keyhole, with a narrow extension to the south side. This enclosure wall is double faced and core filled, unlike Features A-D. It is built with aa boulders and cobbles, and the wall averages 2.50 m wide and 0.70 m high. The interior is divided into two sections by a low wall, 0.40 m high, that is oriented perpendicular to the old roadbed. The narrow extension of this feature is joined to a similar narrow extension of Feature F to the south by a 2.20 m wide area of rock fill. The filled area is flat and ramp-like, and slopes downhill from the roadbed surface, permitting access from the road to both Features E and F. One broken green bottle base (c. 1920-1940) was observed on the roadbed near the ramp.

FEATURE F: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 12.40 m by 6.65 m by 1.20 m

Generally keyhole shape in plan, it is located 5.00 m north from the shoulder rip-rap of the existing Palani Highway, and abuts the old Palani Roadbed. The walls are constructed with stacked boulders and cobbles five courses high, and 0.75 m wide.

FEATURE G: L-shape wall
FUNCTION: Agriculture (probably recent)
DIMENSIONS: 2.80 m by 1.77 m by 1.20 m

Feature G is c. 8.00 m east of the old Palani Roadbed and is probably not functionally related to the enclosure features built along the road. The wall is loosely stacked along perimeter the of a pahoehoe outcrop, abutting high areas of pahoehoe and forming a small enclosed area. This enclosed area is 3.20 m (N-S) by 5.30 m (E-W). It is constructed with generally squarish blocks of pahoehoe, loosely stacked, with some sections along the interior faced.

A rock pile is located at the east end interior of the enclosed area. It is c. 1.45 m in diameter at the base, with a maximum height of c. 0.5 m at the center. The pile is haphazard with some cobbles scattered around the base.

A deposit of black loam resembling potting soil is present, and arrears to have been brought to the site. Several plastic plant bags (some containing soil), buckets, water containers and a gardening trowel were found in the immediate area.

FEATURE H: Modified outcrop
FUNCTION: Agriculture
DIMENSIONS: 4.50 m by 2.50 m by 2.29 m

Feature H consists of cleared aa under a natural overhang with a loosely stacked wall. The cleared area is 0.450 m deep from the ground surface. Aa boulders and cobbles have been cleared away and piled to the south in a crude wall-like formation abutting the natural outcrop face. The wall measures 2.40 m (NE-SW) by 1.60 m. The west side is faced two to four courses with a maximum height of 0.70 m. A tin can was found inside the cleared area. This feature is adjacent to the east side of the old roadbed, across from Feature C.

FEATURE I: Modified outcrop
FUNCTION: Quarry/possible agriculture
DIMENSIONS: 3.50 m by 2.10 m by 1.20 m

This modified outcrop is immediately adjacent to the east side of the old Palani Roadbed, between Features A and H. It appears to be a quarry site, possibly used during construction of the roadbed. Chunks of rough pahoehoe and aa are cleared out along face of an outcrop. A small overhang occurs along the south and east sides of the clearing with a crawlspace underneath the overhang. The crawlspace has a floor of aa pebbles. A pile of cobbles and boulders are against the interior north side of the clearing. Other boulders are loosely stacked in a linear pile along the exterior northern perimeter of the clearing. In addition there is a rock pile inside of the clearing that measures 1.06 m (E-W) by 1.20 m (N-S) and 0.30 m in height. Approximately 12 rusted tin cans, a broken food jar and a tobacco can are scattered in the feature.

FEATURE J: Enclosure
FUNCTION: Agriculture
DIMENSIONS: 8.90 m by 7.00 m by 1.57 m

Feature J is 2.50 m north from Feature A, on the east side of the old Palani Roadbed. The enclosure is roughly C-shape in plan with the major axis oriented N-S. The walls are constructed with large stacked boulders and average 1.20 m in width. Wall height varies from 1.57 m along the northeast side to 0.85 m along the west side. The northeast portion of the wall (4.90 m long) connects to the entrance of a 3.71 m wide overhang. Ceiling height in the shallow overhang is 1.61 m. Extending east is an overhang ceiling which is 1.61 m. There is a shelf inside of the overhang which is 0.39 m in height and 0.64 m in length and filled with basalt gravels. A 0.10 m thick deposit of brown silty loam is present; no portable remains were observed.

SITE NO.: State: 13436 **PHRI:** T-219
SITE TYPE: Wall
TOPOGRAPHY: Irregular pahoehoe with a relatively steep slope.
VEGETATION: Sisal, Christmas-berry, guava, koa-haole, lantana, and various grasses.
ELEVATION: c. 605 feet
CONDITION: Poor-fair
INTEGRITY: Unaltered except by roadway construction
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Land division
DIMENSIONS: 134.80 m by 1.30 m by 0.60 m

DESCRIPTION: This site is a bifaced and core filled wall. It is constructed with stacked boulders, one to six high, and cobble filled. The height varies from 0.30 m to 1.30 m, and width averages 0.60 m. Both ends of the wall have been terminated at the shoulder of the existing Palani Highway. The road is oriented generally NE-SW and roughly parallels the old Palani Roadbed, located c. 12.00 m to the east. There are four minor angles (20-40 degrees) along the length of the wall. Pahoehoe excavations occur c. 2.0-3.0 m to the east of the wall and may be a probable source for building material.

SITE NO.: State: 13437 **PHRI:** T-220
SITE TYPE: Complex (7 Features)
TOPOGRAPHY: Undulating pahoehoe and aa surface flows.
VEGETATION: Christmas-berry, lantana, air plants, and laua'e.
ELEVATION: c. 515-518 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: *Prehistoric*
FUNCTIONAL INTERPRETATION: Agriculture-marker
DESCRIPTION: The overall complex area measures 56.40 m at 330 degrees Az. by 24.00 m. The site consists of a stepped terrace (Feature A), a pavement (Feature B), a faced outcrop (Feature C), a terrace (Feature D), and three cairns (Features E-G).

FEATURE A: Stepped terrace
FUNCTION: Agriculture
DIMENSIONS: 45.90 m by 13.58 m by 1.48 m

The terrace is oriented NW-SE. It begins as a single stacked wall and then it proceeds to five courses then seven courses high. The stepped terrace is constructed with pahoehoe and aa boulders and cobbles and paved with angular aa gravel. Portions of the retaining wall are stacked and portions are collapsed.

The northernmost and upper terrace measures 45.90 m by 4.20 m. The retaining wall is raised on the south side and is stacked three to six courses high for a maximum height of 0.94 m. The lower and southernmost terrace measures 34.20 m by 9.30 m. It is stacked six courses high, and is 1.10 m in height, where it joins with the upper terrace.

FEATURE B: Pavement
FUNCTION: Agriculture
DIMENSIONS: 7.80 m by 3.80 m by 1.50 m

This pavement is east of and adjacent to Feature A. It is constructed with rough cobbles and outlined with aa cobbles that are stacked in places. North and adjacent to the paved area is a depression bordered on three sides by the built-up area and on the fourth side by a rock ledge. The depression measures 5.00 m by 3.00 m and is 1.80 m deep. The base of the depression is cleared and has a 0.02 m thick soil deposit that covers an area 2.80 m by 0.90 m.

FEATURE C: Faced outcrop
FUNCTION: Agriculture
DIMENSIONS: 2.50 m by 0.00 m by 1.00 m

Feature C is 22.00 m south and 5.70 m east of Feature A. It consists of a natural ledge that has been stacked with aa boulders and cobbles to form a crude retaining wall. In areas along the natural ledge occasional cobbles can be found placed along the top edge.

FEATURE D: Terrace
FUNCTION: Agriculture
DIMENSIONS: 14.00 m by 10.00 m by 0.80 m

This terrace is in the immediate vicinity of Features A and B. Large pahoehoe boulders are stacked two to three courses high around the perimeter, with smaller pahoehoe cobbles filling the interior. This terrace is roughly L-shaped with the major axis oriented E-W, and the extension to the south at the east end. The extension is 4.00 m N-S and 3.50 m E-W. On the west end of the terrace is a small circular platform, constructed on the edge and on top of the perimeter wall. It is 0.70 m in diameter and two courses (0.38 m) high. A 0.08-0.10 m thick deposit of sandy loam is present on the terrace.

FEATURE E: Cairn
FUNCTION: Marker
DIMENSIONS: 0.85 m by 0.85 m by 0.65 m

This cairn is the westernmost of an alignment of three cairns (with F and G). It is 10.00 m south from the west end of Feature D. It is circular at the base and constructed with aa boulders and cobbles with three courses of single pahoehoe cobbles on top. To the north of the cairn alignment is a linear rock mound that extends 11.50 m at 100 degrees Az.

FEATURE F: Cairn
FUNCTION: Marker
DIMENSIONS: 0.85 m by 0.85 m by 0.70 m

Circular at the base and constructed with aa boulders and cobbles with three courses of single pahoehoe cobbles on top. Feature F is the center cairn. Feature E and Feature G are in line at 100 degrees Az. and are on either side of Feature F, which is 4.20 m from Feature E and 3.80 m from Feature G.

FEATURE G: Cairn
FUNCTION: Marker
DIMENSIONS: 0.90 m by 0.90 m by 0.85 m

Circular at the base and constructed with aa boulders and cobbles with three courses of single pahoehoe cobbles on top. Feature G is the easternmost cairn.

SITE NO.: State: 13438 *PHRI:* T-221
SITE TYPE: Complex (10 Features)
TOPOGRAPHY: Aa flows with some pahoehoe.
VEGETATION: Christmas-berry, lantana, air plant, ferns, grass, and noni.
ELEVATION: c. 529 feet
CONDITION: Poor-good
INTEGRITY: Unaltered
PROBABLE AGE: Historic/Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-transportation
DESCRIPTION: Overall complex area measures 200.0 m (N-S) by 40.0 m (E-W). The site consists of four terraces (Feature A, Features C and D and Feature F), two mounds (Features B and I), three terraces (Features C, D and Feature F), a pahoehoe excavation (Feature E), a trail (Feature G), a roadbed (Feature H) and a cairn (Feature J).

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 5.10 m by 5.00 m by 0.50 m

The terrace wall is built with stacked aa cobbles and the surface interior is paved with aa gravels. The terrace boundary is distinguished by large cobbles and boulders to the north and the south and by a downward slope to the east. In addition, there is an oval shaped, cleared aa depression west and adjacent to the terrace wall.

FEATURE B: Mound
FUNCTION: Agriculture
DIMENSIONS: 2.50 m by 2.40 m by 0.70 m

This mound is 5.00 m north from Feature A. It is built with a loosely stacked perimeter of aa cobbles and filled with gravel and a few cobbles.

FEATURE C: Terrace
FUNCTION: Agriculture
DIMENSIONS: 7.50 m by 2.30 m by 0.65 m

The terrace is 14.80 m west from Feature B. It is roughly rectangular shape, and raised on the southwest side. The riser wall is constructed with stacked aa boulders and cobbles and the terrace surface is paved with cobbles and gravels. It is collapsing at the southeast end where collapse extends 1.80 m to the exterior of the terrace wall.

Immediately to the northeast of the terrace are two cleared depressions in the natural aa flow. The largest of these is at the northern edge of the terrace; it is 3.90 by 2.20 m and 1.05 m deep. The second depression is 2.00 m to the south. It is 2.90 by 1.60 m and 0.75 m deep.

FEATURE D: Terrace
FUNCTION: Agriculture
DIMENSIONS: 5.00 m by 4.00 m by 0.20 m

Feature D is in the immediate vicinity of Feature C. It is an oval shaped terrace with a perimeter of large aa cobbles, and is filled with aa gravels. The surface is level and flat. The perimeter may have been stacked at one time, but it is presently collapsed.

FEATURE E: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 4.70 m by 2.00 m by 0.90 m

An excavated pahoehoe ledge with stacked angular pahoehoe boulders and cobbles on top of the ledge. Smaller cobbles cover the interior. On the eastern ledge of this feature is a rock mound that measures 1.20 m by 1.00 m by 0.40 m high. Large pahoehoe boulders are at the base with smaller cobbles on top, two to three courses high.

FEATURE F: Terrace
FUNCTION: Agriculture
DIMENSIONS: 8.40 m by 3.30 m by 1.20 m

This terrace is adjacent to Features C and D, and the east end abuts the retaining wall of the old Palani Roadbed (Feature H). The terrace is roughly crescent shape in plan and constructed with a perimeter of large aa boulders stacked two to three courses high. It is filled with aa gravel.

FEATURE G: Trail
FUNCTION: Transportation
DIMENSIONS: 50.00 m by 1.20 m

The trail section is oriented northwest and west from the Feature F terrace. It has a flattened, packed surface of aa gravel and a perimeter of larger aa cobbles. The trail alignment is nonlinear.

FEATURE H: Roadbed
FUNCTION: Transportation
DIMENSIONS: 200.00 m by 4.30 m by 2.00 m

This feature is an abandoned section of Palani Road. It is identical in construction to the section described above (SIHP Site 13426). The south end of this section is at the shoulder riprap of the existing Palani Highway alignment. The north end is terminated at Site 13434.

FEATURE I: Mound
FUNCTION: Indeterminate
DIMENSIONS: 7.30 m by 2.00 m by 1.00 m

The rock mound is located 10.00 m west from Feature E. It is generally linear in plan and constructed with boulders from an adjacent pahoehoe flow. Height varies from 0.50 to 1.00 m. A somewhat discrete rock concentration occurs at the southeast end of this linear mound. The concentration is 1.20 m by 0.90 m and is two courses high.

FEATURE J: Cairn
FUNCTION: Indeterminate
DIMENSIONS: 0.60 m by 0.55 m by 0.70 m

Feature J is situated 8.0 m west of Feature E. It is built with two stacked pahoehoe boulders. The top boulder is slightly smaller than the boulder base.

SITE NO.: State: 13439 **PHRI:** T-222
SITE TYPE: Cairn
TOPOGRAPHY: The terrain consists of aa and pahoehoe flows.
VEGETATION: Christmas-berry, air plants, and grass.
ELEVATION: c. 555 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Indeterminate marker
DIMENSIONS: 1.15 m by 1.00 m by 1.00 m
DESCRIPTION: The cairn is constructed with stacked aa cobbles.

SITE NO.: State: 13440 **PHRI:** T-223
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: Irregular and undulating terrain consisting of aa and pahoehoe flows.
VEGETATION: Christmas-berry, koa-haole, lantana, and fountain grass.
ELEVATION: c. 506 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric-early historic
FUNCTIONAL INTERPRETATION: Agriculture

DESCRIPTION: The overall complex area measures 23.0 m at 330 degrees Az. by 13.20 m. The site consists of a terrace (Feature A), a filled crevice (Feature B) and a pahoehoe excavation (Feature C).

FEATURE A: Terrace
FUNCTION: Agriculture
DIMENSIONS: 4.20 m by 3.40 m by 0.00 m

A terrace built up on the edge of a pahoehoe outcrop with pahoehoe boulders and cobbles.

FEATURE B: Filled crevice
FUNCTION: Agriculture
DIMENSIONS: 3.40 m by 1.60 m by 0.00 m

Feature B is located 5.60 m northwest from Feature A. The crevice is filled with pahoehoe boulders and cobbles.

FEATURE C: Pahoehoe excavation
FUNCTION: Agriculture
DIMENSIONS: 13.20 m by 2.60 m by 0.00 m

Located 16.20 m northwest from Feature A. Pahoehoe cobbles and gravels are haphazardly strewn in a concave area along a pahoehoe flow edge. In the southwest end of the feature is a circle of pahoehoe boulders on the north flow edge measuring 1.90 m (N-S) by 1.20 m (E-W). A loam deposit is present 1.00 m north; it covers an area 2.50 by 1.2 m (N-S).

SITE NO.: State: 13447 **PHRI:** T-230
SITE TYPE: Complex (19 Features)
TOPOGRAPHY: Pahoehoe finger flows.
VEGETATION: Christmas-berry, lantana, grasses, guava, and koa-haole.
ELEVATION: c. 475 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture-possible habitation
DESCRIPTION: Overall area of this complex is 68.00 m (E-W) by 40.00 m (N-S). Features identified at the site include a platform (Feature A), six pahoehoe excavations, three modified blisters, and nine filled blisters.

FEATURE A: Platform
FUNCTION: Habitation
DIMENSIONS: 4.60 m by 4.30 m by 0.50 m

Feature is a platform with a large upright in the northwest corner. The perimeter consists of single pahoehoe boulders. The platform is roughly paved with pahoehoe cobbles and gravels. A pahoehoe excavation is located 2.00 m south of the platform. Also, piled pahoehoe boulders are 4.00 m to the southwest of the platform.

SITE NO.: State: 13448 **PHRI:** T-231
SITE TYPE: Complex (7 Features)
TOPOGRAPHY: A flat to gentle westward sloping terrain consisting of pahoehoe outcroppings.
VEGETATION: Christmas-berry, koa-haole, various grasses, lantana, and guava.
ELEVATION: c. 485 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Agriculture
DESCRIPTION: The site consists of a series of five interconnecting and two separate pahoehoe excavations. The five connecting pahoehoe excavations are cleared hollows in an area covered by large pahoehoe blocks and small boulders.

These five features are located on the south side of the complex. The overall measurement is 8.50 m at 290 degrees Az. by 10.00 m. The excavations range in size from 0.90 by 0.70 m to 2.00 by 0.90 m. Some visible pavement of pebbles and at least 0.14 m of soil are present within the excavations.

An L-shaped pahoehoe ledge excavation consists of some pahoehoe blocks placed along the upper pahoehoe flow. The interior is paved with pebbles and small cobbles. It measures 9.00 m at 18 degrees Az. by 4.5 m. The thickness of the excavated pahoehoe layer is 0.30 m and the maximum depth of the excavation is 0.53 m. Soil is visible at the base.

Another pahoehoe excavation is lined and filled with large pahoehoe cobbles and small boulders. It measures 4.60 m at 304 degrees Az. by 7.6 m. Soil is present in a small paved area on the west side of the Feature.

SITE NO.: State: 13449 **PHRI:** T-232
SITE TYPE: Complex (3 Features)
TOPOGRAPHY: Gentle sloping pahoehoe and aa flows.
VEGETATION: Christmas-berry, kiawe, koa-haole, ferns, air plants, and lantana.
ELEVATION: c. 480 feet
CONDITION: Good
INTEGRITY: Unaltered
PROBABLE AGE: Prehistoric
FUNCTIONAL INTERPRETATION: Habitation-transportation-possible agriculture
DESCRIPTION: The overall complex area measures 50.00 m NE-SW by 12.0 m NW-SE. The site consists of a lava tube cave (Feature A), a cairn (Feature B) and a steppingstone trail (Feature C).

FEATURE A: Lava tube cave
FUNCTION: Habitation
DIMENSIONS: 50.00 m by 5.00 m by 2.00 m

Feature A is a lava tube with three caved-in areas that serve as openings. Oriented in a SW direction, it extends to Site 13458. The width of the cave varies between 3.00-5.00 m and the height varies between 0.60-2.00 m.

A small retaining wall crosses part of the northeast end of the northeast chamber. The retaining wall is oriented at 125 degrees Az. and measures 3.60 m by 0.60 m and 0.45-1.12 m in height. It is constructed with stacked pahoehoe slabs and boulders.

Portable remains consists of Echinoidea and marine shell fgagments.

FEATURE B: Cairn
FUNCTION: Possible agricultural mound
DIMENSIONS: 3.20 m by 2.20 m by 1.10 m

Circular shape in plan, the outer edges are constructed with pahoehoe boulders stacked three to four courses high. Four large upright pahoehoe boulders are built into the cairn exterior wall, extending the full height of the feature and evenly spaced apart. The interior of the cairn consists of pahoehoe cobbles and gravels filled to the top of the feature.

FEATURE C: Steppingstone trail
FUNCTION: Transportation
DIMENSIONS: 18.28 m by 0.55 m

The trail is oriented NW-SE. It consists of 21 pahoehoe slabs of various sizes and shapes placed across an aa flow. From its northwestern end, the runs 7.7 m at 160 degrees Az.. It makes a slight curve and continues 10.34 m at 150 degrees Az. The southeastern end is at a pahoehoe cobble field.

SUBSURFACE FINDINGS

Subsurface testing was conducted at three sites (five features) within the added portion of the project area (Table 2). The testing was conducted January 22-29, 1990, as part of the testing field work for the Queen Liliuokalani Trust lands. Features selected for testing were those which exhibited morphological characteristics of burial monuments. These included a platform, three faced mounds, and a modified outcrop. The sizes and locations of excavation units were designed to locate subsurface skeletal remains, if they were present. One meter square units were used for all features except the modified outcrop, which could be adequately tested with a 0.25 m square unit.

During excavation, the rock fill was removed from the units as a single layer, and underlying soil deposits were excavated in natural layers, or arbitrary 0.1 m levels within natural layers. Depth was measured from the top of the feature, and in most cases, excavation terminated at or just below surrounding ground surface. Portable remains were located in test units at Features E and G, Site 13428. In both cases, single _kukui_ nuts were found. These items were complete, but were fragmented and unburned. The deposits at these features contained other seeds, such as _koa-haole_, and it is uncertain at this time whether the _kukui_ nuts were purposely placed (planted) in the features, or were introduced by other means. No other portable remains were observed in the five test units.

Samples were collected from soil deposits at three of the features. These were examined in the laboratory and compared with soils collected from a total of sixteen features (Donham 1990b:41-44). All test units were excavated to bedrock. After recordation and photographing was completed, the units were backfilled, and the surface features rebuilt. The excavation findings are summarized here briefly for each feature tested within the added survey area.

Table 2.

SUMMARY OF SUBSURFACE TESTING

SIHP No.	Fea.	Formal Type	Unit Size	Max. Depth	Material Recovered
13424	B	Mod. outcrop	0.25 sq m	0.59 m BS	Soil sample
13428	C	Faced mound	1.00 sq m	0.67 m BS	Soil sample
13428	E	Faced mound	1.00 sq m	1.05 m BS	-
13428	G	Platform	1.00 sq m	0.90 m BS	Soil sample
13434	A	Faced mound	1.00 sq m	1.48 m BS	-

Site 13424, Feature B

The feature consists of a pahoehoe excavation that was filled with chunky pahoehoe blocks and contained three areas that were leveled and paved. The paved areas were defined with boulder perimeters, some of which were set upright. A 0.25 by 0.25 m test unit was placed in the center of the most formal paved area. Rock fill consisted of a 0.28 m thick layer of cobbles directly beneath a single layer of paving pebbles. Beneath the cobbles was a 0.26 m thick deposit of pahoehoe pebbles. A 0.05 m thick deposit of sterile silty loam was present beneath the pebbles, which were partially intermixed with the soil. Bedrock was encountered 0.59 m below the top of the feature. The soil was black (5YR2.5/1), and contained numerous tiny pieces of gravel, and scattered weathered pebbles.

Site 13428, Feature C

This faced mound was constructed with a perimeter of pahoehoe cobbles and was filled with small cobbles and various-sized pebbles. Maximum height of the perimeter was 1.21 m above ground surface. A one m square test unit was located in the center of the mound, and the fill was removed, keeping the perimeter relatively intact. The fill surface was 0.05 m below the datum point along the top of the perimeter. A 0.19 m thick layer of cobbles was present on top of the fill; pebble fill extended 0.28 cm, and overlaid a single layer of cobbles, which was at the base of the surface structure. Beneath the cobble base was a 0.10 m thick layer of sterile silty loam. Bedrock was present beneath the soil. The soil was dark reddish-brown (5YR2.5/2) and contained weathered gravel.

Site 13428, Feature E

Similar in construction to Feature C, this mound had a cobble perimeter and was filled with generally smaller cobbles and pebbles. The feature is larger than Feature C and the fill is more level, giving the appearance of a small platform. Maximum height of the perimeter was 1.28 m. A one m square test unit was excavated in the center of the mound, leaving the perimeter intact. The fill here was found to be generally undifferentiated, with cobbles and pebbles mixed throughout. The fill extended to 0.65 m below mound surface in the eastern portion of the unit, and to 0.76 m below surface in the western portion. The bedrock surface was encountered immediately beneath the core fill in the east side of the unit. In the west side, a soil deposit mixed with pebbles was present between the fill and bedrock. Thickness of the soil varied with slope of the bedrock, and reached a maximum thickness 0.30 in the southwest corner of the unit. A single kukui nut shell was encountered in the rock fill at 0.57 m below mound surface. Soil was dark reddish-brown (5YR3/2) silty loam of duff-like consistence, with organic detritus and land snails.

Site 13428, Feature G

Feature G is a paved rectangular platform with a faced perimeter of boulders and large cobbles. Surface area is 11.40 sq m. A one m square test unit was placed in the center of the platform. The northern portion of the unit consisted of relatively large cobble fill, and the southern half consisted of small, packed and leveled pebble paving. During excavation, it became obvious that the cobble layer was deposited on top of the pebble pavement, which had covered the platform surface at one time but was now only visible in a small area 1.20 m in diameter. The pebble paving was found to be an average of 0.05 m thick, and it overlaid a layer of small cobbles, one to two stones thick. Larger cobble fill was present beneath the small cobbles. This fill varied in thickness, due to the sloping surface of the underlying bedrock. Along the north wall of the unit, fill was 0.7 m thick; along the south wall, it was 0.3 m thick. A soil deposit which varied in thickness from 0.01 to 0.06 m was present at the base of the rock fill. The soil was dark reddish-brown silty loam with small angular gravel, land snails, <u>koa haole</u> seeds, and a single <u>kukui</u> nut (in fragments).

Site 13434, Feature A

This faced mound has a perimeter of boulders and is filled with cobbles and pebbles. The perimeter has a maximum height of 0.80 m above surface, and the core fill was recessed 0.10 m below the top of the perimeter. The mound was located on an aa outcrop that had been artificially leveled and filled. A one m square test unit was excavated into the northern section of the mound, and a portion of the perimeter was removed in order to continue excavation into the underlying aa fill. The core fill was found to be undifferentiated cobbles and pebbles, and directly overlaid the aa pebbles of the modified outcrop beneath the mound. The aa fill continued to a depth of 1.48 m below the top of the mound, where a deposit of soil and pebbles was encountered. This layer was 0.02 m thick and overlaid a sterile layer of decomposing aa bedrock, which could be penetrated to a maximum depth of 1.60 m below the top of the mound. No portable remains were located in the fill or deposits beneath the feature.

The findings of test excavations at these and eleven other similar features in the Queen Liliuokalani Trust lands project area indicate that relatively formalized structures were built for what appear to be agricultural purposes. The features tested are superficially very similar to features known to contain burials in other areas of North Kona, yet no burials, or indications of decomposed skeletal remains, were encountered. The absence of midden remains or artifacts of any kind in or around these features likewise indicates it is unlikely they were used for habitation. Platforms such as Feature G at Site 13428 have been shown in many instances to be habitation features. There is no indication for such use at the tested platforms, which leads to the assumption that they are larger versions of formalized clearance mounds that may have also been used as planting beds.

Evidence of fill layering (larger cobbles placed over paved or pebble-filled surfaces) was observed at the Site 13428 platform, and at other tested platforms in the Queen Liliuokalani Trust lands project area. This layering may indicate that the platforms were built up gradually, rather than as a single construction phase, and that they were used for different specific purposes, depending upon the agricultural activities being conducted at different points in time. More detailed information is obtainable concerning construction phases of the platforms and mounds. This information is best obtained through excavation techniques designed for such a purpose, rather than the techniques used here, which were to determine the presence or absence of burials.

CONCLUSION

DISCUSSION

During the inventory survey conducted within the original Kealakehe project area, 82 sites consisting of 840 component features were identified (Donham 1990a). Within the c. 52 acre area added to the original project area, 24 sites consisting of 279 component features were identified. These additional sites were identified and first reported on during an inventory survey of the Queen Liliuokalani Trust Lands in Keahuolu (Donham 1990b). The resultant total for the revised project area is 106 sites with 1,119 component features. The overall site count for the 800 acre Kealakehe portion of the project area is 53; the overall total for the Keahuolu portion is 52; one site (a wall) is on the boundary between the two ahupua'a. The two Keahuolu parcels account for less than one quarter of the total revised survey area acreage, yet contain 69% (777) of the total number of identified features.

General frequency patterns for various formal feature types have been only slightly altered with the introduction of new data from the added Keahuolu acreage (Table 3). Three feature types occur in the added area

Table 3.

FEATURE COUNTS BY FORMAL CATEGORY

Formal Type	Original Survey Area	Added Survey Area	Total Count	Percent of Total
Alignment	-	3	3	0.2
Cairn	26	12	38	3.4
Cave	3	5	8	0.7
C-shape	1	-	1	0.1
Enclosure	22	9	31	2.8
Filled Crevice	-	1	1	0.1
Hearth	2	-	2	0.2
Kerbst. trail	5	-	5	0.5
Midden scatter	1	-	1	0.1
Modified outcrop	46	29	75	6.7
Overhang	-	1	1	0.1
Phh. excavation	258	84	342	30.6
Pavement	5	5	10	0.9
Platform	16	3	19	1.7
Roadbed	1	2	3	0.2
Rock Mound	350	110	460	41.1
Stpst. trail	11	1	12	1.1
Terrace	73	11	84	7.5
Trail	2	1	3	0.2
Wall	18	2	20	1.8
Total:	840	279	1,119	100.0

that were not represented in the original survey area. These include three alignments, a filled crevice, and an overhang shelter.

Four formal types, each represented by a few features in the original survey area, are not present in the added acreage. These include C-shapes, hearths, midden scatters, and kerbstone trails.

In the original survey area, the predominant feature types were pahoehoe excavations and rock mounds, which together accounted for 72.4% of all identified features. The added feature frequencies result in a combined percentage of 71.7% for pahoehoe excavations and rock mounds, which is a very minor decrease. The added data do, however, enhance the marked difference in occurrences of these two feature types between Keahuolu and Kealakehe. Among the 342 (revised count) identified pahoehoe excavations, 257 (75%) are in Keahuolu; among the 460 rock mounds, 415 (90%) are in Keahuolu.

The clear majority of features identified within the added survey area represent agricultural functions. These include all the rock mounds, pahoehoe excavations, modified outcrops, enclosures, and terraces (244, 87% of total features in added area). Other features that are of likely agricultural function include the filled crevice, some or all of the pavements, and at least one of the three platforms. The overall proportion of agricultural features in the added area is very similar to the proportion derived from the original survey area data, which was 87.6% of the 840 identified features with agricultural functions (Donham 1990a:17).

Habitation features identified in the added area include all of the caves, the overhang shelter, and two of the platforms (eight features; 2.9% of total features in added area. This proportion is over twice as high as the proportion for habitation features within the original survey area (1.4%). The higher proportion of habitation features for the added area is attributable primarily to a higher number of rock shelters (five caves and one overhang). These features all appear to be short-term shelters and contain sparse to very sparse deposits of marine shell midden. Two of the caves (Sites 13425 and 13431) contain additional portable remains, such as kukui nut shell, coral, waterworn basalt, and charcoal.

The only features identified in the added area which possibly represent permanent habitation are platforms at Sites 13430 and 13447. The Site 13430 platform is rectangular with a surface area of 21.07 sq m; no midden remains were observed on this feature, and soil deposits are present on top. The Site 13447 platform has a surface area of 19.80 sq m; it too lacks associated midden deposits on the surface.

Features reflecting transportation account for 1.4% (4) of the total added features. This is about half the relative frequency of transportation features for the original survey area, which was 2.3%. Most of the original survey area transportation features (15 of 19) were in Kealakehe; this pattern is also reflected in the added survey area data. Two of the added transportation features represent sections of the old Palani Roadbed; one is a steppingstone trail section and one is a simple footpath section.

No features indicating ceremonial functions were identified within the added survey area. The revised project area total for this functional category remains at five features—two enclosures, two platforms, and one stepped terrace.

Within the added survey area, five features were initially identified as possibly containing human burials. These included a modified outcrop, three faced mounds, and a platform. Each of these features was tested prior to completion of the Queen Liliuokalani Trust Lands survey. None of the features contained skeletal remains, and their functional interpretations were revised from possible burial to agriculture. Therefore, no burial features or possible burial features are identified within the added acreage at this time. There is, however, always the possibility that burials will be encountered during additional field investigations.

Findings from the subsurface testing of possible burial features in Keahuolu may indicate that some of the faced mounds and small platforms identified in the original survey area as possible burial features may also have alternative functions. Most of the terraces and platforms in the possible burial category for the original survey area are, however, in Kealakehe and are concentrated in two complexes, one of which has been previously identified as a burial site.

Features with indeterminate specific functions identified within the added area include three alignments and 12 cairns. The frequency for cairns in the added area (4.3%) is proportionally greater than the cairn frequency for the original survey area (3.1%), and results in a revised overall frequency of 3.4%.

In summary, the added survey data do not substantially change the general land use patterns indicated for the original survey area. The added data do, however, enhance differences in the archaeological record that signal potential differences in land use between the two _ahupua'a_ of Kealakehe and Keahuolu. The Keahuolu parcels exhibit a greater concentration of features than does the Kealakehe portion of the project area. The Kealakehe portion contains a wider range of functional types than Keahuolu, which has a relatively specialized agricultural pattern. This pattern consists of a large number of rock mounds, pahoehoe excavations, and modified outcrops, with a limited number of terrace and platform features.

The differences between the two _ahupua'a_ as they are represented within the project area appear to be most related to: (a) more intensive use of Kealakehe for cattle ranching, resulting in differential preservation of surface features between the two _ahupua'a_; (b) more intensive use of Keahuolu for agriculture, due to its more favorable location in relation to rainfall patterns; (c) a possible period of intensive agricultural activities in Keahuolu during the historic period, related to the sisal mill and plantation; and (d) the presence of the Great Wall of Kuakini in Keahuolu, indicating the likely presence of relatively concentrated and/or politically important residential sites associated with Kailua village. Such features are present in the Queen Liliuokalani Trust lands situated makai of the Keahuolu parcels of the present project.

GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

General significance assessments and recommended general treatments for all identified sites are summarized in Table 4. Specific field work tasks for individual sites are summarized in Table 1. 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). DLNR-HSS/SHPO uses these criteria for evaluating cultural resources. Sites determined to be potentially significant for information content fall under Criterion D, which defines significant resources as ones which "...have yielded, or may be likely to yield, information important in prehistory or history." Sites potentially significant as representative examples of site types 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 are evaluated under guidelines prepared by the Advisory Council on Historic Preservation (ACHP) entitled "Guidelines for Consideration of Traditional Cultural Values in Historic Preservation Review" (ACHP Draft Report, August 1985). The guidelines define cultural value as "...the contribution made by an historic property to an ongoing society or cultural system. A traditional cultural value is a cultural value that has historical depth." The guidelines further specify that "[a] property need not have been in consistent use since antiquity by a cultural system in order to have traditional cultural value."

To further facilitate management decisions regarding the subsequent treatment of resources, the general significance of the archaeological resources identified during the inventory survey were also evaluated in terms of potential scientific research, interpretive, and/or cultural values (PHRI Cultural Resource Management [CRM] Value Modes; see Appendix C for individual assessments of sites). Research value, refers to the potential of archaeological resources for producing information useful in the understanding of culture history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. Interpretive value refers to the potential of archaeological resources for public education and recreation. Cultural value, within the framework for significance evaluation used here, refers to the potential of archaeological resources for the preservation and promotion of cultural and ethnic identity and values. These three value modes are derived from the above state and federal evaluation criteria.

Table 4.

SUMMARY OF GENERAL SIGNIFICANCE ASSESSMENTS AND RECOMMENDED GENERAL TREATMENTS

SIHP Site Number	Significance Category A	X	B	C	Recommended Treatment FDC	NFW	PID	PAI
13424	-	+	-	-	-	+	-	-
13426	-	+	-	-	-	+	-	-
13432	-	+	-	-	-	+	-	-
13433	-	+	-	-	-	+	-	-
13434	-	+	-	-	-	+	-	-
13439	-	+	-	-	-	+	-	-
Subtotal:	0	6	0	0	0	6	0	0
13420	+	-	-	-	+	-	-	-
13421	+	-	-	-	+	-	-	-
13422	+	-	-	-	+	-	-	-
13423	+	-	-	-	+	-	-	-
13425	+	-	-	-	+	-	-	-
13427	+	-	-	-	+	-	-	-
13428	+	-	-	-	+	-	-	-
13429	+	-	-	-	+	-	-	-
13430	+	-	-	-	+	-	-	-
13431	+	-	-	-	+	-	-	-
13435	+	-	-	-	+	-	-	-

General Significance Categories:

A=Important for information content, further data collection necessary (PHRI=research value);

X=Important for information content, no further data collection necessary (PHRI=research value, SHPO=not significant)

B=Excellent example of site type at local, region, island, State, or National level (PHRI=interpretive value); and

C=Culturally significant (PHRI=cultural value).

Recommended General Treatments:

FDC=Further data collection necessary (detailed recording, surface collections, and limited excavations, 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);

PAI=Preservation "as is", with no further work (and possible inclusion into landscaping), or possibly minimal further data collection necessary

Table 4. (Cont.)

SIHP Site Number	Significance Category A	X	B	C	Recommended Treatment FDC	NEW	PID	PAI
13436	+	-	-	-	+	-	-	-
13437	+	-	-	-	+	-	-	-
13438	+	-	-	-	+	-	-	-
13440	+	-	-	-	+	-	-	-
13447	+	-	-	-	+	-	-	-
13448	+	-	-	-	+	-	-	-
13449	+	-	-	-	+	-	-	-
Subtotal:	18	0	0	0	18	0	0	0
Total:	18	6	0	0	18	6	0	0

Based on the above federal criteria, six of the total 24 sites are assessed as significant solely for information content. No further work is recommended for these sites. They have been measured, mapped, described, photographed, and plotted. Data collected from them during the present survey is considered sufficient; their preservation is not essential, although they could perhaps be considered for inclusion into development landscaping. Further data collection is recommended for the remaining 18 sites.

As an initial step, it is recommended that sites requiring further archaeological work be accurately located and plotted by professional surveyors, with the aid of an archaeologist, on an appropriate scale topographic map of the project area. This would greatly aid development planning by allowing further archaeological work determinations (further data collection, data recovery and/or preservation) to be more accurately considered on a site-by-site basis.

The evaluations and recommendations presented within this addendum report have been based on a 100% aerial, variable-coverage surface, and limited subsurface inventory survey of the project area. There is always the possibility, however remote, that potentially significant, unidentified surface and/or subsurface cultural remains will be encountered in the course of future archaeological investigations or subsequent development activities. In such situations, archaeological consultation should be sought immediately.

REFERENCES CITED

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BOTANICAL SURVEY

BOTANICAL SURVEY

KEALAKEHE PLANNED COMMUNITY

NORTH KONA, HAWAI'I

by

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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 (Kalanchoë 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 leaf-lets 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 search 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.

A 20-acre nature study park or preserve sited around the largest concentration of uhiuhi would be the most biologically sound and practical solution. This larger nature park would preserve not only the uhiuhi but also other natives in the area such as the Bidens, 'ohe, mamane, naio, kalomona, lama, alahe'e, and maiapilo. Attempts would be made to transplant the smaller uhiuhi outside the preserve onto the site. Seedlings started from seeds collected from all the uhiuhi plants outside the park would also be planted here, thus preserving the gene pool, even if the original plants were lost.

However, it is the legal opinion of the State's Department of the Attorney General that "... because it does not seem the uhiuhi 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 uhiuhi trees must be preserved in place." (letter to Wm. W. Paty, Chairperson, Board of Land and Natural Resources, 20 December 1989). With the above in mind, the following mitigation measures are recommended. An 5-acre preserve should be set up around the cluster of six trees and two outlying trees. This would also preserve a number of other native species in the area including the candidate Bidens species. Propagation material from other natives not found within the 5-acre park, such as maua, wiliwili, halapepe (Pleomele hawaiiensis), olopua (Nestegis sandwicensis), and pua-kala (Argemone glauca) as well as from the separate uhiuhi plants, should be collected for inclusion onto the site. This 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 at a kiosk; the pamphlets would highlight the native species, describe how the Hawaiians used the plants, present ways these natives could be used in landscaping to conserve water, etc. One-half acre plots should be established around each of the remaining eleven plants outside the preserve. Long-term management of these separate, small one-half acre plots and the 5-acre preserve should include an active management plan for the eradication of introduced plants, especially fountain grass, koa-haole, and Christmas berry.

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. 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 the landscape 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 the uhiuhi, wiliwili, 'ohe, naio, alahe'e, maiapilo, mamane, kalomona, and Bidens micrantha ssp. ctenophylla.

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PLANT SPECIES LIST -- Kealakehe Planned Community

Following is a checklist of all those vascular plant species inventoried during the field studies. Plant families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocots, and Dicots. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux (1984); the flowering plants (Monocots and Dicots) are in accordance with Wagner et al. (in press). In most cases, common English and/or Hawaiian names given follow St. John (1973) or Porter (1972).

For each species, the following information is provided:

1. Scientific name with author citation.
2. Common English and/or Hawaiian name, when known.
3. Biogeographic status. The following symbols are used:
   E = endemic = native only to the Hawaiian Islands
   I = indigenous = native to the islands and also to one or more other geographic area(s)
   P = Polynesian = plants of Polynesian introduction prior to Western contact (1778); not native
   X = introduced or alien = all those plants brought to the islands intentionally or accidentally after Western contact; not native.
4. Presence (+) or absence (-) of a particular species within each of four vegetation types recognized on the project site (see text for discussion):
   o = Open mixed shrubland
   c = Canthium/Christmas berry shrubland
   k = Koa-haole scrub
   f = Fountain grass grassland

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	+	+	+	–

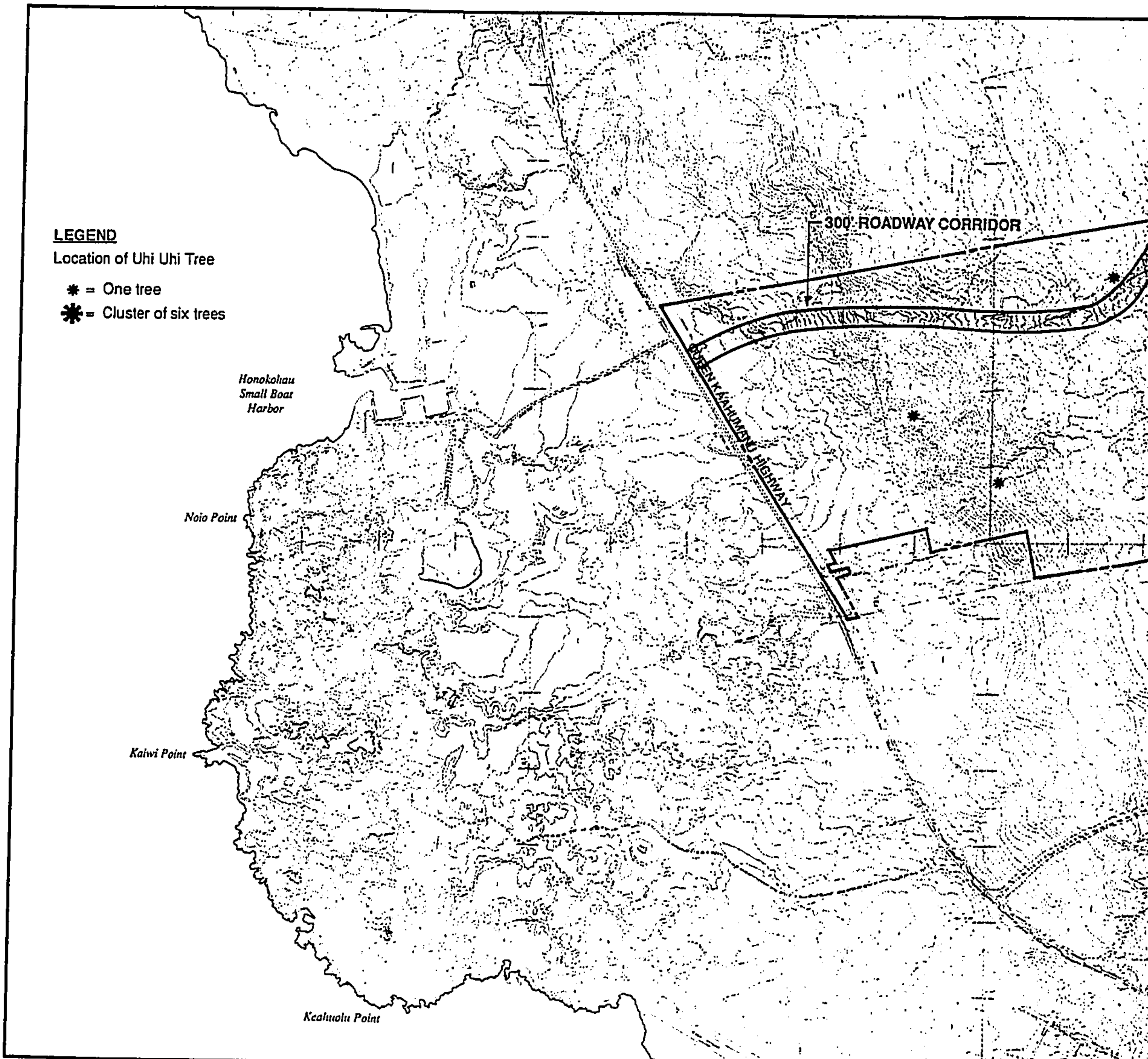
Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
EUPHORBIACEAE (Spurge Family)						
Aleurites moluccana (L.) Willd.	kukui, tutui	P	+	+	+	−
Chamaesyce hirta (L.) Millsp.	hairy spurge, garden spurge	X	+	+	+	+
Chamaesyce hypericifolia (L.) Millsp.	graceful spurge	X	+	−	+	+
Chamaesyce hyssopifolia (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	X	+	+	−	−
Caesalpinia kavaiensis H. Mann.	uhiuhi	I	+	−	+	−
Chamaecrista nictitans (L.) Moench	partridge pea, lauki	E	+	+	+	−
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	+	+	+	–

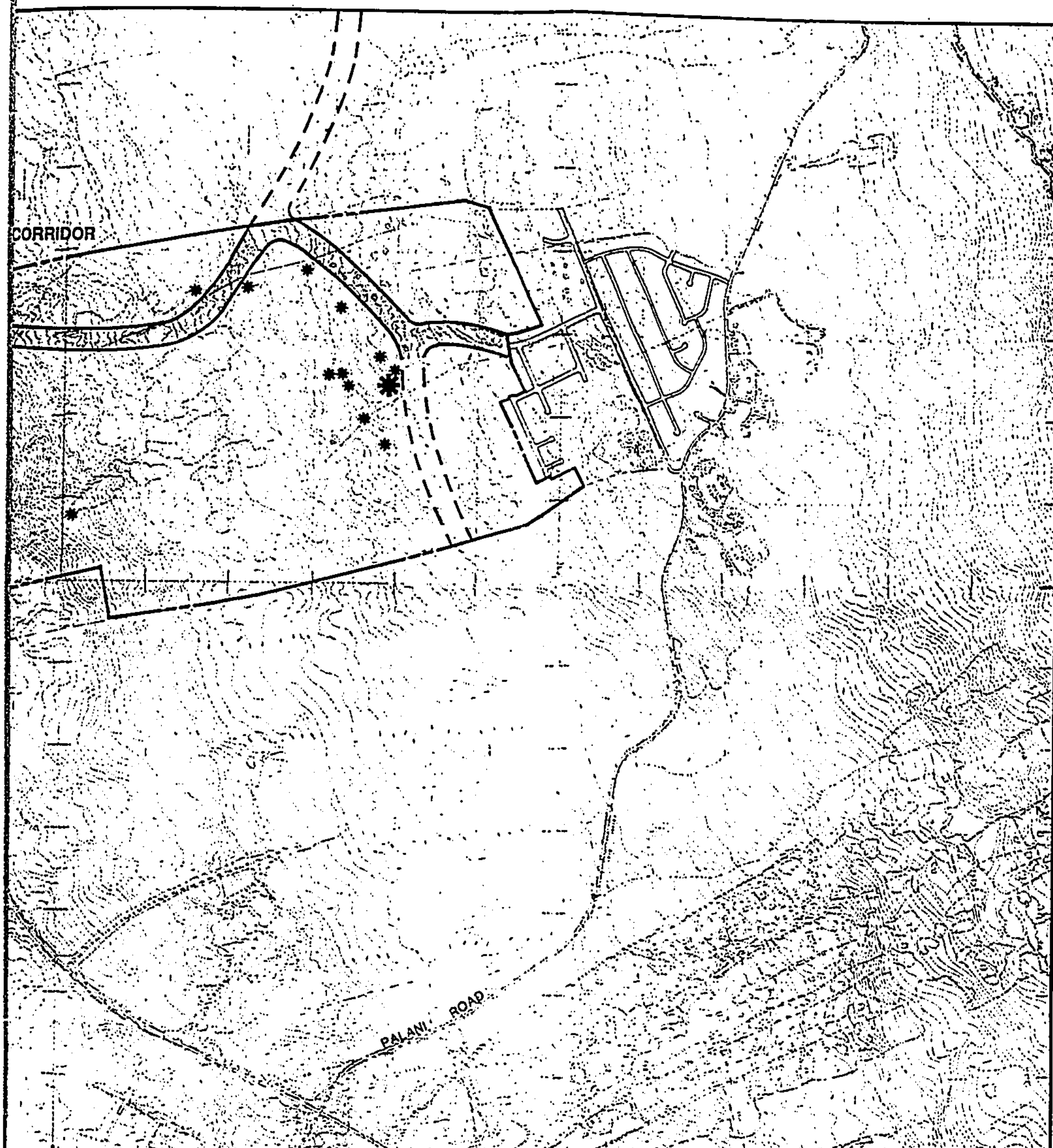
Scientific Name	Common Name	Status	Vegetation Type o	c	k	f
MYOPORACEAE (Myoporum Family)						
Myoporum sandwicense A. Gray	naio	I	+	–	+	–
MYRTACEAE (Myrtle Family)						
Metrosideros polymorpha Gaud.	'ohi'a, 'ohi'a-lehua	E	–	+	–	–
Psidium cattleianum Sabine	strawberry guava, waiawi 'ula'ula	X	+	+	–	–
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	+	-	-	-



KEALAKEHE PROPOSED ROADWAY CORRIDOR



800 400 0 800

SCALE IN FEET

NORTH

Prepared by: BELT COLLINS & ASSOCIATES

EXHIBIT 2

ENDANGERED FLORA SPECIES LOCATION

FAUNA SURVEY

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

Prepared for

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By

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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.

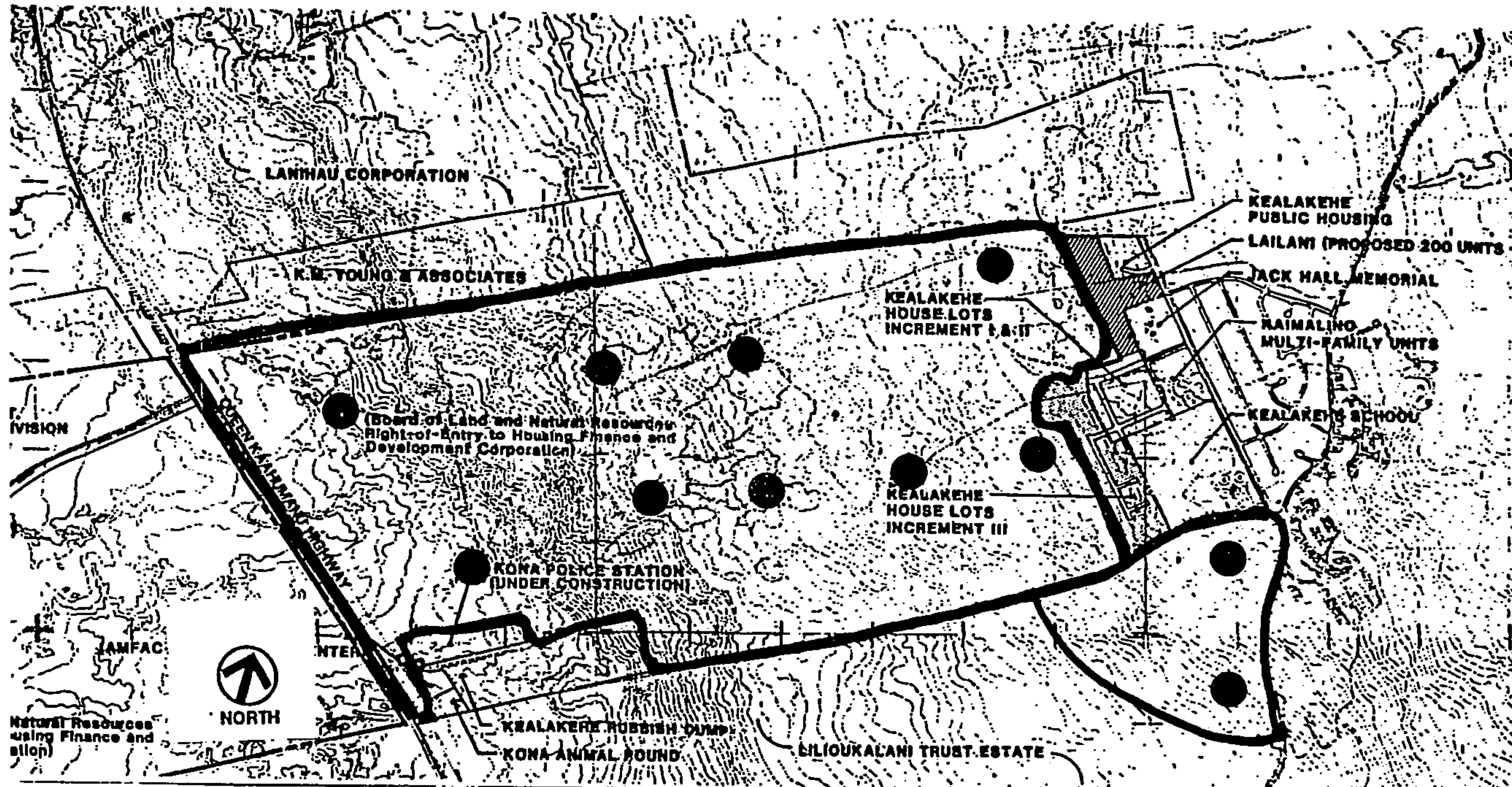

Fig. 1. Kealakehe property with eight minute count stations marked by a ●.

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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NOISE IMPACTS

NOISE STUDY
FOR THE PROPOSED
KEALAKEHE PLANNED COMMUNITY PROJECT
KONA, HAWAII

Prepared for:

BELT COLLINS & ASSOCIATES

Prepared by:

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JUNE 1990

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CHAPTER I. SUMMARY

The existing and future traffic noise levels in the vicinity of the proposed Kealakehe Planned Community Project in Kona, Hawaii were evaluated for their potential impact on present and future noise sensitive areas. Evaluations were performed for the CY 1992 period following completion of the Kealakehe House Lots III increment, as well as for the CY 2010 period following complete project build-out. The future traffic noise levels along the primary access roadways to the project were calculated with and without the proposed development. The noise analysis assumed that the necessary roadway improvements would be implemented to accommodate the increases in future project and non-project traffic.

Along the Queen Ka'ahumanu Highway and Palani Road, traffic noise levels are expected to increase significantly by 3 to 5 Ldn between CY 1990 and CY 2010. Worsening traffic conditions may require improvements to the existing highway and other roadways in the project area. Project traffic are predicted to cause a 0.2 to 0.8 Ldn increase in traffic noise levels along the existing Queen Ka'ahumanu Highway from the present to CY 2010. Along Palani Road, project traffic are predicted to cause a 0 to 0.3 Ldn increase in traffic noise levels. These increases in traffic noise levels over a 20 year period are not considered to be significant.

Large traffic noise increases are expected to occur as a result of non-project traffic growth in the Kona area by CY 2010. The projected increases are in the order of 3 to 5 Ldn, and are the result of a three-fold increase in project and non-project traffic volumes in the Kona area. Residents along Palani Road may be impacted by future increases in traffic noise if adequate setback distances are not provided from the roadway. Noise mitigation measures should be incorporated into those roadway improvement projects which are necessary to accommodate the increased traffic volumes along Palani Road.

The Preferred Master Plan for the project locates a golf course and Community Center at 200+ FT setback distance along Queen Ka'ahumanu Highway. These uses are not normally considered to be noise sensitive. For this reason, and the relatively small increases in traffic noise associated with project traffic, the plan should not cause severe or adverse noise impacts on future noise sensitive developments along Queen Ka'ahumanu Highway.

Proposed residential developments in the mauka (or east) sections of the project may be impacted by the relatively high traffic noise levels along the north section of Palani Road and along the proposed mauka extension of Kealekehe Parkway. Noise mitigation measures, such as adequate setback distances, berms, or sound attenuation walls, may be employed to minimize traffic noise impacts on these future residences.

Unavoidable, but temporary, noise impacts may occur during the construction of the proposed project. Because construction activities are predicted to be audible at adjoining properties, the quality of the acoustic environment may be degraded to unacceptable levels during periods of construction. Mitigation measures to reduce construction noise to inaudible levels will not be practical in all cases. For this reason, the use of quiet equipment and construction curfew periods as required under the State Department of Health noise regulations are recommended to minimize construction noise impacts.

CHAPTER II. PURPOSE

One objective of this study was to describe the existing and future noise environment in the environs of the proposed Kealakehe Planned Community Project in Kona on the island of Hawaii. Traffic noise level increases and impacts associated with the proposed development were to be determined within the project site as well as along the public roadways expected to service the project traffic. Another objective was to determine future traffic noise level increases associated with both project and non-project traffic, and the potential noise impacts associated with these increases. Recommendations for minimizing these noise impacts were also to be provided as required. Assessments of possible future impacts from short term construction noise at the project site were also included in the noise study objectives.

CHAPTER III. NOISE DESCRIPTORS AND THEIR RELATIONSHIP TO LAND USE COMPATIBILITY

The noise descriptor currently used by federal agencies to assess environmental noise is the Day-Night Average Sound Level (Ldn). This descriptor incorporates a 24-hour average of instantaneous A-Weighted Sound Levels as read on a standard Sound Level Meter. By definition, the minimum averaging period for the Ldn descriptor is 24 hours. Additionally, sound levels which occur during the nighttime hours of 10:00 PM to 7:00 AM are increased by 10 decibels (dB) before computing the 24-hour average by the Ldn descriptor. A more complete list of noise descriptors is provided in **APPENDIX B** to this report.

TABLE 1, derived from **Reference 1**, presents current federal noise standards and acceptability criteria for residential land uses. Land use compatibility guidelines for various levels of environmental noise as measured by the Ldn descriptor system are shown in **FIGURE 1**. Noise levels of 55 Ldn or less occur in rural areas, or in areas which are removed from high volume roadways. In urbanized areas which are shielded from high volume streets, Ldn levels generally range from 55 to 65 Ldn, and are usually controlled by motor vehicle traffic noise. Residences which front major roadways are generally exposed to levels of 65 Ldn, and as high as 75 Ldn when the roadway is a high speed freeway. In the Kona area, noise levels at lots which front Queen Ka'ahumanu Highway and Palani Road are typically above 60 Ldn. Due to noise shielding effects from intervening structures, interior lots are usually exposed to 3 to 10 Ldn lower noise levels than the front lots which are not shielded from the traffic noise.

For determining noise acceptability for funding assistance from federal agencies (FHA/HUD and VA), an exterior noise level of 65 Ldn or lower is considered acceptable. This standard is applied nationally (**Reference 2**), including Hawaii. Because of our open-living conditions, the predominant use of naturally ventila-

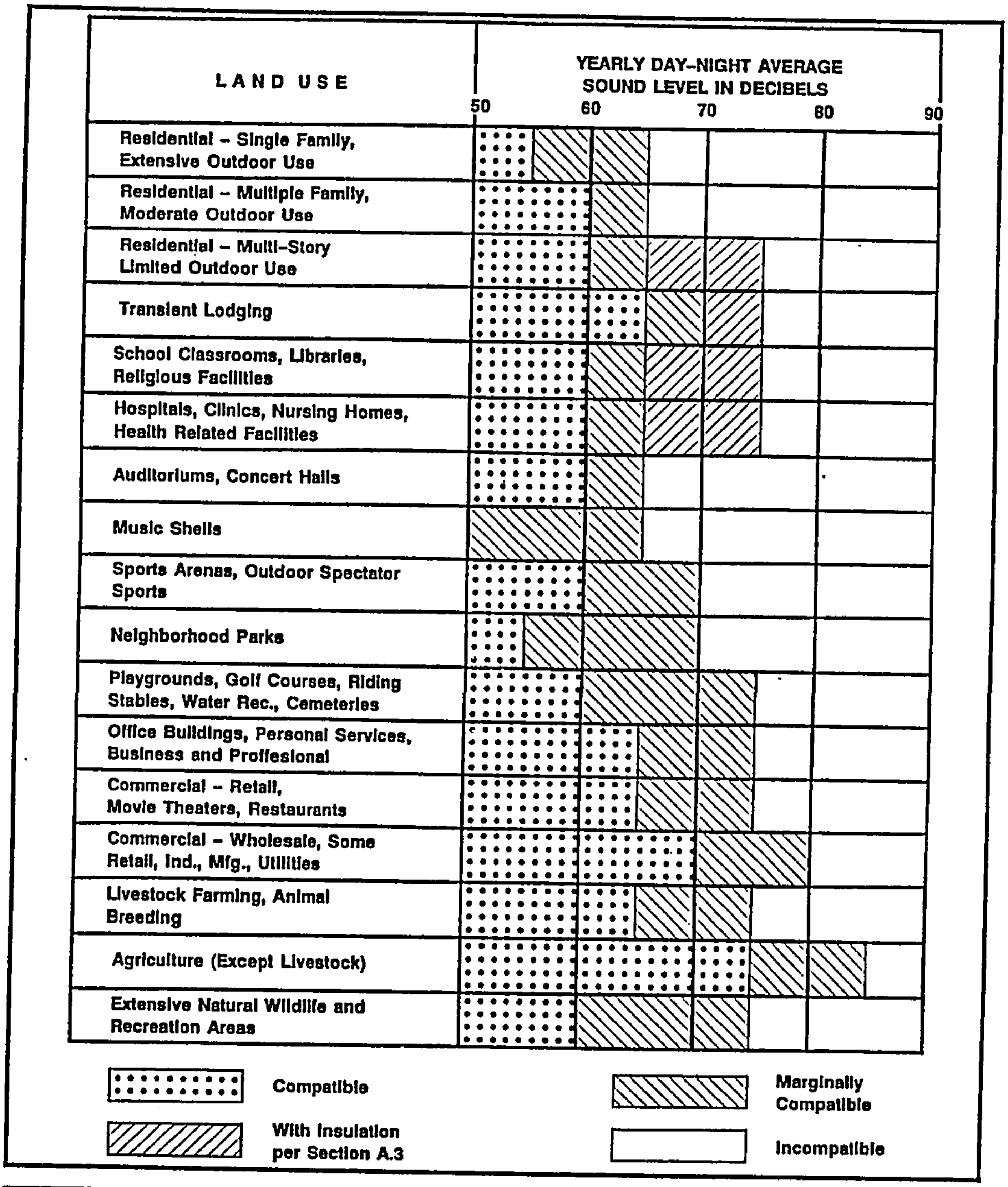
TABLE 1

EXTERIOR NOISE EXPOSURE CLASSIFICATION (RESIDENTIAL LAND USE)

NOISE EXPOSURE CLASS	DAY-NIGHT SOUND LEVEL	EQUIVALENT SOUND LEVEL	FEDERAL[1] STANDARD
Minimal Exposure	Not Exceeding 55 L_{dn}	Not Exceeding 55 L_{eq}	Unconditionally Acceptable
Moderate Exposure	Above 55 L_{dn} But Not Above 65 L_{dn}	Above 55 L_{eq} But Not Above 65 L_{eq}	Acceptable[2]
Significant Exposure	Above 65 L_{dn} But Not Above 75 L_{dn}	Above 65 L_{eq} But Not Above 75 L_{eq}	Normally Unacceptable
Severe Exposure	Above 75 L_{dn}	Above 75 L_{eq}	Unacceptable

Notes: (1) Federal Housing Administration, Veterans Administration, Department of Defense, and Department of Transportation.

(2) FHWA uses the L_{eq} instead of the L_{dn} descriptor. For planning purposes, both are equivalent if: (a) heavy trucks do not exceed 10 percent of total traffic flow in vehicles per 24 hours, and (b) traffic between 10:00 PM and 7:00 AM does not exceed 15 percent of average daily traffic flow in vehicles per 24 hours. The noise mitigation threshold used by FHWA for residences is 67 L_{eq}.



LAND USE COMPATIBILITY
WITH YEARLY DAY-NIGHT AVERAGE SOUND LEVEL
AT A SITE FOR BUILDINGS AS COMMONLY CONSTRUCTED
(Source: American National Standards Institute S3.23-1980)

FIGURE 1

ted dwellings, and the relatively low exterior-to-interior sound attenuation afforded by these naturally ventilated structures, an exterior noise level of 65 Ldn does not eliminate all risks of noise impacts. Because of these factors, and as recommended in **Reference 3**, a lower level of 55 Ldn is considered as the "Unconditionally Acceptable" (or "Near-Zero Risk") level of exterior noise. However, after considering the cost and feasibility of applying the lower level of 55 Ldn, government agencies such as FHA/HUD and VA have selected 65 Ldn as a more appropriate regulatory standard.

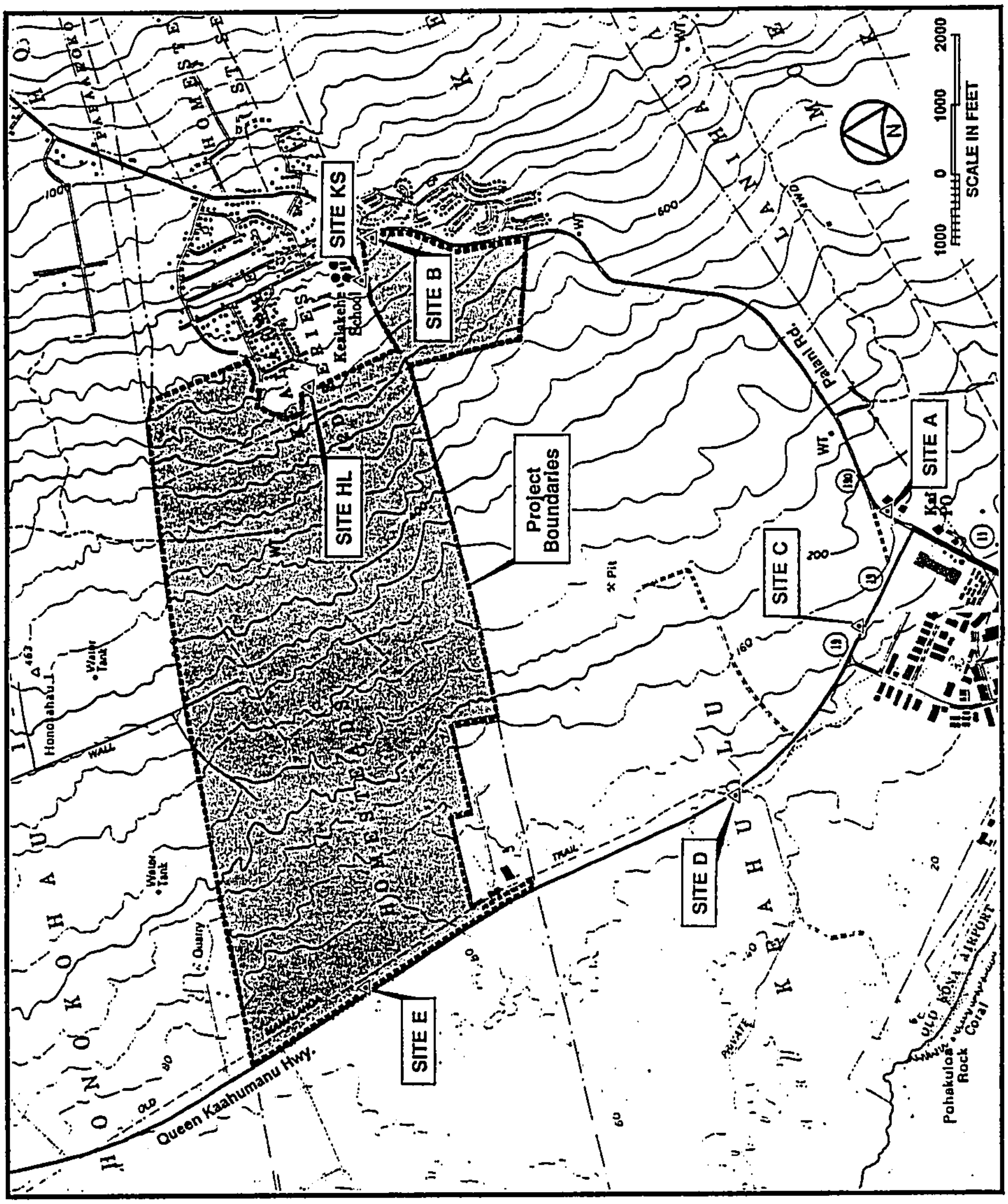
As indicated in **FIGURE 1**, exterior noise levels as high as 60 to 75 Ldn are considered to be "Compatible" or "Marginally Compatible" for those existing and planned land uses within the Civic Center area adjacent to Queen Ka'ahumanu Highway. These compatible noise levels should be achievable at the planned 200+ FT setback of the Civic Center from the highway centerline.

CHAPTER IV. GENERAL STUDY METHODOLOGY

Existing traffic noise levels were measured at seven locations in the project environs to provide a basis for developing the project's traffic noise contributions along the roadways which will service the proposed development: Queen Ka'ahumanu Highway, Palani Road, the proposed Kealekehe Parkway (Honokohau Boat Harbor Road), and the proposed Main Project Access Road. The locations of the measurement sites are shown in **FIGURE 2.** Noise measurements were performed during the latter part of June 1989. The traffic noise measurement results, and their comparisons with computer model predictions of existing traffic noise levels are summarized in **TABLE 2.** The results of the traffic noise measurements were compared with calculations of existing traffic noise levels to validate the computer model used.

Traffic noise calculations for the existing conditions as well as noise predictions for the Years 1992 and 2010 were performed using the Federal Highway Administration (FHWA) Noise Prediction Model (**Reference 4**). Traffic data entered into the noise prediction model were: hourly traffic volumes, average vehicle speeds, estimates of traffic mix, and soft ground propagation loss factor. The traffic studies for the project (**References 5 and 6**) and Hawaii State Department of Transportation counts on Queen Ka'ahumanu Highway and Palani Road (**Reference 7**), were the primary sources of data inputs to the model. For existing and future traffic, it was assumed that the average noise levels, or Leq(h), during the PM peak hour were equal to the 24-hour Ldn along each roadway segment. This assumption was based on computations of both the hourly Leq and the 24-hour Ldn of traffic noise on Queen Ka'ahumanu Highway and Palani Road (see **FIGURES 3 and 4**).

Traffic noise calculations for both the existing and future conditions in the project environs were developed for ground level receptors without the benefit of shielding effects. **FIGURE 5** identifies the major access roadways to the project for which



LOCATIONS OF NOISE MEASUREMENT SITES

FIGURE 2

TABLE 2

TRAFFIC NOISE MEASUREMENTS
(June 27, 1989)

Location	Time of Day (HRS)	Ave.Speed (MPH)	---Hourly Traffic Volume--- Auto	Med.Truck	Heavy Truck	Measured Leq (dB)	Predicted Leq(dB)
A. 50 FT from the center-line of Palani Road at Fire Station.	0715 TO 0750	45	1,129	21	21	67.6	67.7
B. 50 FT from the center-line of Palani Road at Kealakaa St.	1525 TO 1539	45	986	21	4	64.3	64.2
C. 50 FT from the center-line of Queen Kaahumanu Hwy. at Industrial Park.	0925 TO 0954	46	1,232	29	29	68.7	68.9
D. 50 FT from the center-line of Queen Kaahumanu Hwy. at Road to Children's Center.	1012 TO 1042	48	1,009	49	34	68.1	68.4
E. 50 FT from the center-line of Queen Kaahumanu Hwy. North of Police Station.	1148 TO 1224	49	1,014	53	43	68.7	69.2
HL. Makai Boundary of Existing Residential Area.	1841 TO 1843	N/A	N/A	N/A	N/A	43.8	N/A
KS. Makai Boundary of Kealakehe School.	1820 TO 1829	N/A	N/A	N/A	N/A	46.3	N/A

FIGURE 3

HOURLY VARIATIONS OF TRAFFIC NOISE AT 50 FT SETBACK DISTANCE FROM THE CENTERLINE OF QUEEN KA'AHUMANU HIGHWAY AT PALANI ROAD

(TOWARD KEAHOLE AIRPORT: 5/3-5/88)

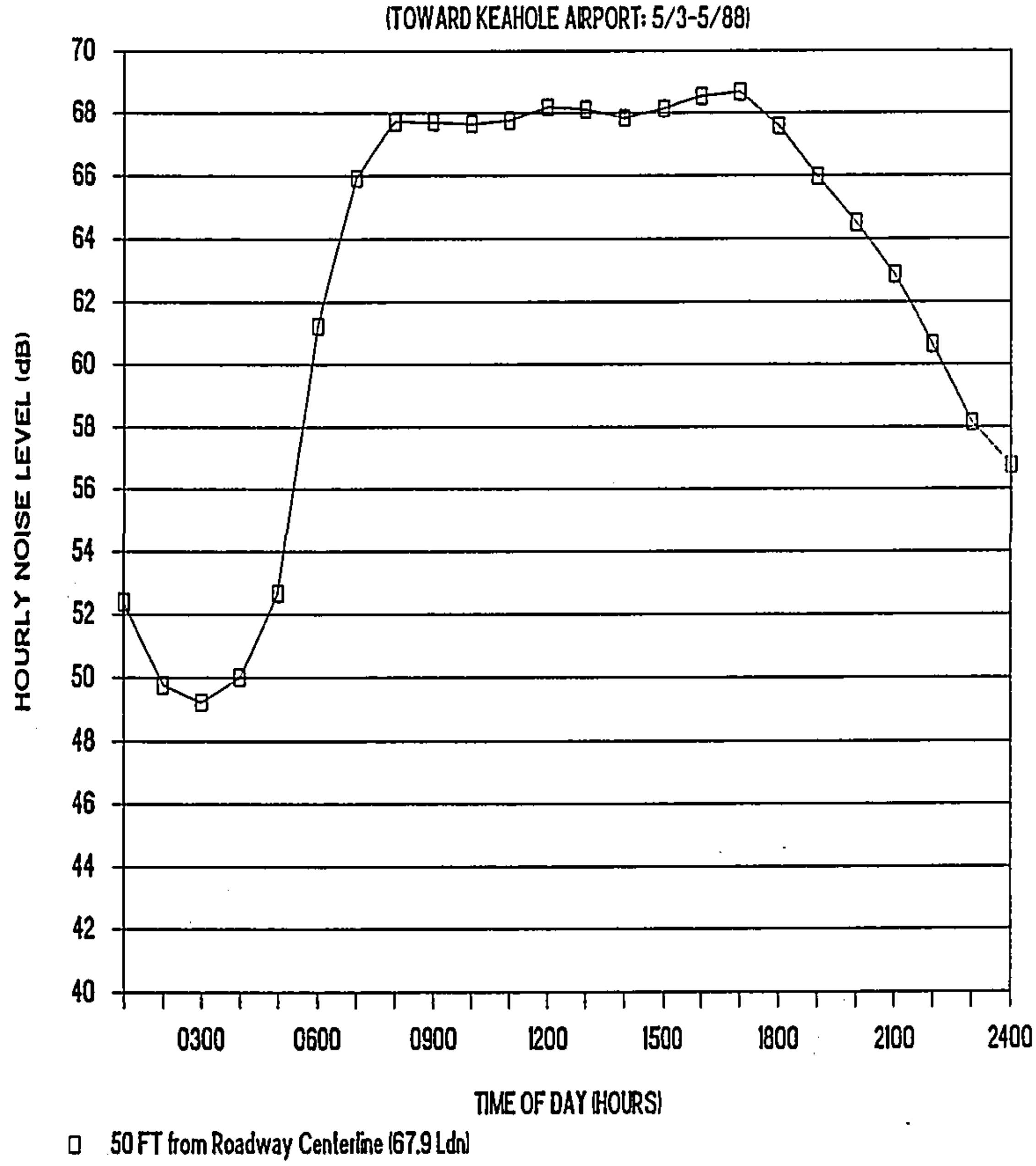
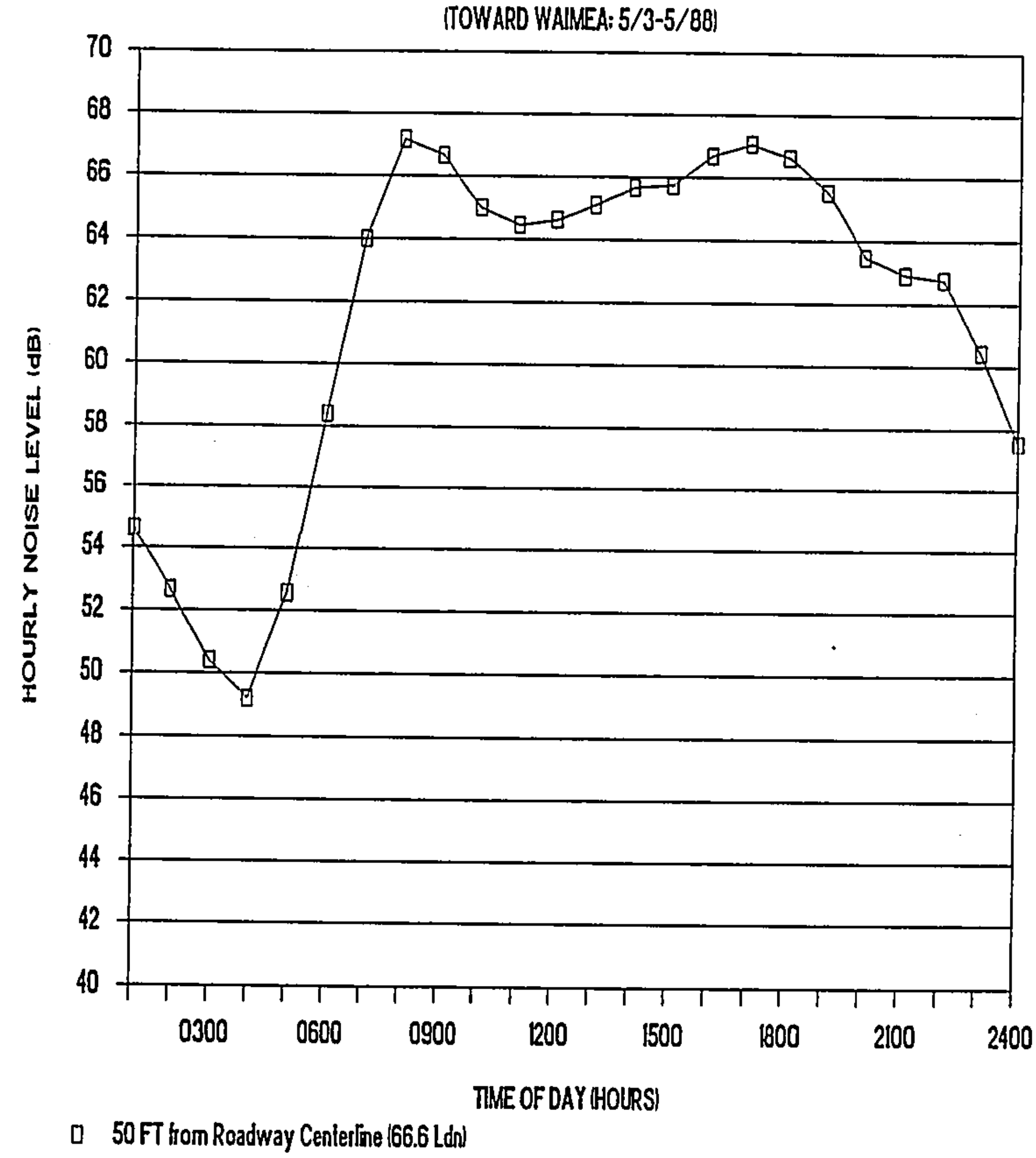
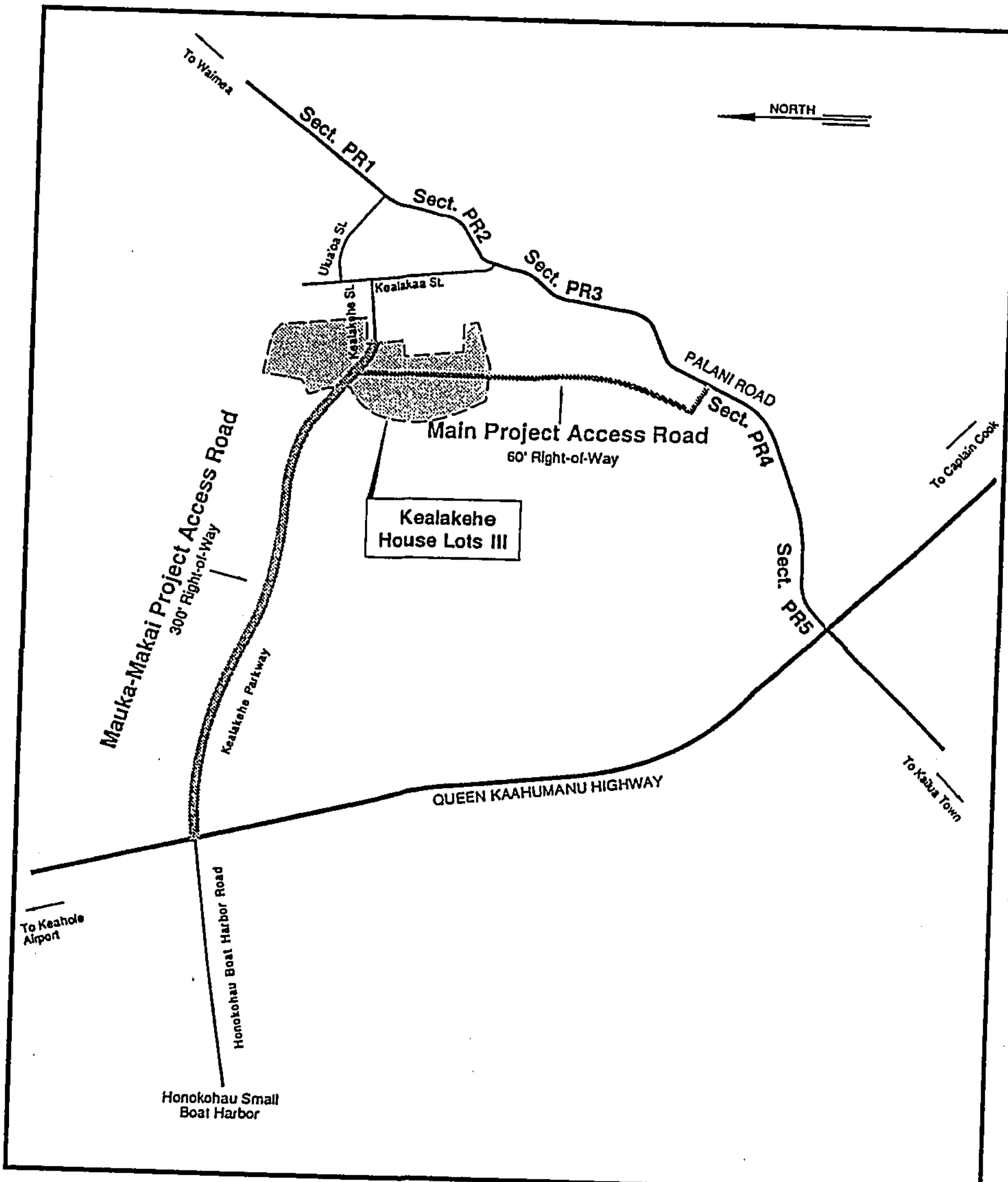


FIGURE 4

HOURLY VARIATIONS OF TRAFFIC NOISE AT 50 FT SETBACK DISTANCE FROM THE CENTERLINE OF PALANI ROAD AT QUEEN KA'AHUMANU HIGHWAY

(TOWARD WAIMEA: 5/3-5/88)





ULTIMATE ACCESS ROADWAYS TO PROJECT SITE

FIGURE 5

traffic noise levels were calculated. The forecasted increases in traffic noise levels over existing levels were calculated for conditions with and without the project. The relative contributions of non-project and project related traffic to the total noise levels were also calculated. Evaluations of possible traffic noise impacts were performed for periods following completion of the Kealakehe House Lots III increment and following total project build-out by CY 2010.

CHAPTER V. EXISTING NOISE ENVIRONMENT

The existing traffic noise levels in the project environs (see **FIGURE 2**) are in the "Significant Exposure, Normally Unacceptable" category at 50 FT distance from the centerlines of Queen Ka'ahumanu Highway and Palani Road. Traffic noise levels along the Right-of-Way of a roadway generally represent the worst case (or highest) levels due to the proximity of the Right-of-Way to the noise sources. At greater setback distances of approximately 92 to 96 FT, traffic noise along Queen Ka'ahumanu Highway decrease to the "Moderate Exposure, Acceptable" category. Setback distances of approximately 49 to 86 FT are required from the centerline of Palani Road to be in the "Moderate Exposure, Acceptable" noise exposure category.

Calculations of existing traffic noise levels during the PM peak traffic hour are presented in **TABLES 3A and 3B**. The hourly Leq (or Equivalent Sound Level) contributions from each roadway section in the project environs were calculated for comparison with forecasted traffic noise levels with and without the project. The existing setback distances from the roadways' centerlines to their associated 60, 65, and 70 Ldn contours were also calculated as shown in **TABLES 4A and 4B**. The contour line setback distances do not consider noise shielding effects or the additive contributions of traffic noise from intersecting street sections. The existing setback distances to the 65 Ldn contour lines are relatively large along Queen Ka'ahumanu Highway and the makai (or west) section of Palani Road. Along the mauka (or east) section of Palani Road, the setback distances to the 65 Ldn contour are relatively small and in the order of 50 FT. Along Ulua'oa and Kealakaa Streets, existing traffic noise levels are very low, and in the order of 50 to 60 Ldn at 50 FT setback distance from the roadways' centerlines.

Existing traffic noise levels at the mauka (inland) portions of the project site are very low (less than 60 Ldn) due to their

TABLE 3A

COMPARISONS OF EXISTING AND CY 1992 TRAFFIC NOISE LEVELS
ALONG ACCESS ROADS TO PROJECT SITE
(PM PEAK HOUR AND 50 FT FROM ROADWAY CENTERLINES)

LOCATION	SPEED (MPH)	VPH	***** HOURLY LEQ IN dB **** AUTO	MT	HT	ALL VEH
EXISTING (CY 1990) PM PEAK HR. TRAFFIC:						
Q. Ka'ahumanu Hwy. (North)	49	1,429	65.4	60.7	65.1	69.0
Q. Ka'ahumanu Hwy. (Front)	49	1,509	65.7	60.9	65.4	69.2
Q. Ka'ahumanu Hwy. (South)	48	1,509	65.3	60.6	65.1	68.9
Palani Rd. (Section PR1)	45	903	62.1	56.0	60.8	65.1
Palani Rd. (Section PR2)	45	860	61.9	55.8	60.6	64.9
Palani Rd. (Section PR3)	45	1,296	63.7	57.6	62.4	66.7
Palani Rd. (Section PR4)	45	1,412	64.1	57.9	62.7	67.0
Palani Rd. (Section PR5)	45	1,412	65.6	59.4	64.2	68.5
Ulua'oa Street	30	149	47.6	40.8	47.2	50.9
Kealakaa Street	35	481	55.3	48.2	54.0	58.1
CY 1992 PM PEAK HR. TRAFFIC WITH HOUSE LOTS III:						
Q. Ka'ahumanu Hwy. (North)	49	1,997	66.9	62.1	66.6	70.4
Q. Ka'ahumanu Hwy. (Front)	49	1,813	66.5	61.7	66.2	70.0
Q. Ka'ahumanu Hwy. (South)	48	1,813	66.1	61.4	65.9	69.7
Palani Rd. (Section PR1)	45	1,153	63.2	57.1	61.9	66.1
Palani Rd. (Section PR2)	45	1,059	62.8	56.7	61.5	65.8
Palani Rd. (Section PR3)	45	1,474	64.2	58.1	62.9	67.2
Palani Rd. (Section PR4)	45	1,681	64.8	58.7	63.5	67.8
Palani Rd. (Section PR5)	45	1,688	66.3	60.2	65.0	69.3
Ulua'oa Street	30	189	48.7	41.8	48.3	51.9
Kealakaa Street	35	430	54.8	47.7	53.5	57.7
Kealakehe Parkway	47	315	60.3	54.1	58.7	63.1
Main Project Access Road	37	179	51.9	46.1	51.7	55.3

Notes:

The following assumed traffic mixes of autos, medium trucks, and heavy trucks were used for existing and future conditions:

(a) Queen Ka'ahumanu Highway: 95.0% autos, 2.5% medium trucks, and 2.5% heavy trucks or buses.

(b) Palani Road: 96.4% autos, 1.8% medium trucks, and 1.8% heavy trucks or buses.

(c) Ulua'oa and Kealakaa Streets: 97.4% autos, 1.3% medium trucks, and 1.3% heavy trucks or buses.

(d) Kealakehe Parkway and Main Project Access Road: 96.4% autos, 1.8% medium trucks, and 1.8% heavy trucks or buses.

TABLE 3B

COMPARISONS OF EXISTING AND CY 2010 TRAFFIC NOISE LEVELS
ALONG ACCESS ROADS TO PROJECT SITE
(PM PEAK HOUR AND 50 FT FROM ROADWAY CENTERLINES)

LOCATION	SPEED (MPH)	VPH	***** HOURLY LEQ IN dB **** AUTO	MT	HT	ALL VEH
EXISTING (CY 1990) PM PEAK HR. TRAFFIC:						
Q. Ka'ahumanu Hwy. (North)	49	1,429	65.4	60.7	65.1	69.0
Q. Ka'ahumanu Hwy. (Front)	49	1,509	65.7	60.9	65.4	69.2
Q. Ka'ahumanu Hwy. (South)	48	1,509	65.3	60.6	65.1	68.9
Palani Rd. (Section PR1)	45	903	62.1	56.0	60.8	65.1
Palani Rd. (Section PR2)	45	860	61.9	55.8	60.6	64.9
Palani Rd. (Section PR3)	45	1,296	63.7	57.6	62.4	66.7
Palani Rd. (Section PR4)	45	1,412	64.1	57.9	62.7	67.0
Palani Rd. (Section PR5)	45	1,412	65.6	59.4	64.2	68.5
Ulua'oa Street	30	149	47.6	40.8	47.2	50.9
Kealakaa Street	35	481	55.3	48.2	54.0	58.1
CY 2010 PM PEAK HR. TRAFFIC WITH FULL PROJECT DEVELOPMENT:						
Q. Ka'ahumanu Hwy. (North)	49	4,590	70.5	65.7	70.2	74.1
Q. Ka'ahumanu Hwy. (Front)	49	4,020	69.9	65.2	69.6	73.5
Q. Ka'ahumanu Hwy. (South)	48	4,020	69.6	64.9	69.4	73.2
Palani Rd. (Section PR5)	45	3,050	68.9	62.8	67.6	71.9
Kealakehe Parkway	47	3,080	70.2	64.0	68.6	73.0

Notes:

The following assumed traffic mixes of autos, medium trucks, and heavy trucks were used for existing and future conditions:

(a) Queen Ka'ahumanu Highway: 95.0% autos, 2.5% medium trucks, and 2.5% heavy trucks or buses.

(b) Palani Road: 96.4% autos, 1.8% medium trucks, and 1.8% heavy trucks or buses.

(c) Ulua'oa and Kealakaa Streets: 97.4% autos, 1.3% medium trucks, and 1.3% heavy trucks or buses.

(d) Kealakehe Parkway and Main Project Access Road: 96.4% autos, 1.8% medium trucks, and 1.8% heavy trucks or buses.

TABLE 4A

EXISTING AND CY 1992 DISTANCES TO 60, 65, AND 70 Ldn CONTOURS

STREET SECTION	60 Ldn SETBACK (FT) EXISTING	60 Ldn SETBACK (FT) CY 1992	65 Ldn SETBACK (FT) EXISTING	65 Ldn SETBACK (FT) CY 1992	70 Ldn SETBACK(FT) EXISTING	70 Ldn SETBACK(FT) CY 1992
Q. Ka'ahumanu Hwy. (North)	199	249	92	115	43	54
Q. Ka'ahumanu Hwy. (Front)	206	233	96	108	44	50
Q. Ka'ahumanu Hwy. (South)	197	223	92	104	43	48
Palani Rd. (Section PR1)	109	129	51	60	24	28
Palani Rd. (Section PR2)	106	121	49	56	23	26
Palani Rd. (Section PR3)	139	151	64	70	30	33
Palani Rd. (Section PR4)	147	165	68	77	32	36
Palani Rd. (Section PR5)	185	209	86	97	40	45
Ulua'oa Street	12	14	6	7	3	3
Kealakaa Street	38	35	17	16	8	8
Kealakehe Parkway	N/A	81	N/A	38	N/A	17
Main Project Access Road	N/A	24	N/A	11	N/A	5

<u>Notes:</u>

(1) All setback distances are from the roadways' centerlines.
(2) See TABLE 3A for traffic volume, speed, and mix assumptions.
(3) Ldn assumed to be equal to PM Peak Hour Leq along all roadways.
(4) Setback distances are for unobstructed line-of-sight conditions.
(5) Soft ground conditions assumed along all roadways.

TABLE 4B

EXISTING AND CY 2010 DISTANCES TO 60, 65, AND 70 Ldn CONTOURS

STREET SECTION	60 Ldn SETBACK (FT) EXISTING	60 Ldn SETBACK (FT) CY 2010	65 Ldn SETBACK (FT) EXISTING	65 Ldn SETBACK (FT) CY 2010	70 Ldn SETBACK(FT) EXISTING	70 Ldn SETBACK(FT) CY 2010
Q. Ka'ahumanu Hwy. (North)	199	433	92	201	43	93
Q. Ka'ahumanu Hwy. (Front)	206	396	96	184	44	85
Q. Ka'ahumanu Hwy. (South)	197	379	92	176	43	82
Palani Rd. (Section PR5)	185	309	86	144	40	67
Kealakehe Parkway	N/A	370	N/A	172	N/A	80

Notes:

(1) All setback distances are from the roadways' centerlines.
(2) See TABLE 3B for traffic volume, speed, and mix assumptions.
(3) Ldn assumed to be equal to PM Peak Hour Leq along all roadways.
(4) Setback distances are for unobstructed line-of-sight conditions.
(5) Soft ground conditions assumed along all roadways.

large setback distances from Queen Ka'ahumanu Highway. The proposed residential areas of the project are located beyond a quarter mile from the highway. At 49 FT or greater setback distance from the centerline of the mauka sections of Palani Road, traffic noise levels from this lower volume roadway are less than 65 Ldn. Existing background ambient noise measurements obtained at Sites "HL" and "KS" confirm that noise levels in the mauka portions of the project are very low, and in the order of 45 to 50 Ldn. Based on the above information, it was concluded that the existing noise levels at the proposed residential portions of the project are not expected to exceed current FHA/HUD noise standards or cause adverse noise impacts on future project residents.

CHAPTER VI. FUTURE TRAFFIC NOISE ENVIRONMENT

__Following Completion of Housing Lots III.__ Predictions of future traffic noise levels following completion of the proposed Kealakehe House Lots II residential subdivision were made using the traffic volume assignments of **Reference 5** for CY 1992 with and without the project. The future projections of project plus non-project traffic on the roadways which would service the project are shown in **TABLE 3A** for the PM peak hour of traffic. As indicated in **TABLE 3A**, by CY 1992, traffic noise levels on existing roadways will increase moderately by 0.6 to 1.5 dB.

TABLE 4A summarizes the predicted setback distances to the 60, 65, and 70 Ldn traffic noise contour lines along the roadways servicing the House Lots III increment and attributable to both project plus non-project traffic. The setback distances in **TABLE 4A** do not include the beneficial effects of noise shielding from terrain features and highway cuts, or the detrimental effects of additive contributions of noise from intersecting streets. As indicated in **TABLE 4A**, moderately large setback distances to the 65 Ldn contour of 104 to 115 FT from the centerline of Queen Ka'ahumanu Highway are predicted in CY 1992. Along Palani Road, shorter setback distances of 56 to 97 FT to the 65 Ldn contour line are predicted.

TABLE 5A presents the predicted increases in traffic noise levels associated with non-project and project traffic by CY 1992, and as measured by the Ldn descriptor system. As indicated in **TABLE 5A**, the increases in traffic noise along Queen Ka'ahumanu Highway due to House Lots III project traffic are very small or insignificant when compared to those increases expected from non-project traffic. Similar conclusions apply along Palani Road. Project traffic noise increases are expected to be greatest relative to non-project traffic along Ulua'oa and Kealakehe Streets. However, current traffic volumes and noise levels along these two streets are very low, and the additional project traffic on these

TABLE 5A

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 1992)

STREET SECTION	NOISE LEVEL INCREASES NON-PROJECT TRAFFIC	(Ldn) DUE TO PROJECT TRAFFIC
Q. Ka'ahumanu Hwy. (North)	1.0	0.5
Q. Ka'ahumanu Hwy. (Front)	0.9	-0.1
Q. Ka'ahumanu Hwy. (South)	0.9	-0.1
Palani Rd. (Section PR1)	0.7	0.3
Palani Rd. (Section PR2)	0.8	0.1
Palani Rd. (Section PR3)	0.5	0.0
Palani Rd. (Section PR4)	0.5	0.2
Palani Rd. (Section PR5)	0.5	0.3
Ulua'oa Street	0.0	1.0
Kealakaa Street	0.0	-0.5
Kealakehe Parkway	N/A	63.1
Main Project Access Road	N/A	55.3

two streets will not increase noise levels to unacceptable levels.

As a result of the construction of the Main Project Access Road, traffic noise levels are expected to increase at the inland areas mauka of Queen Ka'ahumanu Highway. By CY 1992, following the construction of this new roadway, background ambient noise levels at the future House Lots III residential area (see **FIGURE 5**) are expected to increase significantly from existing low levels. However, in the planned residential areas fronting these two roadways, setback distances to the 65 Ldn contour lines are expected to be less than 20 FT from the centerline of the Main Project Access Road. For this reason, traffic noise impacts along this roadway are not expected following completion of the House Lots III increment in CY 1992.

Following Complete Project Build-Out. The CY 2010 projections of project plus non-project traffic on the roadways which would service the project are shown in **TABLE 3B** for the PM peak hour of traffic. As indicated in **TABLE 3B**, by CY 2010, traffic noise levels on existing roadways will increase significantly by 3 to 5 dB.

TABLE 4B summarizes the predicted setback distances to the 60, 65, and 70 Ldn traffic noise contour lines along the roadways in CY 2010 and attributable to both project plus non-project traffic. The setback distances in **TABLE 4B** do not include the beneficial effects of noise shielding from terrain features and highway cuts, or the detrimental effects of additive contributions of noise from intersecting streets. As indicated in **TABLE 4B**, relatively large setback distances to the 65 Ldn contour of 176 to 201 FT from the centerline of Queen Ka'ahumanu Highway are predicted in CY 2010. Along Palani Road, moderately large setback distances of 100 to 144 FT to the 65 Ldn contour line are predicted.

TABLE 5B presents the predicted increases in traffic noise levels associated with non-project and project traffic by CY 2010, and as measured by the Ldn descriptor system. As indicated in **TABLE 5B**, the increases in traffic noise along Queen Ka'ahumanu

TABLE 5B

CALCULATIONS OF PROJECT AND NON-PROJECT TRAFFIC NOISE CONTRIBUTIONS (CY 2010)

STREET SECTION	NOISE LEVEL INCREASES (Ldn) DUE TO NON-PROJECT TRAFFIC	PROJECT TRAFFIC
Q. Ka'ahumanu Hwy. (North)	4.3	0.8
Q. Ka'ahumanu Hwy. (Front)	4.1	0.2
Q. Ka'ahumanu Hwy. (South)	4.1	0.2
Palani Rd. (Section PR5)	3.4	-0.1
Kealakehe Parkway	N/A	73.0

Highway due to project traffic are very small or insignificant when compared to those increases expected from non-project traffic. Similar conclusions apply along Palani Road. Project traffic noise increases are expected to be greatest relative to non-project traffic along Ulua'oa and Kealakehe Streets, and the two new access roadways to the project site.

As a result of the construction of the mauka portions of the Kealakehe Parkway, traffic noise levels are expected to increase at the inland areas mauka of Queen Ka'ahumanu Highway and along the north boundary of the project. By CY 2010, following the construction of the parkway, background ambient noise levels at planned residential areas along the parkways are expected to increase significantly from existing low levels. Future traffic noise levels along the Right-of-Way and at intersection with Queen Ka'ahumanu Highway are expected to be slightly above 65 Ldn following complete project build-out. Although commercial and golf course uses are planned at the intersection, traffic noise mitigation measures may be required along the planned residential areas fronting this roadway.

CHAPTER VII. DISCUSSION OF PROJECT RELATED TRAFFIC NOISE IMPACTS AND POSSIBLE NOISE MITIGATION MEASURES

The increases in traffic noise levels attributable to the project from the present to CY 2010 are predicted to range from 0.2 to 0.8 Ldn along Queen Ka'ahumanu Highway, where traffic noise levels are expected to remain above 65 Ldn along the highway Right-of-Way. This degree of increase in traffic noise levels attributable to the project will be difficult to perceive over a 20-year period from CY 1990 to CY 2010, and is not considered to be significant. Existing and planned land uses along the highway are primarily commercial and light industrial. For these reasons, traffic noise impacts along Queen Ka'ahumanu Highway and resulting from project traffic are not considered to be serious.

Relatively large increases in traffic noise levels along the improved Palani Road are expected to occur as a result of project plus non-project traffic. By CY 2010, traffic noise levels are expected to increase along Palani Road by 3.4 Ldn, primarily as a result of non-project traffic. Setback distances of 100 to 144 FT from Palani Road's centerline will be required to meet FHA/HUD noise standards under unobstructed line-of-sight conditions between the roadway and noise sensitive receptors. Under conditions of noise shielding by terrain features or man-made obstructions, setback distances required to meet the FHA/HUD standard would be significantly less, and be probably less than 100 FT from the roadway centerline.

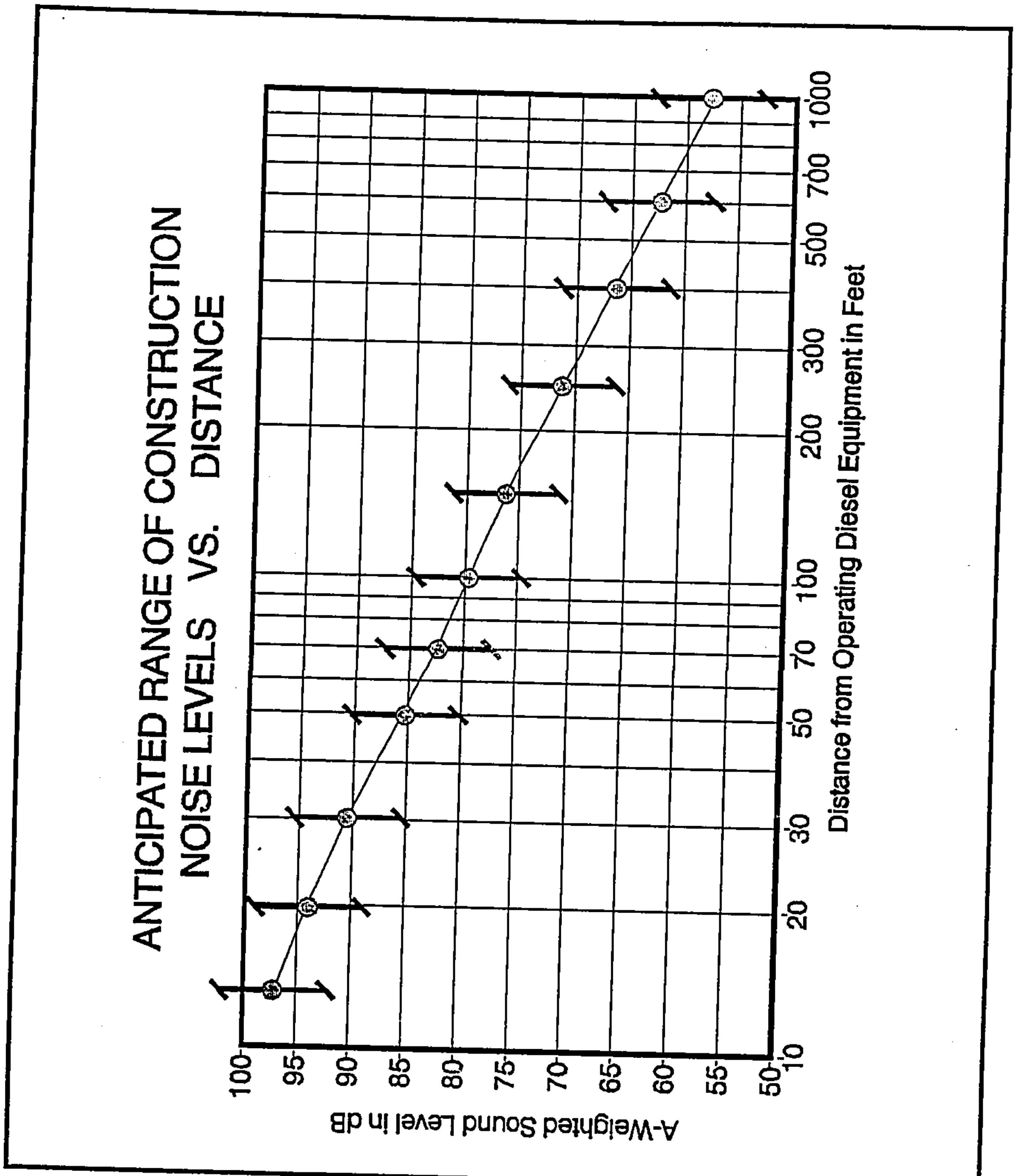
Potential noise impacts along the improved Palani Road are possible, both in respect to existing and planned noise sensitive receptors along the roadway. Existing residences located along the roadway may be impacted by the added traffic noise as well as by the future roadway improvements if noise mitigation measures are not included with the construction of the roadway improvements. Mitigation of off-site traffic noise impacts are generally performed by individual property owners fronting the roadways'

Right-of-Way or by public agencies during roadway improvement projects. These mitigation measures generally take the form of increased setbacks, sound attenuating walls, total closure and air conditioning, or the use of sound attenuating windows. Severe noise impacts should not occur as a result of the proposed project as long as noise mitigation measures are incorporated into any improvement projects along Palani Road.

CHAPTER VIII. OTHER NON-TRAFFIC NOISE CONSIDERATIONS

Construction Noise. Audible construction noise will probably be unavoidable during the entire project construction period. The total period of construction is unknown, but it is anticipated that the actual work will be moving from one location on the project site to another during that period. Actual length of exposure to construction noise at any receptor location will probably be less than the total construction period for the entire project. Typical levels of noise from construction activity (excluding pile driving activity) are shown in **FIGURE 6**. The impulsive noise levels of impact pile drivers are approximately 15 dB higher than the levels shown in **FIGURE 6**, while the intermittent noise levels of vibratory pile drivers are at the upper end of the noise level ranges depicted in the figure. Adverse impacts from construction noise are not expected to be in the "public health and welfare" category due to the temporary nature of the work and due to the administrative controls available for its regulation. Instead, these impacts will probably be limited to the temporary degradation of the quality of the acoustic environment near the project site.

Mitigation of construction noise to inaudible levels will not be practical in all cases due to the intensity of construction noise sources (80 to 90+ dB at 50 FT distance), and due to the exterior nature of the work (pile driving, grading and earth moving, trenching, concrete pouring, hammering, etc.). The use of properly muffled construction equipment should be required on the job site. In addition, if soil conditions allow, the use of vibratory pile driving equipment is also recommended for minimizing construction noise impacts. The incorporation of State Department of Health construction noise limits and curfew times, which are applicable on the island of Oahu (**Reference 8**), is another noise mitigation measure which can be applied to this project. **TABLE 6** depicts the allowed hours of construction for normal construction



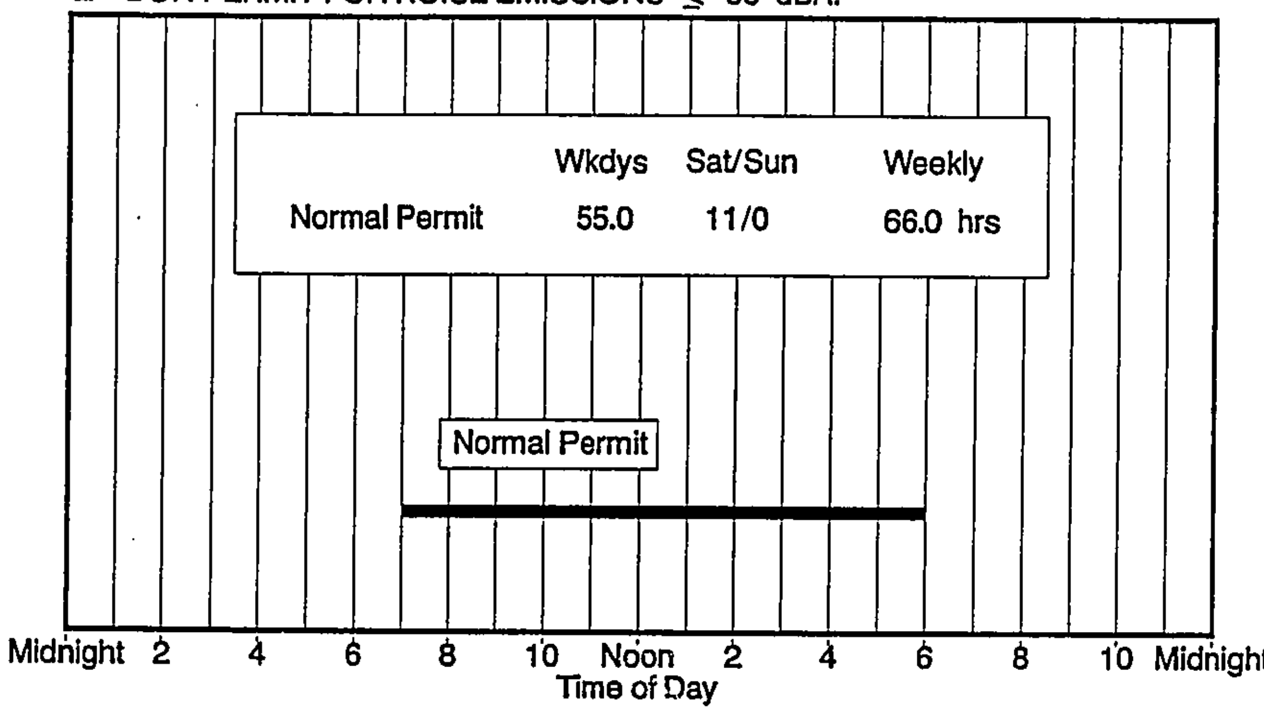
CONSTRUCTION NOISE LEVELS VS. DISTANCE

FIGURE 6

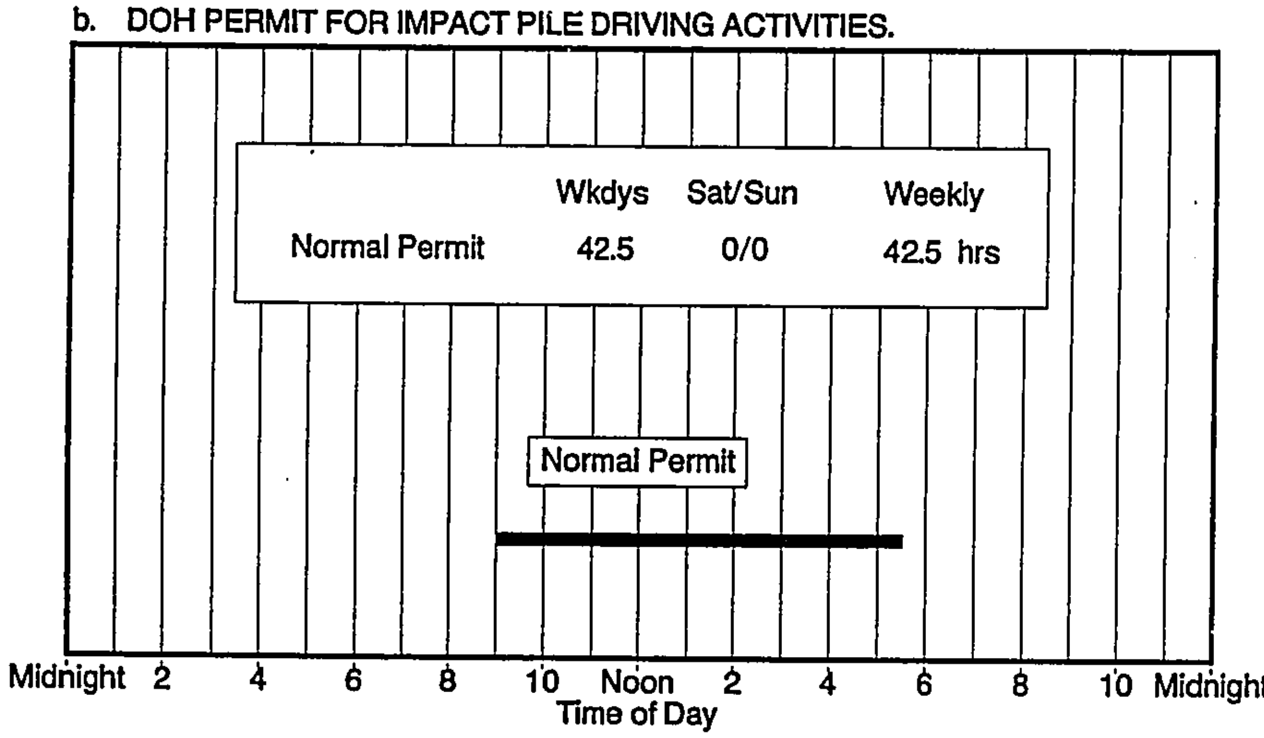
TABLE 6

AVAILABLE WORK HOURS UNDER DOH PERMIT PROCEDURES FOR CONSTRUCTION NOISE

a. DOH PERMIT FOR NOISE EMISSIONS $\leq$ 95 dBA.



b. DOH PERMIT FOR IMPACT PILE DRIVING ACTIVITIES.



noise (levels which do not exceed 95 dB at the project's property line) and for construction noise which exceed 95 dB at the project's property line. Noisy construction activities are not allowed on holidays under the DOH permit procedures.

APPENDIX A. REFERENCES

(1) "Guidelines for Considering Noise in Land Use Planning and Control"; Federal Interagency Committee on Urban Noise; June 1980.

(2) "Environmental Criteria and Standards, Noise Abatement and Control, 24 CFR, Part 51, Subpart B"; U.S. Department of Housing and Urban Development; July 12, 1979.

(3) "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety"; Environmental Protection Agency (EPA 550/9-74-004); March 1974.

(4) Barry, T. and J. Reagan, "FHWA Highway Traffic Noise Prediction Model"; FHWA-RD-77-108, Federal Highway Administration; Washington, D.C.; December 1978.

(5) "Traffic Impact Assessment Report for the Kealakehe House Lots III;" Pacific Planning & Engineering, Inc.; February 1990.

(6) Transmittal from Pacific Planning & Engineering, Inc. containing CY 2010 traffic projections; June 21, 1990.

(7) May 3-5, 1988 24-Hour Traffic Counts; Queen Ka'ahumanu Highway at Palani Road; Hawaii State Department of Transportation.

(8) "Title 11, Administrative Rules, Chapter 43, Community Noise Control for Oahu"; Hawaii State Department of Health; November 6, 1981.

APPENDIX B

EXCERPTS FROM EPA'S ACOUSTIC TERMINOLOGY GUIDE

Descriptor Symbol Usage

The recommended symbols for the commonly used acoustic descriptors based on A-weighting are contained in Table I. As most acoustic criteria and standards used by EPA are derived from the A-weighted sound level, almost all descriptor symbol usage guidance is contained in Table I.

Since acoustic nomenclature includes weighting networks other than "A" and measurements other than pressure, an expansion of Table I was developed (Table II). The group adopted the ANSI descriptor-symbol scheme which is structured into three stages. The first stage indicates that the descriptor is a level (i.e., based upon the logarithm of a ratio), the second stage indicates the type of quantity (power, pressure, or sound exposure), and the third stage indicates the weighting network (A, B, C, D, E.....). If no weighting network is specified, "A" weighting is understood. Exceptions are the A-weighted sound level and the A-weighted peak sound level which require that the "A" be specified. For convenience in those situations in which an A-weighted descriptor is being compared to that of another weighting, the alternative column in Table II permits the inclusion of the "A". For example, a report on blast noise might wish to contrast the LCdn with the LAdn.

Although not included in the tables, it is also recommended that "Lpn" and "LepN" be used as symbols for perceived noise levels and effective perceived noise levels, respectively.

It is recommended that in their initial use within a report, such terms be written in full, rather than abbreviated. An example of preferred usage is as follows:

The A-weighted sound level (LA) was measured before and after the installation of acoustical treatment. The measured LA values were 85 and 75 dB respectively.

Descriptor Nomenclature

With regard to energy averaging over time, the term "average" should be discouraged in favor of the term "equivalent". Hence, Leq, is designated the "equivalent sound level". For Ld, Ln, and Ldn, "equivalent" need not be stated since the concept of day, night, or day-night averaging is by definition understood. Therefore, the designations are "day sound level", "night sound level", and "day-night sound level", respectively.

The peak sound level is the logarithmic ratio of peak sound pressure to a reference pressure and not the maximum root mean square pressure. While the latter is the maximum sound pressure level, it is often incorrectly labelled peak. In that sound level meters have "peak" settings, this distinction is most important.

"Background ambient" should be used in lieu of "background", "ambient", "residual", or "indigenous" to describe the level characteristics of the general background noise due to the contribution of many unidentifiable noise sources near and far.

With regard to units, it is recommended that the unit decibel (abbreviated dB) be used without modification. Hence, DBA, PNdB, and EPNdB are not to be used. Examples of this preferred usage are: the Perceived Noise Level (Lpn was found to be 75 dB. Lpn = 75 dB). This decision was based upon the recommendation of the National Bureau of Standards, and the policies of ANSI and the Acoustical Society of America, all of which disallow any modification of bel except for prefixes indicating its multiples or submultiples (e.g., deci).

Noise Impact

In discussing noise impact, it is recommended that "Level Weighted Population" (LWP) replace "Equivalent Noise Impact" (ENI). The term "Relative Change of Impact" (RCI) shall be used for comparing the relative differences in LWP between two alternatives.

Further, when appropriate, "Noise Impact Index" (NII) and "Population Weighed Loss of Hearing" (PHL) shall be used consistent with CHABA Working Group 69 Report Guidelines for Preparing Environmental Impact Statements (1977).

APPENDIX B (CONTINUED)

TABLE I

A-WEIGHTED RECOMMENDED DESCRIPTOR LIST

TERM	SYMBOL
1. A-Weighted Sound Level	L_A
2. A-Weighted Sound Power Level	L_{WA}
3. Maximum A-Weighted Sound Level	L_{max}
4. Peak A-Weighted Sound Level	L_{Apk}
5. Level Exceeded x% of the Time	L_x
6. Equivalent Sound Level	L_{eq}
7. Equivalent Sound Level over Time (T) (1)	$L_{eq(T)}$
8. Day Sound Level	L_d
9. Night Sound Level	L_n
10. Day-Night Sound Level	L_{dn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$
12. Sound Exposure Level	L_{SE}

(1) Unless otherwise specified, time is in hours (e.g. the hourly equivalent level is $L_{eq(1)}$). Time may be specified in non-quantitative terms (e.g., could be specified a $L_{eq(WASH)}$ to mean the washing cycle noise for a washing machine).

SOURCE: EPA ACOUSTIC TERMINOLOGY GUIDE, BNA 8-14-78, NOISE REGULATION REPORTER.

APPENDIX B (CONTINUED)

TABLE II

RECOMMENDED DESCRIPTOR LIST

TERM	A-WEIGHTING	ALTERNATIVE(1) A-WEIGHTING	OTHER(2) WEIGHTING	UNWEIGHTED
1. Sound (Pressure) (3) Level	L_A	L_{pA}	L_B, L_{pB}	L_p
2. Sound Power Level	L_{WA}		L_{WB}	L_W
3. Max. Sound Level	L_{max}	L_{Amax}	L_{Bmax}	L_{pmax}
4. Peak Sound (Pressure) Level	L_{Apk}		L_{Bpk}	L_{pk}
5. Level Exceeded x% of the time	L_x	L_{Ax}	L_{Bx}	L_{px}
6. Equivalent Sound Level	L_{eq}	L_{Aeq}	L_{Beq}	L_{peq}
7. Equivalent Sound Level (4) Over Time(T)	$L_{eq(T)}$	$L_{Aeq(T)}$	$L_{Beq(T)}$	$L_{peq(T)}$
8. Day Sound Level	L_d	L_{Ad}	L_d	L_{pd}
9. Night Sound Level	L_n	L_{An}	L_{Bn}	L_{pn}
10. Day-Night Sound Level	L_{dn}	L_{Adn}	L_{Bdn}	L_{pdn}
11. Yearly Day-Night Sound Level	$L_{dn(Y)}$	$L_{Adn(Y)}$	$L_{Bdn(Y)}$	$L_{pdn(Y)}$
12. Sound Exposure Level	L_S	L_{SA}	L_{SB}	L_{Sp}
13. Energy Average value over (non-time domain) set of observations	$L_{eq(e)}$	$L_{Aeq(e)}$	$L_{Beq(e)}$	$L_{peq(e)}$
14. Level exceeded x% of the total set of (non-time domain) observations	$L_{x(e)}$	$L_{Ax(e)}$	$L_{Bx(e)}$	$L_{px(e)}$
15. Average L_x value	L_x	L_{Ax}	L_{Bx}	L_{px}

(1) "Alternative" symbols may be used to assure clarity or consistency.

(2) Only B-weighting shown. Applies also to C,D,E,.....weighting.

(3) The term "pressure" is used only for the unweighted level.

(4) Unless otherwise specified, time is in hours (e.g., the hourly equivalent level is Leq(1). Time may be specified in non-quantitative terms (e.g., could be specified as Leq(WASH) to mean the washing cycle noise for a washing machine.

SOCIAL IMPACTS

COMMUNITY RESOURCES, INC.

SOCIO-ECONOMIC IMPACT ASSESSMENT OF

PROPOSED KEALAKEHE RESIDENTIAL DEVELOPMENT,

NORTH KONA, HAWAII

Prepared for:

Belt Collins & Associates

and

Housing Finance Development Corporation, State of Hawaii

Prepared by:

Community Resources, Inc.

Date:

Original Draft, January 1990,
With Selected Factual Updates, July 1990

Personnel involved in CRI's work on this project: John M. Knox, Ph.D., Principal, CRI staff (John Kirkpatrick, Heidi Meeker, Bob Stanfield, and Paula Yanagisako), and CRI associate William H. Dendle, III.

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EXECUTIVE SUMMARY

The Hawaii State Housing Finance Development Corporation has proposed development of a residential community at Kealakehe, North Kona, Hawaii County. The project will eventually include about 3,900 residential units, a public golf course, a neighborhood commercial area, roadways, and sites for schools and other public facilities.

The primary aim of the project is to provide affordable housing in a rapidly growing region. About 60% of the homes in the project will be priced to rent or sell to families with low, or moderate income(individuals and families earning below 120% of the County's median income) or special needs groups. The project responds to an existing shortage of housing for these groups and to expected growth in the resident population over the next 20 years.

Community Issues and Concerns: When West Hawaii residents were interviewed for this study, most viewed the project in the light of perceived problems in the area:

- They supported the project as the first serious effort to alleviate the shortage of available housing, and as making homeownership possible for many in the area;
- They were concerned that the project could aggravate existing infrastructure problems -- notably, traffic congestion -- and hoped that project infrastructure would be put in place quickly, in order not to strain existing systems; and
- They saw the Kealakehe project as potentially a model community. Its design, financing, and governance could avoid problems perceived in some existing neighborhoods.

West Hawaii residents were uncertain about working families' ability to afford homes in the project. Some thought that resort workers and other residents would economize to afford homes, while others expected that more affluent people would end up owning the bulk of the homes.

Several interviewees were concerned about impacts on nearby residential areas. More raised questions about the State's makai land, which is not included in the project. They sought assurances that the land will remain open.

Socio-Economic Impacts: Economic and demographic growth in West Hawaii are expected to occur with or without the project. The project's major impacts are functions of locating many homes in one place, organizing a planned community, and providing affordable housing.

At buildout, the project will house about 7,500 to 11,200 people. (Population and employment estimates are given in the form of a range, to allow for decisions still to be made about the number of units in the project.) Some of the owners of market homes are expected to be part-time residents of West Hawaii, but these will amount to 7% or less of the on-site population.

Project construction will generate about 190 to 280 direct jobs per year if the entire development is built out over twenty years. Operational employment created at the project will total 370 to 470 jobs.

Project impacts include:

- A better balance between the West Hawaii housing supply and demand, leading to some improvements in social life (less crowding in existing neighborhoods; reduced stress, less transiency among in-migrants);
- Potentially, design and subdivision organization choices which will serve as models for other West Hawaii developments, encouraging community pride and the provision of needed services, notably child care;
- For nearby residential areas, improved access to public facilities, but also an increase in nearby population, changing community character slightly and increasing use of public facilities and infrastructure (which is to be expanded in response to demand);
- For nearby commercial areas and the proposed regional center, an increase in the number of potential customers and workers nearby, increasing the chance of success;
- Increased demand for nearby recreational resources; and
- Provision of a public golf course -- a less expensive alternative to golf at resort courses.

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CONTENTS (Cont.)

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1.0 INTRODUCTION

1.1 THE KEALAKEHE PLANNED COMMUNITY

The Housing Finance Development Corporation (HFDC) of the State of Hawaii proposes to develop land in Kealakehe division and part of the adjacent Keahuolu division, North Kona district, County of Hawaii, as a planned residential community. The project is intended to provided affordable housing for Hawaii's citizens and to help alleviate the current housing shortage.

The project's location is shown in Figure 1. Figure 2 shows the major elements of the project.

In Kealakehe, an area of some 90 acres makai of the existing Kealakehe community would be developed first. An additional 500 acres of State land would be devoted to housing and built out in increments after the initial section is completed. In Keahuolu, to the south, some 150 acres, makai of Palani Road, now owned by the Queen Liliuokalani Trust (QLT) would be developed as part of the Kealakehe project.

The Kealakehe residential community would include, when fully built, some 3,000 to 4,000 housing units. At least 60% of these would be "affordable" -- priced to be affordable to families making from 80% to 120% of the median income in the County of Hawaii.

Additional elements of the project are:

- An 18-hole public golf course, located between the proposed Kealakehe residential community and the Queen Kaahumanu Highway;
- Roadways, including a mauka-makai connector and a road parallel to (and mauka of) the Queen Kaahumanu Highway;
- Sites for public facilities -- a new Kona high school, an elementary school, and a civic center near the Police Station; and
- A neighborhood shopping area.

Project construction is scheduled to begin in late 1990 with the construction of the mauka-makai road. Construction of the first phase of housing will begin in 1991. The project would be built out over about 20 years -- depending in part on demand for affordable housing.

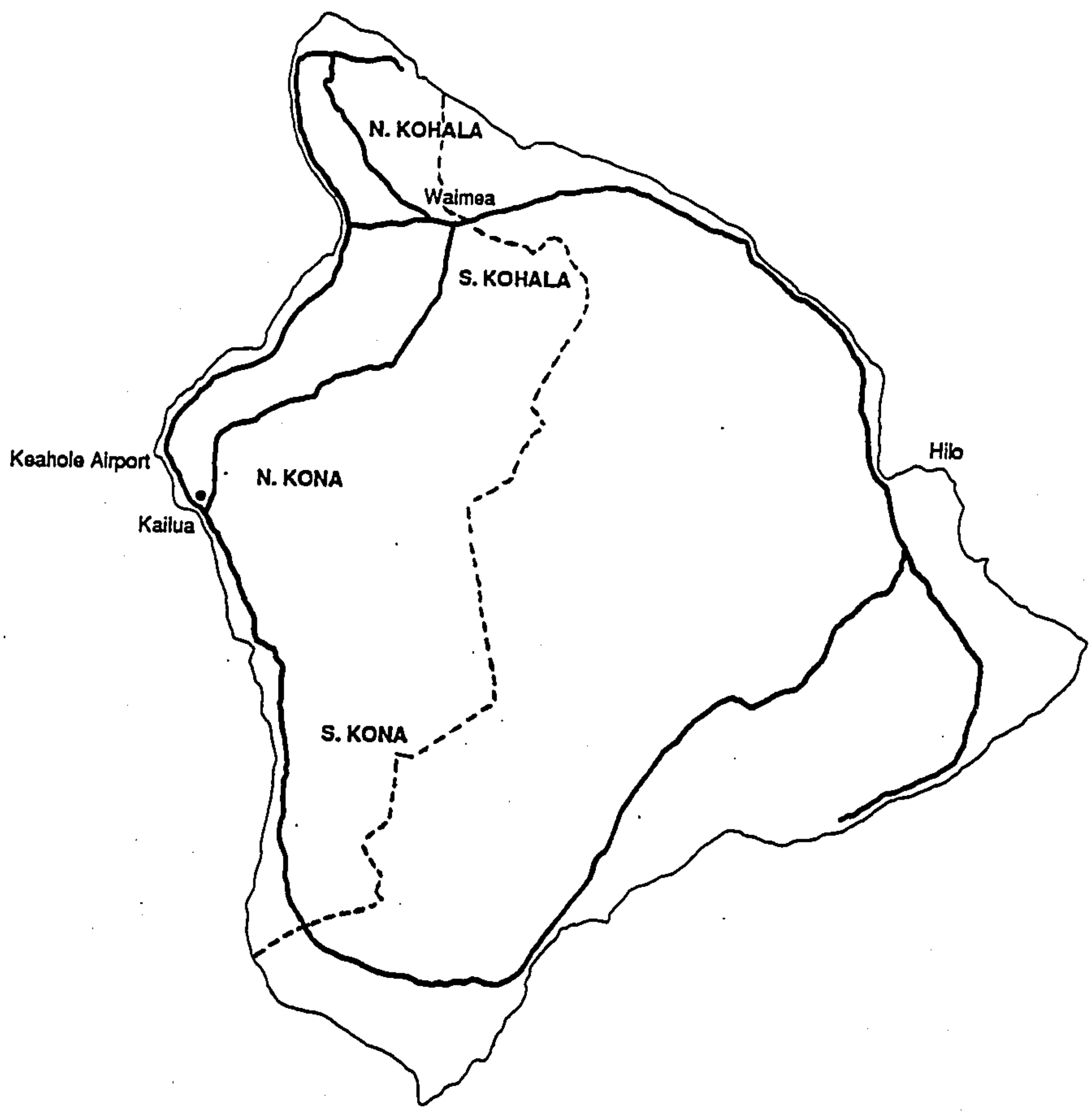


Figure 1: ISLAND OF HAWAII

• Kealakehe Project Site

- - - Boundary of West Hawaii Study Area

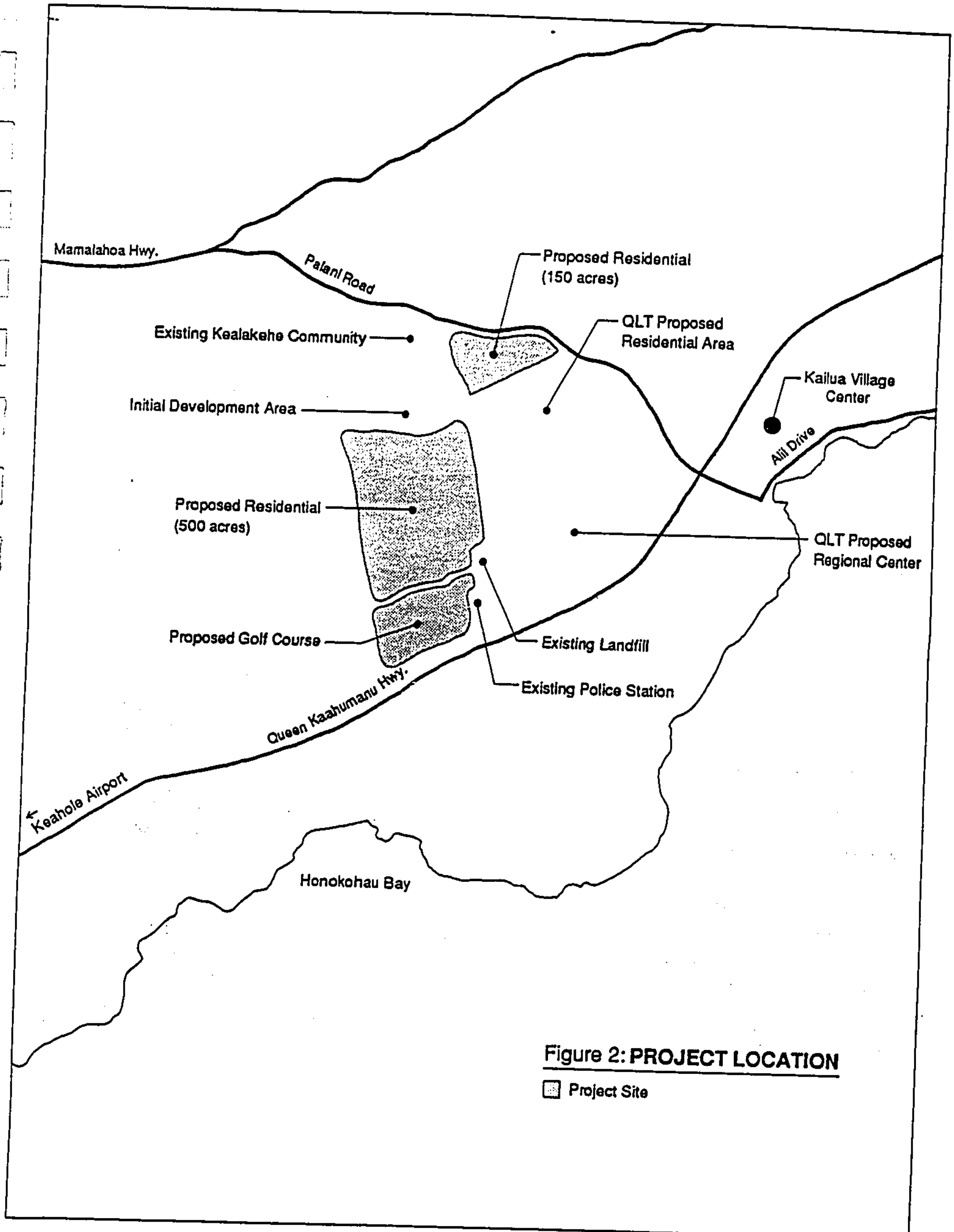


Figure 2: **PROJECT LOCATION**

Project Site

Currently, the project site is occupied only by a landfill, about four acres in size, the Hawaii Humane Society's animal shelter, and the Kealakehe Police Station. The police station will remain in operation on the site. The landfill is to be replaced by a new landfill proposed for Puuanahulu, which could open in 1991. The Humane Society's lease is reviewed annually.

The Queen Liliuokalani Trust is currently proposing its own development in Keahuolu. Its plans for a new regional center include commercial space, offices, a hospital, a hotel for business travelers, and residential land.

The QLT project and the Kealakehe project are separate, but related. The Trust is applying for a change in State Land Use designation to Urban. The area covered by the application includes about 60 acres of land that are part of the Keahuolu land used for the HFDC Kealakehe project. (The remaining 90 acres of land slated for HFDC development is already designated Urban.)

The State's land in Kealakehe includes an additional parcel of about 700 acres between Queen Kaahumanu Highway and the ocean. However, that area is outside the present project. Current plans call for a sewage treatment plant on that site and expansion of Honokohau Harbor at the northern side of that site. Use of most of the area in the makai parcel has not been planned. (The concept of eventually developing the makai land to finance affordable housing is considered a possible long range strategy.)

1.2 PURPOSE AND SCOPE OF THIS REPORT

This report provides an assessment of the socio-economic impacts of the proposed Kealakehe Planned Community project. It has been prepared for Belt Collins & Associates, for eventual inclusion in the Environmental Impact Statement being written for the State Housing Finance Development Corporation.

Social impact assessments are made in order to identify and disclose information of use to decision-makers and members of the general public, as they evaluate the implications of proposed developments.

The impacts of a project will occur in relation to the conditions existing at the time the project is built. Hence those impacts must be judged in relation to probable future conditions in the surrounding area, not just the situation existing at the time of writing the report. Construction of the present project could extend over a 20-year period, so major growth trends in West Hawaii form an important part of the context for assessing the project.

This report has four main sections:

- This section includes introductory material;
- The second section summarizes trends which form the socio-economic context for the project;
- The third section identifies community issues and concerns, including both general concerns and issues raised specifically with regard to the project; and
- The fourth section identifies socio-economic impacts of the project. Where appropriate, possible mitigating measures are noted.

While Community Resources, Inc.(CRI) was assessing the social impacts of the Kealakehe project, a separate assessment was being prepared by CRI for the QLT Keahuolu project. During the community interviews outlined in Section 3 of this report, both projects were discussed. Different issues and concerns arose with regard to the two projects and were separated for each report.

1.3 DEFINITION OF STUDY AREA

The project can be considered both in relation to a broad area affected by ongoing and anticipated economic growth, and in relation to its immediate area.

For the purposes of market analysis, a study area including the judicial districts of South Kona, North Kona, South Kohala, North Kohala, and Hamakua was identified (KPMG Peat Marwick, 1990). That area includes current and future visitor destination areas and the larger area in which persons who work at such resorts are likely to reside. By providing housing in a planned community, the project is expected to affect housing conditions and residents' housing choices throughout this region.

Other social impacts are expected to be largely felt in the North Kona district, notably at the project site and in nearby residential and urban areas.

In this report, attention will focus on the West Hawaii region, or the North Kona district, as appropriate with regard to particular citizen concerns and social impacts. Also, some economic trends and impacts can be quantified fairly rigorously at the state and/or county level, and with less certainty for the regional level. Accordingly, these are discussed with regard to the County of Hawaii as well as the West Hawaii region.

("West Hawaii is defined as the four judicial districts of North Kona, South Kona, South Kohala, and North Kohala. Hamakua is not discussed in this report, as it is not part of the area traditionally viewed as West Hawaii. Occasionally, reference is made to Kona, meaning the two judicial districts of North and South Kona, or to the Kona area. The latter phrase refers to interviewees' notion of an area centering on Kailua-Kona.)

2.0 CURRENT AND ANTICIPATED REGIONAL TRENDS

2.1 ONGOING TRENDS

Economic and Labor Force Trends: West Hawaii's economy is based on the visitor industry, construction, diversified agriculture and ranching, and high technology initiatives (in ocean science and astronomy). The visitor industry has emerged as the leading industry both in terms of size and potential growth.

Construction activity has continued to increase in Hawaii County -- construction put in place in 1988 was valued at $162,750,000, an increase of 26.6% over 1987. Currently, three major luxury hotels are under construction in West Hawaii.

Currently, West Hawaii employers report a labor shortage, particularly among skilled construction workers and entry level service workers for restaurant, retail, and resort operations.

Recent available unemployment and workforce estimates from the Department of Labor and Industrial Relations (DLIR) (personal communication, Manuel Fragrante, Researcher, Research and Statistics Office, Hawaii State DLIR, December 15, 1989) show:

	1988 Annual Average		August 1989	
	Civilian Labor Force	Unemp. Rate	Civilian Labor Force	Unemp. Rate
North Kona	9,776	3.7%	10,645	2.1%
South Kona	3,778	4.0%	4,108	2.4%
North Kohala	1,795	6.6%	1,929	3.9%
South Kohala	2,819	4.4%	3,060	2.6%
West Hawaii	18,168	4.3%	19,742	2.4%
Hawaii County	54,676	5.0%	59,206	2.9%

(NOTE: DLIR estimates for sub-county areas are based on 1980 census shares, hence usually under-estimate numbers for high-growth areas like West Hawaii. Based on actual population and labor force participation rates, CRI would estimate West Hawaii's 1988 civilian labor force as about 19,100 -- a figure to be used later in this section for forecasting purposes.)

The most recent detailed analysis of occupational patterns is provided by the 1980 Census. Table 1 shows selected data from the 1980 and 1970 Censuses. Some conclusions from this table:

TABLE 1: LABOR FORCE SIZE AND CHARACTERISTICS -- STATE AND COUNTY OF HAWAII, AND WEST HAWAII DISTRICTS, 1970 AND 1980

	STATE OF HAWAII		COUNTY OF HAWAII		NORTH KONA		SOUTH KONA		SOUTH KOHALA		NORTH KOHALA	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
POTENTIAL LABOR												
FORCE (aged 16+)	522,018	723,479	43,075	67,205	3,632	10,115	2,629	4,265	1,446	3,290	2,240	2,286
not in labor force	34.1%	31.7%	39.5%	38.7%	44.3%	27.8%	41.6%	33.8%	34.2%	35.9%	38.4%	39.8%
armed forces	9.5	8.1	0.4	0.3	0.0	0.1	0.0	0.0	0.0	0.0	1.1	1.0
civil. labor force	56.4	60.2	60.1	61.0	55.7	72.1	58.4	66.2	65.8	64.1	60.5	59.3
CIVILIAN												
LABOR FORCE(CLF)	294,484	435,780	25,889	41,006	2,022	7,293	1,535	2,823	951	2,110	1,355	1,355
unemployed	3.0%	4.7%	2.7%	7.0%	4.8%	5.2%	2.3%	5.7%	4.1%	6.3%	1.9%	9.2%
EMPLOYED CLF	285,556	415,181	25,180	38,150	1,925	6,913	1,500	2,662	912	1,978	1,330	1,230
OCCUPATION	%	%	%	%	%	%	%	%	%	%	%	%
service	15.4	17.9	16.3	16.5	19.3	21.5	16.0	17.3	15.9	18.0	25.9	34.2
manager./profes.	NC	23.5	NC	20.0	NC	21.2	NC	13.6	NC	20.6	NC	15.2
technical, sales & adminis.	NC	32.0	NC	26.1	NC	28.2	NC	24.8	NC	19.2	NC	13.7
farm/fish/forest	NC	3.4	NC	10.3	NC	7.1	NC	19.5	NC	14.0	NC	14.2
precision, craft, repair	NC	11.6	NC	12.7	NC	12.1	NC	14.8	NC	16.5	NC	9.7
operators, fabricators, laborers	NC	11.7	NC	14.4	NC	9.9	NC	10.0	NC	11.8	NC	12.9
INDUSTRY (selected)												
agric., mining	4.7	3.6	12.5	11.2	N/A	6.2	N/A	19.4	N/A	16.8	N/A	8.1
construction	9.3	7.2	10.6	9.1	23.6	11.2	20.4	14.3	13.6	12.3	2.6	5.0
manufacturing	10.9	7.9	15.0	8.3	1.0	1.9	3.2	1.2	2.3	5.1	29.3	8.1
retail trade	17.4	19.9	14.8	17.5	13.1	23.6	8.9	18.4	15.9	13.8	2.9	7.0
financ., real estate	5.0	7.6	2.8	5.7	4.0	8.6	3.5	4.5	3.5	7.6	1.1	2.3
personal, entertain. & recreat. services	8.5	9.2	11.2	10.9	N/A	20.7	N/A	15.2	N/A	16.0	N/A	31.4
health, educ, & professional	17.2	17.7	14.1	16.7	7.8	11.4	18.3	13.1	13.9	14.8	14.7	20.5
public adminis.	11.4	10.0	6.5	7.3	4.2	2.7	3.7	4.8	3.1	2.1	5.5	8.1
COMMUTE TO WORK												
45 minutes or more	N/A	13.5	N/A	6.0	N/A	4.8	N/A	6.8	N/A	13.9	N/A	22.6
mean travel (min.)	N/A	21.5	N/A	16.5	N/A	16.4	N/A	20.6	N/A	21.7	N/A	24.1

Notes: All figures based on 15 sample; hence, numbers represent estimates.
"N/A" = "Not Available" in published form. "NC" = 1970 categories or bases "Not Comparable" to 1980 Census.

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape File 3-A; State of Hawaii, 1973, Community Profiles for Hawaii. .pr or=l

- Compared to workers countywide or statewide, employed residents of North Kona, North Kohala, and South Kohala were much more likely to be in tourism-related occupations or industries in 1980.

- In North Kohala, there was a dramatic 1970-80 shift from agriculture to tourism-related work, due to the sugar phaseout. Many such tourism jobs were located outside North Kohala, as indicated by high average commute times.

- South Kona's workforce was more involved in agricultural occupations and industries than was the case elsewhere in West Hawaii or the rest of the county, on average.

- South Kona and North Kohala had relatively low proportions of managerial/professional workers.

Continuing West Hawaii resort development would suggest even more concentration in tourism today, as well as more intensive use of available workers. Preliminary results of the 1988 "Tourism Impact Management System" survey by the Department of Business and Economic Development (1989) indicate:

- The percentage of employed workers who consider themselves "in the visitor industry" was around 40% in Kona and 35% in Kohala, compared to an islandwide figure of just 25%.

- North Kona's civilian labor force participation rate is *now close to 80% -- i.e., four out of every five* potential workers aged 15 or above now holds a job or is actively seeking one.

Population Levels and Composition: West Hawaii has been one of the fastest growing areas in the State of Hawaii. Its population nearly tripled from 1970 to 1988 (from 14,500 to 40,700). (See Table 2.) The growth rates have been particularly high in North Kona and South Kohala, sites of major resort development in the 1970's and 1980's. Growth in South Kona has essentially just matched the islandwide rate. In North Kohala, there was no growth from 1970 to 1980 and only modest estimated population increases since 1980.

As of 1980, North Kona was the only district in Hawaii County where a majority of the population consisted of Caucasians. (See Census data in Table 3.) Nearly a quarter of North Kona's population at that time had been living on the Mainland five years previously, and 40% had been Mainland-born -- much larger percentages than for the county as a whole.

TABLE 2: POPULATION TRENDS, STATE OF HAWAII, COUNTY OF HAWAII, AND STUDY AREA, 1970 - 1988

	April 1, 1970	April 1, 1980	Est. July 1, 1988
North Kona District	4,832	13,748	21,600
South Kona District	4,004	5,914	7,500
South Kohala District	2,310	4,607	7,900
North Kohala District	3,326	3,249	3,700
Total West Hawaii Study Area	14,472	27,518	40,700
County of Hawaii	63,468	92,053	117,500
State of Hawaii	769,913	964,691	1,098,200

	AVERAGE ANNUAL RATE OF GROWTH		
	1970-1980	1980-1988	1970-1988
North Kona District	11.0%	5.6%	8.6%
South Kona District	4.0%	2.9%	3.5%
South Kohala District	7.1%	6.8%	7.0%
North Kohala District	-0.2%	1.6%	0.6%
Total West Hawaii Study Area	6.6%	4.9%	5.8%
County of Hawaii	3.8%	3.0%	3.4%
State of Hawaii	2.3%	1.6%	2.0%

Source: Hawaii State Department of Business and Economic Development, 1988, and unpublished tables for the 1989 Data Book.

TABLE 3: TOTAL POPULATION AND DEMOGRAPHIC BREAKDOWNS -- STATE AND COUNTY OF HAWAII, AND WEST HAWAII DISTRICTS, 1970 AND 1980

	STATE OF HAWAII		COUNTY OF HAWAII		NORTH KONA		SOUTH KONA		SOUTH KOHALA		NORTH KOHALA	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
TOTAL POPULATION	769,913	964,691	63,468	92,053	4,832	13,748	4,004	5,914	2,310	4,607	3,326	3,249
	%	%	%	%	%	%	%	%	%	%	%	%
ETHNICITY*												
Caucasian	38.8	34.4	28.8	35.0	44.0	53.8	17.7	30.0	39.2	46.5	25.6	27.8
Japanese	28.3	24.9	37.5	26.6	23.1	11.8	39.6	27.5	24.4	14.6	23.8	16.1
Chinese	6.8	5.8	2.9	1.7	3.7	1.6	0.8	0.8	1.3	1.4	4.3	1.0
Filipino	12.2	13.7	16.5	13.9	8.4	7.2	26.2	13.0	6.6	5.6	29.2	24.0
Hawaiian	9.3	12.3	12.3	18.8	19.3	22.1	14.7	23.5	26.4	28.5	15.3	24.7
Other	4.6	9.0	2.0	4.1	1.5	3.5	1.0	5.2	2.0	3.4	1.7	6.4
AGE												
Less than 5 yr.	9.2	8.1	8.6	9.1	9.1	9.1	9.0	9.8	9.3	10.2	10.0	9.2
5 - 17 yr.	26.6	20.5	27.8	21.5	27.0	20.3	29.8	20.7	28.3	23.6	29.4	22.9
18 - 64 yr.	58.5	63.5	54.4	59.2	55.7	63.9	48.9	58.8	56.1	58.6	51.1	54.4
65 or more yr.	5.8	7.9	9.2	10.2	8.2	6.7	12.4	10.6	6.4	7.7	9.5	13.6
Median age (yr.)	25.0	28.4	28.9	29.4	28.6	28.9	29.7	29.7	28.1	29.3	27.3	31.9
PLACE OF BIRTH*												
Hawaii	NC	57.8	NC	70.5	NC	54.4	NC	71.2	NC	64.9	NC	75.6
Other U.S.**	NC	28.0	NC	20.0	NC	39.9	NC	20.8	NC	30.4	NC	13.6
Foreign country	NC	14.2	NC	9.4	NC	5.7	NC	7.8	NC	4.7	NC	10.8
RESIDENCE 5 YRS. PREVIOUS* (people aged 5+)												
Same house	46.0	49.3	62.5	52.9	51.1	38.8	56.1	57.4	45.6	50.7	49.9	68.9
Same island	NC	25.2	NC	24.9	NC	28.1	NC	22.9	NC	17.3	NC	12.1
Different island	NC	2.8	NC	8.1	NC	7.0	NC	6.5	NC	14.9	NC	4.4
Different state	NC	16.9	NC	11.1	NC	23.1	NC	10.7	NC	16.4	NC	11.6
Different country	NC	5.9	NC	3.1	NC	3.0	NC	1.2	NC	0.7	NC	3.1
EDUCATION* (people aged 25+)												
0-8 years only	24.8	16.2	37.2	20.1	28.9	8.0	26.1	23.6	24.1	8.6	44.2	29.0
Hi school only	35.9	35.1	31.6	35.5	66.0	40.9	21.9	33.8	34.2	37.0	30.0	39.0
College, 4+ yr.	14.0	20.3	7.5	15.2	8.8	18.8	6.4	12.4	13.1	20.7	5.9	8.1

Notes: *Figures based on 15% sample; hence, numbers represent estimate.
**Including persons born in U.S. territories, and persons born abroad or at sea to American parent/s.
"NC" = 1970 categories or bases "Not Comparable" to 1980.

Sources: U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape Files 1-A and 3-A; State of Hawaii, 1973, Community Profiles for Hawaii.

Substantial in-migration from the Mainland is also apparent in the 1980 Census data for South Kohala. By contrast, South Kona and North Kohala had a more ethnically mixed population, including more people born in Hawaii (more than 70% each).

Housing Stock: Housing in West Hawaii (with the possible exception of North Kohala) is now considered to be in very short supply, leading to crowding and to high rentals and sales costs. The housing situation is discussed further in Section 4.3.

Family Life: With Hawaii County labor force participation is lower than elsewhere in the State, the proportion of families with full-time homemakers is likely to be higher than elsewhere. However, resort work, which is increasingly important in West Hawaii, is criticized by some as leading parents to give their children little supervision, or as creating stress in family life (Section 3.2). Available data on family conditions do include some indications of possible strain, but no clear proof:

- o West Hawaii workers (particularly those in North Kona) are more likely than those in East Hawaii to work more than 48 hours a week and to work evening and/or weekend hours often (Hawaii State Department of Business and Economic Development, Tourism Branch, 1989);
- o The proportion of students applying for the State's "A+" afterschool care -- presumably latchkey children or children depending on afterschool care from persons other than their parents -- was higher for elementary schools between Kealakehe and Kealakekua than for more rural areas of West Hawaii and for the County as a whole (personal communication, Ethel Yoshimasu, Hawaii District Superintendent's Office, Hawaii State Department of Education, January 1990);
- o Staff and teachers at Kealakehe Elementary and Intermediate Schools estimate that about half their students live in families headed by women -- a figure far higher than 1980 Census figures for the district and the County.

2.2 LIKELY FUTURE TRENDS

Following is a review of future changes expected to occur <u>with or without</u> the proposed Kealakehe project.

Countywide Quantitative Trends: The State of Hawaii's official "M-K Series" forecast for the period through year 2010 (as shown in Table 4 and Figure 3) indicate substantial economic and population growth for Hawaii County:

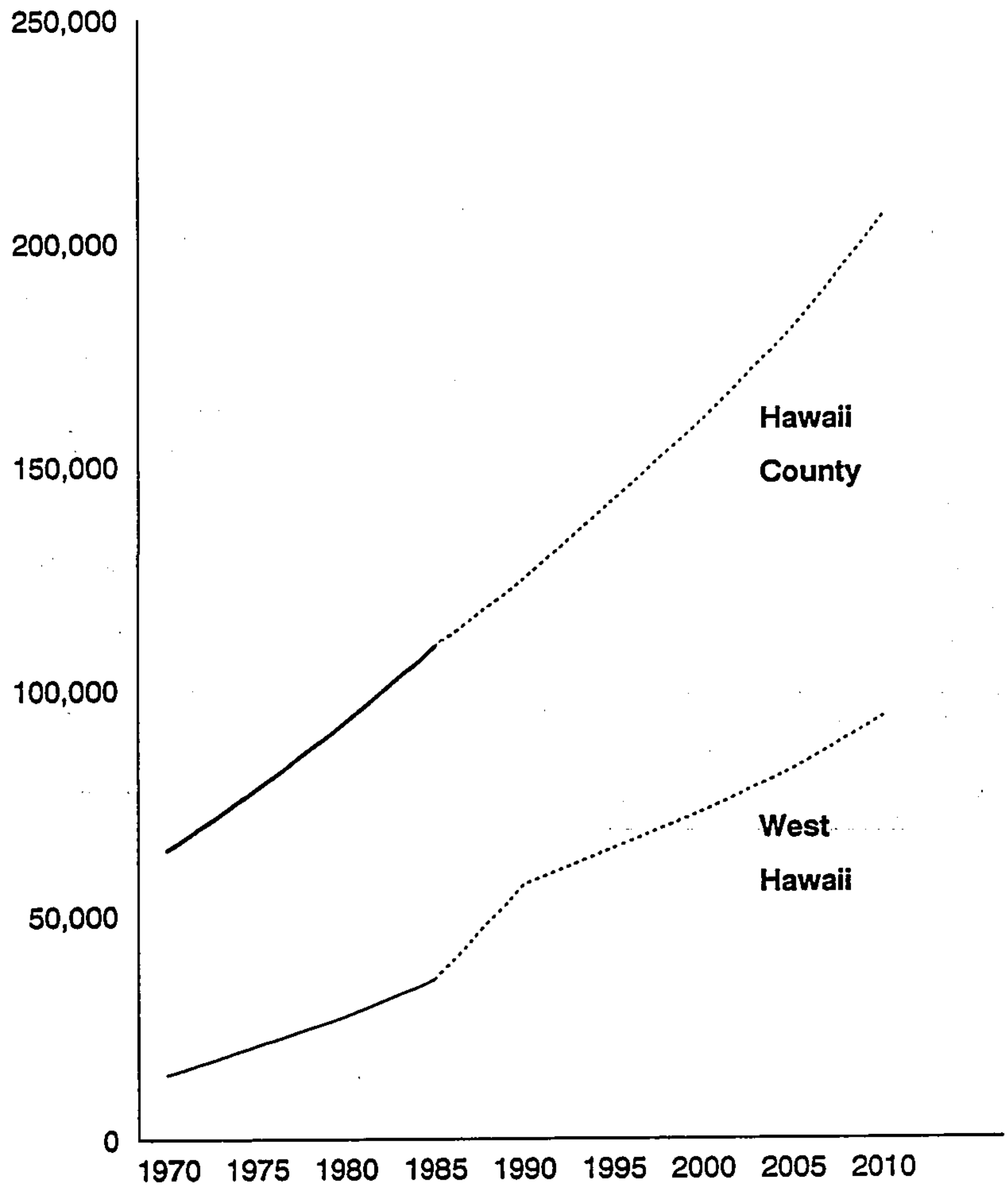
TABLE 4: OFFICIAL STATE POPULATION AND ECONOMIC PROJECTIONS FOR HAWAII COUNTY, 1990 - 2010

	1990	1995	2000	2005	2010
Resident Population	124,600	142,500	160,400	180,800	206,100
Average Daily Visitor Population	11,400	17,900	24,700	32,600	39,600
Civilian Jobs:	50,800	59,300	68,200	78,300	89,800
Jobs in Selected Industries: *	%	%	%	%	%
Agriculture	8.6%	7.5%	6.6%	5.8%	5.2%
Construction	3.7%	3.7%	3.7%	3.6%	3.6%
Trade (excluding eating/drinking)	16.9%	16.7%	16.8%	16.8%	16.7%
Eating and Drinking	8.8%	9.8%	10.7%	11.7%	12.5%
Banking, Finance	3.9%	3.7%	3.7%	3.8%	3.8%
Services	26.9%	28.7%	30.0%	30.9%	31.8%
-- Hotels	--12.1%	--12.4%	--12.5%	--12.7%	--12.8%
Government	18.8%	18.3%	18.0%	17.5%	17.1%
Personal Income (millions of 1982 dollars)	1,328	1,643	1,965	2,342	2,812
Per Capita Income (1982 dollars)	10,700	11,500	12,300	13,000	13,600

NOTE: * Percentages of wage and salary workforce (excluding tne self-employed).

SOURCE: Hawaii State Department of Business and Economic Development, 1988b.

FIGURE 3: HISTORICAL AND ANTICIPATED POPULATION TRENDS, HAWAII COUNTY, 1970 - 2010



SOURCES: Hawaii Department of Business and Economic Development, 1989; KPMG Peat Marwick, 1990.

- Resident population increasing by 75% over the estimated 1988 figure of 117,500, to reach 180,800 persons by the year 2005 and 206,100 by year 2010;

- The visitor count growing threefold, to reach 36,900 in 2010;

- An ongoing shift in the distribution of jobs, with fewer people working in agriculture and more in tourism (hotels, eating and drinking);

- Per capita personal income increasing by 40% from 1990 to 2010, to an average of $13,600 (1982 dollars).

West Hawaii Quantitative Trends: Projected massive growth in West Hawaii's visitor industry is expected to produce major increases in employment and population.

For example, the West Hawaii Regional Plan (Office of State Planning, 1989) estimated current West Hawaii "resort units" (hotel plus condominiums) at 7,429 -- a figure which would increase to 39,009 if all planned and proposed resort developments were to build out. (The report assumes the actual build-out figure by the year 2005 would be just 25,279 units, which is still nearly three and a half times the existing inventory.)

Unpublished projections made by the Hawaii County Planning Department in April 1989 assumed only slightly slower growth -- a total of about 26,000 visitor units (13,600 hotel rooms plus 12,400 resort condominiums) by the year 2010. More than 60% of these are assumed to be located in North Kona; most of the rest in South Kohala; and only a handful in South Kona or North Kohala.

In terms of population and employment, the State's M-K projections apply only to the county level. However, several other documents (all roughly compatible with the M-K projections at the countywide level) do give forecasts for West Hawaii in particular. These include:

(1) The Hawaii County Planning Department's General Plan contains three series of population and visitor industry projections. The lowest of these ("Series A," the current basis for County infrastructure planning) indicates a year 2005 countywide population of 173,000, slightly lower than the M-K figure of 180,800. Projected distribution of this total population is:

North Kona	43,250	25%
South Kona	10,899	6%
South Kohala	19,203	11%
North Kohala	5,363	3%
(West Hawaii Subtotal)	(78,715)	(46%)
South Hilo	44,115	26%
Puna	39,790	23%
Rest of East Hawaii	10,380	6%
COUNTY TOTAL	173,000	100%

Additionally, the County Planning Department's unpublished April 1989 projections anticipate that about 53% of the island's employment will be located in West Hawaii (primarily North Kona and South Kohala) by the year 2010.

(2) The Office of State Planning's West Hawaii Regional Plan also extends only to the year 2005. It projects a year 2005 countywide population of 170,400 and a West Hawaii population of 79,000 -- figures highly compatible with the General Plan "Series A" and preliminary draft M-K forecasts. The plan also assumes 25,900 new countywide jobs resulting from West Hawaii resort development, but does not attempt to predict what portion of these jobs will be in West Hawaii.

(3) The market assessment for the Kealakehe project (KPMG Peat Marwick, 1990) is based on the final M-K projections, with additional assumptions and projections for West Hawaii. It projects a slightly higher year 2005 West Hawaii resident population (82,300) than do the West Hawaii Regional Plan or the County Series A projections, but is otherwise consistent with them. That is, all three assume the West Hawaii population will, roughly, double by 2005.

Table 5 contains a summary of key assumptions and results from this market assessment.

Based on the M-K projections, current employment estimates, and the market assessment discussed above, Community Resources, Inc. (CRI) has developed some additional projections of future West Hawaii jobs and labor supply, for the years 2005 and 2020. These are shown in Table 6..

The CRI analysis results in a total projected West Hawaii jobcount of 37,700 for the year 2005 and 45,000 for 2010. New labor supply resulting from natural increase (excess of births over deaths) in the existing West Hawaii population -- as measured by two separate methods producing highly similar results -- would be able to fill only about 13% of the new jobs from now until 2005 and about 14% of the projected new jobs for the entire period until 2010. If there is no increase in commuting from

TABLE 5: PROJECTED WEST HAWAII SOCIAL AND ECONOMIC TRENDS

	1990	1995	2000	2005	2010
Resident Population					
North Kona	31,200	35,600	40,100	45,200	51,500
South Kona	7,800	9,000	10,100	11,400	13,000
North Kohala	3,900	4,400	5,000	5,600	6,400
South Kohala	13,800	15,800	17,800	20,100	22,900
West Hawaii Total	56,700	64,800	73,000	82,300	93,800
West Hawaii Share of County Resid. Population	45.5%	45.5%	45.5%	45.5%	45.5%
Projected New Visitor Units (Cumulative)					
Hotel	0	5,700	9,085	9,085	9,785
Condo	230	2,010	4,110	5,990	6,470
New Direct Jobs From Visitor Unit Development in Hawaii County (Cumulative) (1)	50	7,470	12,050	16,130	17,080
New Indirect and Induced Jobs From Visitor Unit Development in Hawaii County (Cumulative) (2)	20	2,800	4,520	6,050	6,410
Total New Hawaii County Jobs Attributable to Visitor Unit Development	70	10,270	16,570	22,180	23,490
Persons per Housing Unit, Hawaii County	2.8	2.8	2.75	2.75	2.7
Cumulative Housing Demand (3)					
North Kona	800	2,920	5,800	9,130	13,680
South Kona	840	1,210	1,720	2,210	2,870
North Kohala	190	370	630	850	1,160
South Kohala	500	1,540	3,020	4,830	7,440
West Hawaii Total	2,330	6,040	11,170	17,020	25,150

NOTES:

(1) Approximately 90% of all direct jobs estimated to be located in Hawaii County.

(2) Approximately 40% of indirect/induced jobs estimated to be located in Hawaii County.

(3) Baseline for estimation is 1987 County Planning Department inventory (14,094 units in West Hawaii).

SOURCE: KPMG Peat Marwick, 1990.

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY

SEE FRAME(S)

IMMEDIATELY FOLLOWING

TABLE 5: PROJECTED WEST HAWAII SOCIAL AND ECONOMIC TRENDS

	1990	1995	2000	2005	2010
Resident Population					
North Kona	31,200	35,600	40,100	45,200	51,500
South Kona	7,800	9,000	10,100	11,400	13,000
North Kohala	3,900	4,400	5,000	5,600	6,400
South Kohala	13,800	15,800	17,800	20,100	22,900
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West Hawaii Share of County Resid. Population	45.5%	45.5%	45.5%	45.5%	45.5%
Projected New Visitor Units (Cumulative)					
Hotel	0	5,700	9,085	9,085	9,785
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NOTES:
(1) Approximately 90% of all direct jobs estimated to be located in Hawaii County.
(2) Approximately 40% of indirect/induced jobs estimated to be located in Hawaii County.
(3) Baseline for estimation is 1987 County Planning Department inventory (14,094 units in West Hawaii).

SOURCE: KPMG Peat Marwick, 1990.

TABLE 6: NATURAL GROWTH AND IN-MIGRATION OF LABOR FOR WEST HAWAII, 1988-2010

	1988	2005	2010	Projected 1988-2005 Change	2006-2010 Change	1988-2010 Change
Natural Increase in West Hawaii Population Projected by:						
Growth Rate Trend Model (1)	40,700	48,201	50,660	7,500	2,500	10,000
Age-Cohort Model (2)	40,700	50,055	51,657	9,400	1,600	11,000
Average of Methods	40,700	49,100	51,200	8,400	2,100	10,500
Hawaii County Civilian Jobs (3)	54,600	78,300	89,800	23,700	11,500	35,200
Civilian Jobs Located in West Hawaii (4)	20,000	37,700	45,000	17,700	7,300	25,000
Required Labor Force (at 0.9525 workers/job, 5% unemployment, as per M-K assumptions)	20,100	37,800	45,100	17,700	7,300	25,000
Natural Increase in Labor Force in West Hawaii (5)	19,100	21,400	22,500	2,300	1,100	3,400
Assumed Net In-Commuters	1,000	1,000	1,000	0	0	0
Required Net In-Migrant Labor	0	15,400	21,600	15,400	6,200	21,600
Percentage of Total New West Hawaii Jobs Filled by:						
-- Natural Increase, 1988 Population				13.0%	15.1%	13.6%
-- Net In-Migration				87.0%	84.9%	86.4%

NOTES:

(1) Natural growth rate of 10 per 1000 persons characteristic of West Hawaii trends, 1980-88.

(2) CRI Age-Cohort Model, December 1989.

(3) 2005 and 2010 figures from M-K Series projections; 1988 figure estimated from DLIR data on employed workforce.

(4) Figure for 1988 is CRI estimate, adjusting DLIR figures for actual growth. Future years based on projected West Hawaii share of county population: 48% for 2005; 50% for 2010 (KPMG Peat Marwick, 1990).

(5) Based on natural increase in population and using a labor force per 1,000 population rate of 43.5% for 2005 and 44% for 2010 (from M-K projections).

These figures may somewhat overestimate the amount of net in-migrant labor required. The M-K County projections assume much lower labor force participation rates for Hawaii County than for other counties. If the 2005 participation rate for the Big Island matches that projected by the M-K model for Maui, the proportion of new jobs to be filled by net in-migrants would drop from 87% to 60%.

East Hawaii, the remaining 86% of new jobs would have to be filled by net in-migration (that is, more people moving into West Hawaii than moving away) and by children born to in-migrants.

As the table notes, however, the actual proportion of jobs going to net in-migrants may be somewhat lower, perhaps only 60% by 2005. That is because the analysis is based primarily on M-K assumptions for Hawaii County, and these assumptions include very low rates of labor force participation compared to other counties. If existing residents and their children absorb more jobs, fewer in-migrants will be needed.

The analysis deals with a long period, and does not distinguish recent in-migrants from ones who have lived in the area for decades. If in-migrants come to take West Hawaii jobs at a constant pace, recent in-migrants, who have lived 5 years or less in West Hawaii, could account for only about 12% of the 2005 workforce, and 11% of the 2010 workforce -- a <u>lower</u> percentage of in-migrants to West Hawaii than 1980 Census figures (for all people aged 5 and older) and 1983 West Hawaii survey responses (Hawaii Opinion, 1983) indicate for recent years. (See Table 5.)

Qualitative Changes in West Hawaii: The social impacts of the preceding quantitative changes will depend in large part on (1) geographical distribution of growth; (2) location and timeliness of development of infrastructure (including housing); and (3) characteristics of in-migrant workers.

> <u>Geographical Distribution of Growth:</u> This is still being determined through the government land use process, but several documents provide indications of broad policies. First, both the County and market assessment projected distributions of population indicate that West Hawaii growth will be concentrated primarily in North Kona and secondarily in South Kohala. Second, the <u>West Hawaii Regional Plan</u> calls for development of a major new support community in Kealakehe -- for the present project, in effect -- as well as South Kohala development at Waikoloa, Lalamilo, and Kawaihae. Third, the Hawaii County Planning Department's <u>Draft Keahole to Kailua Development Plan</u> (focusing only on North Kona from Palani Road to the airport) envisions four new "residential villages," separated by greenbelts, at Kealakehe and points north, substantially mauka of the Queen Kaahumanu Highway. An open space greenbelt would separate the new residential areas from Kailua Village.
>
> The foregoing addresses distribution of residential growth only. The <u>West Hawaii Regional Plan</u> calls for resort development to be distributed among various coastal "nodes" -- two in North Kona (Keahole-Keauhou and Kaupulehu-Kukio) and two in South Kohala (Mauna Kea and Waikoloa-Mauna Lani). This is roughly consistent with County General Plan designations.

The Draft Keahole to Kailua Development Plan suggests that a 100 acre Regional Center could be sited makai of the Queen Kaahumanu Highway, on the State's Kealakehe lands. The Queen Liliuokalani Trust is proposing its Keahuolu lands as a location for a Regional Center, including a 30 acre civic center. HFDC includes a 30 acre civic center on County owned land adjacent to the Kealakehe landfill and encompassing the existing police sub station.

Infrastructure Development (location and timeliness) is the second major qualitative determinant of West Hawaii's future. As discussed above in the section on resident issues and concerns, congested highways are already major sources of unhappiness in the Kona area, contributing to a sense of declining quality of life despite economic advances. The magnitude of growth now being planned for West Hawaii could intensify these social impacts, unless solutions are found.

Both the State and County governments are currently in the process of exploring various mechanisms (impact fees, taxing authority, etc.) to assure that physical and social infrastructure development no longer lags far behind population growth in the future. For purposes of this impact assessment, it must be assumed that some solution to the timeliness problems will be found; otherwise, the projected growth is unlikely to occur.

State and County planners are currently debating new North Kona road alignments. One aspect of the Draft Keahole to Kailua Development Plan is a new shoreline road from Honokohau Harbor to Kailua Village. The plan also calls for a new mid-level roadway mauka of the Queen Kaahumanu Highway. road, each to loop mauka of the present roads.

Both State and County agencies are drilling for water at present, and the County plans to develop three new wells in 1990. A new reservoir is planned at the 325 foot elevation on the Kealakehe property, near the northern property boundary.

Bids for a new County landfill were opened in April, 1990, and use of the landfill could begin after about a year's construction work. However, a lawsuit challenging the project's EIS could affect scheduling drastically.

The County's Kealakehe Sewage Treatment Plant is expected to be completed by February 1992. Connections to the plant could be finished in another year. That facility is expected to serve Kailua Village and areas to the south. Plans are under discussions for expansion of the Kealakehe Sewage Treatment Plant to serve major new residential populations.

Characteristics of New In-Migrant Population comprise the third major determinant of social impacts from future West Hawaii growth. Two components may be identified:

- Relatively affluent retirees and second-home owners could widen the gap between "have's" and "have-not's" in West Hawaii, although they may also contribute to local charities and cultural facilities (as has recently occurred in Maui).

  The West Hawaii Regional Plan estimates that under ten percent of resort-induced population growth will be on-site resort residents, whose isolation from the general community would probably reduce any impacts, positive or negative. Undetermined, however, is the likely future number or geographic distribution of off-resort wealthy in-migrants, who would have more direct impacts on residential real estate values and the fabric of community life.

- In-migrant workers and their children (who may be West Hawaii-born), as earlier noted, will be required to fill anywhere from 60% to 90% of new West Hawaii jobs. The question remains as to where these in-migrant workers will come from. Two deliberately extreme scenarios illustrate the range of possible futures:

  -- All future in-migrants are from the Mainland. The ethnic distribution in West Hawaii would probably be concentrated even more heavily among Caucasians. Since previously discussed projections assume that West Hawaii residents will comprise a majority of the Big Island population in about 20 years, the socio-political impacts could be islandwide. As noted below, the M-K forecasts also imply some eventual net in-migration to East Hawaii, but a much lower level. Thus, it may be expected that differences in values and lifestyles between East and West Hawaii residents would grow even greater.

  -- All future in-migrants are from Hawaii. This would substantially mitigate some of the social impacts of rapid population growth.

  However, the methods used for the labor supply analysis in Table 9 would also indicate that projected new jobs in East Hawaii -- while fewer than in West Hawaii -- will (1) absorb all or most of natural increase in labor supply through 2005, and (2) require net in-migration to East Hawaii after 2005.

  Thus, any future "Hawaii in-migrants only" scenario must assume substantial migration from Oahu to both

West Hawaii and also the rest of the Big Island. The M-K model projects future Oahu job growth at a rate slightly less than observed natural population increase during the 1980's, so there is the possibility of some surplus labor from Oahu. However, it must be recognized that the three Neighbor Island counties would be in competition for any Oahu surplus, since the State M-K model estimates that 50% to 60% of the <u>statewide</u> population growth by 2010 will be due to net in-migration from outside Hawaii.

In reality, West Hawaii in-migrant workers will probably come from a variety of locations, including as well as some returning former Hawaii residents, foreign nationals, refugees, Pacific Islanders, and non-Caucasian Mainlanders. (In fact, deliberately imported laborers to Neighbor Islands in recent months have included Micronesian and Mexican-American agricultural workers.) And, while not desired, setbacks in other parts of the economy -- such as sugar in East Hawaii or military-related employment on Oahu -- could also provide additional labor supply for West Hawaii.

In short, the exact composition of the in-migrant workforce cannot be predicted at present. It may, however, be safely predicted that the projected growth levels imply some types of very major shifts in the Big Island's overall population composition over the next 15 to 30 years.

3.0 COMMUNITY ISSUES AND CONCERNS

This section documents contemporary community issues and concerns of direct or indirect relevance to the proposed project:

- o Background issues independent of the project, but which may affect both community response and actual social impacts;

- o Project-specific preliminary concerns raised by some 88 community leaders interviewed for this study.

3.1 METHODS

Conclusions in this section are based on:

(1) Secondary data such as community surveys or published newspaper articles;

(2) Original community interviews conducted for this study (primarily in the North Kona area).

Most of the community interviews actually involved response to two separate but adjacent projects: the State's proposed Kealakehe housing development to the north and the proposal for a regional urban center at Keahuolu, to the south. Because portions of these two projects are adjacent and because CRI was separately contracted to conduct social impact assessments for both, the two clients (the State Housing and Finance Development Corporation for Kealakehe, and the Queen Liliuckalani Trust (QLT) for Keahuolu) agreed to the simultaneous community interview process.

Appendix A lists the 88 "key informants" who were interviewed. These individuals were selected on the basis of knowledge of the community and/or being tentatively identified as belonging to some potentially affected interest group such as nearby residents, business operators, Hawaiians and community leaders. Appendix A lists organizational affiliations in order to indicate some of the networks or interests of those interviewed. However, informants spoke as individuals and not as representatives of their organizations.

The purpose of the interviews, conducted in October and November 1989, was to identify <u>major community issues and concerns</u> (on a preliminary basis, since many planning details for both projects had yet to be finalized). It was not a random public opinion survey, and no attempt was made to measure the extent of project support or opposition.

Interviews were loosely structured, usually beginning with questions about background issues and them moving to the specifics of the two projects (to the the extent they were known at the time). Informants were told that overall input would be summarized in the social impact reports for the two EIS's, but that individual comments would remain confidential.

3.2 BACKGROUND ISSUES INDEPENDENT OF PROJECT

3.2.1 <u>Information from Surveys and Other Secondary Sources</u>

The most recent community survey shedding light on major issues in West Hawaii was the State Tourism Impact Management System (TIMS) study conducted in latter 1988. Preliminary results shown in Table 7 indicate that:

- <u>Lack of affordable housing</u> was the top issue throughout the island, but was ranked even more highly in West Hawaii -- and particularly in North Kona, where 76% said it was a "big problem" for that part of the island.

- <u>Cost of food/clothing</u> and <u>traffic congestion</u> were the next most important North Kona issues, rated as "big problems" by nearly 60%.

  For virtually all the issues on the list (except lack of jobs or urban amenities), North Kona residents were more likely than people elsewhere on the island to feel there was a serious problem. However, the gap was particularly large for <u>traffic</u>. The proportion of North Kona residents saying this was a "big problem" was twice as much as the rate for the island as a whole.

- <u>Lack of sports/recreation facilities</u> was also counted as a major problem by more than 50% of both North Kona and South Kona/Ka'u residents. This was of much less concern in areas such as Kohala or East Hawaii, where plantations and large ranches built gymnasiums and playing fields in earlier years.

- <u>Environmental and/or crowding concerns</u> (rapid population growth, crowded parks, destruction of natural beauty, pollution) were counted as "big problems" by more than a third of North Kona residents -- higher than in most other parts of the island.

- <u>Overall quality of life</u> was felt to have grown worse over the past five years by about a third of North Kona residents -- compared to only 18% islandwide. (However, 36% of North Kona residents felt it had grown better.

TABLE 7: GENERAL COMMUNITY ISSUES AND ATTITUDES, PRELIMINARY 1988 SURVEY RESULTS

		North Kona	N. & S. Kohala	S. Kona Ka'u	Hawaii County
COMMUNITY ISSUES -- %'S RATED "BIG PROBLEM IN YOUR PART OF ISLAND"					
Cost of housing		76%	60%	63%	48%
Cost of food and clothing		58%	41%	57%	44%
Traffic		56%	16%	32%	28%
Not enough sports and recreation facilities		52%	22%	52%	33%
Population growing too fast		43%	31%	29%	22%
Beauty of area being destroyed by development		38%	27%	29%	20%
Pollution of oceans or natural areas		34%	24%	20%	26%
Crowded beach parks		34%	22%	23%	21%
Crime		22%	7%	22%	22%
Lack of nearby jobs		18%	26%	46%	33%
Not enough nearby stores, restaurants, entertain.		12%	22%	24%	18%
Problems between people of different backgrounds		10%	4%	14%	7%
Too many tourists		8%	2%	10%	4%
QUALITY OF LIFE "IN THIS PART OF THE ISLAND" VS. FIVE YEARS AGO					
Today is ...	Better	36%	39%	37%	35%
	Worse	32%	15%	18%	18%
	Same	29%	43%	41%	45%
	Not Sure	3%	4%	4%	2%
TOURISM GROWTH -- %'S AGREEING WITH VARIOUS STATEMENTS					
In my part of the island, it's more important to keep things like they are than to have more tourism jobs.		56%	56%	63%	53%
It is time to stop building new hotels on this island.		54%	49%	53%	48%
We need more tourism jobs on this island.		44%	50%	53%	57%
Survey Base:		168	152	155	789

SOURCE: Hawaii State Department of Business and Economic Development, Tourism Branch, 1989. (Preliminary Results)

Statewide, North Kona was the only heavily resort-impacted area in which a few more people felt life had grown "better" rather than "worse." By comparison, in West Maui 63% said "worse" vs. just 16% "better.")

- o Negative attitudes toward further tourism growth were prevalent throughout the island (and the state), but even more so in West Hawaii than elsewhere in Hawaii County. Statewide preliminary TIMS results indicate such attitudes largely reflect growth-related problems.

Both the TIMS survey and a recent study by the University of Hawaii School of Social Work (Matsuoka et. al., 1988) found that most Kona respondents thought tourism impacts to date had been, on balance, very positive because of the economic benefits. There were, however, strong concerns about continued growth.

The UH Social Work study -- which focused on particular groups rather than the Kona population at large -- also found significant attitudinal differences between business/developer interests on the one hand and environmentalists or human service professionals on the other hand. Longtime Kona residents engaged in farming or fishing were neither as negative as the environmentalists and social workers nor as positive as the business/developer group.

Surveys such as the TIMS study indicate broad background issues for entire populations. Specific controversies may involve a more limited group of people not necessarily representative of the entire population, but these individualized issues are often related to the more general themes.

A review of major Big Island publications (particularly the newspapers West Hawaii Today and the Hawaii Tribune-Herald) indicate a great variety of such issues and controversies relating to the North Kona area. A sampling from the latter part of 1989 would include:

- o Plans for a commercial rocket launching facility in Ka'u produced strong public reaction in Kona. Some residents expressed concern with impacts on air quality, and consequently health, plant life, and the visitor industry. Another issue was the possibility of the island becoming a military target.

- o A proposal to build a gymnasium on the State-managed part of the Old Airport Park and the subsequent decision by the County to build it on the County-leased section of the park were debated. Many thought that accessible sports facilities are much needed, and the Old Airport Park is a good site for these. Others thought the Park should remain dedicated to passive uses.

- The police in the Kona Station have complained that fumes from the adjacent dump enter the station and affect their health. (Community interviewees cited this as an example of poor government planning in Kona. See Sections 3.2.2 and 3.3.)

- The County review of the ohana zoning law responded to complaints in Kona that developers were creating double density, residential condominiums. Residents were concerned that developers are able to sell many extra units, straining the infrastructure.

  (Earlier, County officials were concerned that real estate professionals were raising land prices by obtaining ohana permits for lots. Also, they viewed ohana units as interfering with the planning process, since such units are constructed at the will of the individual homeowner (Jaworowski, 1988).)

3.2.2 Information from Community Interviews for This Study

As previously discussed, community interviews for this study included questions about issues and concerns independent of (although potentially related to) the proposed Kealakehe project.

The major issues emerging from these interviews were all generally linked to rapid growth and its control or management. They can be classified into three broad categories:

- Physical planning and infrastructure;
- Social infrastructure; and
- Socio-political concerns.

Physical Planning and Infrastructure

(1) General Patterns of Future Growth: County and State planning efforts have focused community attention on broad questions about patterns of future urbanization. There were different views about how Kona should grow, but most people seemed to feel that Kailua and areas north to the airport would be and/or should be a major focus of growth. There was a feeling that past growth around Kailua has been unplanned and haphazard.

(2) Preserving Coastal Areas for Public Use: A frequent theme during interviews was opposition to any substantial private development of coastal areas (whether sand beach or lava cliffs) north of Kailua.

(3) Traffic and Transportation Planning: A number of people suggested that traffic congestion is now the Number One problem in the Kailua area. Palani Road was felt to be particularly overburdened, and it was predicted that "people would start shooting" if there were any disruption to or further crowding of Palani Road.

Informants had many suggested solutions, including new roads in various locations, bike lanes, and public transportation. However, there was sharp disagreement between those who felt public buses were badly needed for the elderly and/or school children and those who said public transportation would surely fail because of Kona residents' love affair with automobiles.

(4) Water and Sewer Capacity: In addition to recognizing the key role of such infrastructure in guiding future growth, many informants expressed concern about the true extent of water resources -- either total capacity or government resources for maintenance and delivery. There were concerns about water contamination (or simple poor taste) from development-caused runoff.

Social Infrastructure

(1) Lack of Affordable Housing remains among the most pressing of Kona concerns. Community informants report that costs continue to escalate for both fee-simple and rentals, with some people in the real estate field claiming that rentals have as much as doubled in some areas during the last year alone.

Residents reportedly cope with the housing crisis primarily by taking extra jobs to earn more money, illegal rentals (e.g., converted garages or partitioned houses), and/or sharing housing units with other families. Crowded housing conditions, worker exhaustion, and increased physical and mental health problems were seen as more prevalent due to the situation. Some believed that social ills such as child abuse and incest are also more likely under these conditions.

(2) Lack of Child Care and/or Youth Recreational Opportunities: There are few child care centers for infants or preschoolers, although the demand is rising because of the increasing numbers of families in which all parents must work. Older children have few after-school recreational programs, in part due to the lack of gymnasiums and playing fields in the Kona area.

(3) Social Service Overload was reported by government caseworkers and administrators who cannot find additional staff to deal with the previously described problems. Educators said that most Kona schools are overcrowded.

Socio-Political Issues

(1) Lifestyle: The transition from an agricultural to a service economy -- coupled with strains from rapid growth -- has resulted in a split between older retirees with the resources for a leisurely life and younger families who must work long hours in relatively low-paying jobs.

Many informants felt that Kona no longer has the "slow-paced" lifestyle which was once central to its charm.

(2) Perceived Risks and Disadvantages of a Tourism Economy: Many residents who are not in the visitor industry commented that the industry provides "dead-end jobs." they were concerned that the economy provides only limited opportunities for West Hawaii's young people. They thought service sector wages so low that many employees have to take second jobs to meet their needs, and live in fear of lay-offs. Some saw resort workers as lacking pride in their jobs. One social service professional even thought young adults in the visitor industry likely to suffer from personal and financial instability, and to experience little joy or hope for the future.

(3) Lack of Community Cohesion: Kona residents often characterize themselves as socially fragmented and contentious. They feel there is no single cohesive "core community," but a series of disconnected groups divided by geography, ethnicity, income, or age. Residents of the "mauka communities" south of Kailua are sometimes seen as more cohesive due to longer years in the community and some shared institutions (clubs, churches, etc.), but these residents constitute a smaller portion of the population as time goes by.

A few of those interviewed expressed optimism that Kona is pulling itself together through efforts such as the new "Greater Kona Community Council."

(4) Government Credibility: A number of informants were frankly suspicious of both State and County government. They questioned government's competence, integrity, and the ability of the State and County to work effectively with one another. The wisdom and effectiveness of recent government planning decisions were held in particular question.

Some longtime Kona residents felt that newcomers can be impatient with the lack of government services, not understanding the economic and logistical difficulties of service delivery to relatively small populations spread out over large distances. However, some people felt government officials "just don't like Kona people" for cultural or political purposes, and deliberately withhold quality service for such reasons.

(5) Queen Liliuokalani Trust Performance: Private organizations, as well as government agencies, were evaluated critically by citizens. Questions were raised during interviews concerning the Queen Liliuokalani Trust, since it is the owner of the Keahuolu Lands slated for development as a new urban center.

3.2.3 Public Responses to Planning Efforts for West Hawaii

Planning for growth in West Hawaii has been undertaken by State and County planning agencies. Also, the proposals for development of Kona lands by the State's Housing Finance Development Corporation and the Queen Liliuokalani Trust are responsive to anticipated growth, and amount to plans to manage some of the potential impacts of such growth. West Hawaii residents have responded with interest and concern:

(1) The State's Office of State Planning prepared a West Hawaii Regional Plan during 1988 and 1989.

At an August 1988 public meeting on the Regional Plan in Kona, one resident expressed concern that the designation of four resort "nodes" for all future West Hawaii resort developments excluded other possible sites. Questions were also asked about the adoption of a State impact fee schedule for developers (Flickinger, 1988).

(2) During 1989, Kona residents were also invited to comment on the County's Kailua to Keahole Plan, which identifies separate industrial, commercial, and residential areas for anticipated growth over the next 20 years. Public concerns raised at meetings in March and December 1989 centered on the site of a University of Hawaii campus, impacts on Kailua Village, and the possibly conflicting plans proposed by major area landowners (Flickinger, December 1989).

(3) The Kealakehe development was first announced by the County in 1986, and was discussed in the Hawaii County Council in 1987. West Hawaii residents in general first commented on then-current plans for Kealakehe at a hearing of the Housing Committees of the State House and Senate in February 1989. Kona residents objected strongly to plans to sell makai lands in order to finance affordable housing mauka of the highway. (NOTE: Those plans are not part of the current Kealakehe project.) Residents felt the sale would block future public use of the coastal area. Some also objected to the purchase of land by the State (from the Queen Liliuokalani Trust) when it is already a major area landowner (Flickinger, March 1989; Perez, 1989).

The next public response to the Kealakehe project came in September 1989, when the HFDC presented preliminary conceptual plans for 840 acres of mauka land. Residents raised concerns about increased traffic on Palani Road and suggested the early construction of a mauka-makai road through Kealakehe (Flickinger, September 1989).

3.3 COMMUNITY ISSUES AND CONCERNS WITH REGARD TO CURRENT PROJECT

Table 8 summarizes the issues raised in the interviews. The following text first provides a general overview of residents' concerns, followed by more detailed discussion of individual issues and concerns.

3.3.1 Overview

Kona interviewees welcomed the Kealakehe project as the first major effort to address the area's need for affordable housing. Still, they were concerned that such a solution might further aggravate current problems with traffic congestion and other infrastructure.

Kona residents identified housing as a critical problem that had grown much more severe in the past two years. They felt the demand for houses in the proposed project would be strong since there are now so few units that the average Kona family can buy or rent.

The interviewees pointed out that the project's location would mean more traffic on Palani Road, a road they depend on greatly but they consider to be unsafe and a major traffic bottleneck.

More than anything else, the interviewees wanted to see all of the project's infrastructure in place before anyone moved into the project. They felt this would minimize traffic congestion and strain on water and sewer lines.

Kona residents identified several current social concerns in their area. They thought these could be either magnified or alleviated in the new Kealakehe community. They felt that if those problems were addressed in the planning and design of the project, then the new neighborhood would serve as a model community for the entire West Hawaii region. The Kealakehe project would, they hoped, respond to needs for affordable housing, recreational facilities, transportation, and child care, without straining the limited means of community residents.

Most of those interviewed said they hoped the proposed housing would be available to the average Kona resort workers and others who currently have little chance of owning a home. People wondered if the housing would actually be priced in a range affordable for young Kona families.

The interviewees clearly wanted the development to be attractive and a source of pride to its residents. They suggested

TABLE 8: COMMUNITY ISSUES AND CONCERNS RELATED TO THE PROJECT

Primary	Secondary	Occasional
Kealakehe as a Constructive Response to West Hawaii Social Problems		
Housing		
Approval for first effort to address affordable housing shortage in Kona	Size and density of project hard to visualize; number of homes and people is unnerving	
Infrastructure		
Must install roads and utilities before new residents move in (to reduce impact on Palani Road and sewer, water, and electrical services)	Infrastructure considered fragile and threatened	Suggestion for reducing traffic impacts -- no access to Palani Road, or more traffic signals at Kealakehe intersections
Major concern with the impact of additional traffic on Palani Road		
Public Transportation and Pedestrian Access		
	Students and resort workers could benefit the most from public transportation	New neighborhoods should have sidewalks and pedestrian access to adjacent commercial areas
Recreational Facilities		
Need for passive park space, playgrounds, shade trees, grass, picnic areas and good maintenance	After school, supervised recreational activities would reduce hours children are unsupervised	Need for a place for meetings and social gatherings
Need active recreational facilities, gym, pool, fields, courts, and supervised activities		
Parental Supervision		
Shortage of child care options, particularly affordable programs	New neighborhood must encourage or provide a range of services	
Schools		
High school should be built now to end students' long commute		Overcrowding of schools affects the quality of education

(Continued)

TABLE 8 (Cont.)

Primary	Secondary	Occasional
Project Characteristics and Organization		
Who will live in the community?		
Preference should go to Kona families, resort workers, and first-time home buyers	If housing is expensive, Yuppies and Mainland U.S. retirees will live there	Housing could attract needed resort and other skilled professional workers, in-migrants could come from other Big Island districts or Honolulu
Will average resort worker be able to afford new Kealakehe homes? Will it be a bedroom community for West Hawaii resort workers?	A community of resort workers could mean additional social service requirements	Additional social service need could further strain an already overburdened system
Governance		
Must have strong community associations to enforce strict community standards		Would like project developer to be sensitive to community needs
Financing		
Must assist first time home buyers with a variety of financing methods	Needs a system to qualify buyers that considers uniqueness of the local economy, low wages, tip income, and seasonal layoffs	To reduce costs, houses could be leasehold with buy back and shared appreciation provisions
Owner-occupants desired; no private profit from investment in or sublets of affordable units; rules establishing buyback provisions and a State share in appreciation		
Design		
An attractive project is desired with open space and room between the units	Housing should not all look alike and should have a range of products for large families, renters and the elderly	
Must integrate housing of difference prices, not isolate the lowest cost housing		

(Continued)

TABLE 8 (Cont.)

Primary	Secondary	Occasional
Concerns about Nearby Areas		
Opposition to development of Kealakehe parcel makai of the Queen Kaahumanu Highway	Opposition to the State's purchase of land from the Queen Liliuokalani Trust	A municipal golf course is needed and it serves as an attraction for selling homes
	Concern about the possibility of more traffic and crime in the area, making it less desirable	Multifamily housing becomes more desirable with proximity to new houses and a commercial area
		Concern that single family housing could be less desirable if project isn't attractive or well maintained
		Honokohau Harbor use will increase, compounding traffic problems at the Harbor entrance

NOTE: Issues and concerns listed as "PRIMARY" were mentioned more frequently than comments about the same topics listed under the other two headings. The number of comments on each of the three general topics and on particular issues differed. Topics and issues listed first in this table were more often mentioned than subsequent topics and issues. Again, "SECONDARY" comments were more frequent than "OCCASIONAL" ones on a given issue, but less frequent than "PRIMARY" comments.

financing methods to enable average working families to buy homes. They felt the area could remain desirable if strong community associations enforced housing standards. Many commented on lot sizes, setbacks, the mix of houses in the community. and the overall layout of the project. Most wanted the project to include recreational facilities.

Kona people raised concerns about the relation of the Kealakehe project to surrounding areas. First, some residents expressed very strong concern regarding possible future uses of the State's property makai of the Queen Kaahumanu Highway. (That property is not part of the present project.) Some suggested that the golf course be located makai of the Highway, to block other uses of that area. Others were divided in their views of the most appropriate site for the proposed municipal golf course. Next, several persons were concerned about impacts of the project on nearby residential areas and on Honokohau Harbor.

3.3.2 Kealakehe as a Constructive Response to Kona's Problems

Most of those interviewed discussed the Kealakehe project in terms of what they saw as Kona's social problems.

Most interviewees thought that project design and provision of needed services could minimize or avoid social problems in the new neighborhoods. They suggested what they wanted to see in the new Kealakehe community with the hope that the new neighborhoods could show West Hawaii ways to address social problems. On the other hand, some predicted that, if the future residents of Kealakehe were predominantly young, less affluent and employed in resorts, then existing problems would probably intensify in the new neighborhoods.

Lack of affordable housing was identified as one of Kona's most pressing problems. The Kealakehe project was seen as a much needed solution to the housing problem. They went on to comment:

- The plans were described by some as "wonderful" and "giving our children a chance".
- Most people, including current Kealakehe residents, thought the location was good and in keeping with general growth patterns.
- Some interviewees commented that the project could help people move out of crowded lodgings and give working people a chance to own their own homes.
- However, most people had a hard time visualizing a 3,000- to 4,000-unit subdivision. Many remarked they "didn't want to see another Honolulu."

- A few people raised the possibility that future growth in Kona would be so great that Kealakehe would not be able to meet the demand for affordable housing.

- Current Kealakehe residents and a smaller number of others said the plans involved so many people that it scared them. They felt that if so many people were expected to live close together, social problems such as crime and noise would increase.

Kona residents were unanimous in expressing concerns about the project's possible impact on the area's <u>infrastructure</u>, particularly traffic:

- Many insisted that the project's infrastructure should be put in before project residents moved in. They sought to minimize congestion on Palani Road during construction and to make sure developers would not "run out of money" and leave existing systems more burdened.

- Residents described their infrastructure as "life threatening" when emergency vehicles are stuck in traffic, "fragile," and "like in a third world country."

- Increased traffic on Palani Road was a major concern of Kona residents. They felt the proposed mauka-makai road in the project area would not fully mitigate the additional pressure on Palani Road.

- Residents' suggestions for mitigating measures ranged from allowing no project access to Palani Road to placing traffic signals at the Kealakehe intersections with Palani Road.

- A few people doubted that the infrastructure could ever keep pace with the growth in the area. They questioned the County's capacity to meet rising demand.

The <u>lack of public transportation and pedestrians' needs</u> in Kona were often mentioned after discussions of the bad traffic situation. People felt young people were greatly disadvantaged by the total reliance on private cars.

- Some thought that mass transit would be of value to students and to resort workers. (Another viewpoint was that mass transportation cannot work in Kona, as people are too attached to their automobiles.)

- Many interviewees said the new Kealakehe neighborhood should have sidewalks, pathways, and pedestrian access from Kealakehe to the commercial development proposed on the adjacent Queen Liliuokalani Trust property -- encouraging residents to depend less on their automobiles.

Kona people, regardless of age or occupation, mentioned the need for playgrounds and other recreational facilities. Several mentioned that the only real playground was at the McDonald's restaurant, and so most children now play in the streets.

- Most wanted the Kealakehe project to have passive parks, with grass, shade trees, and picnic areas that are well maintained and close to residential areas.
- Some residents also saw a need for more active recreational facilities such as a gymnasium and swimming pool in the Kealakehe project. A frequent comment was that they would like to have "eveything that Hilo has."
- Several suggested that the facilities should have supervised activities for children to reduce the afterschool hours they spend alone.
- A smaller group of people mentioned a need for a community center for meetings and social gatherings.

In a resort economy, with round the clock work shifts, many children have little parental supervision. School personnel noted that many children were alone during afterschool hours or during vacation and sick days. They felt those children were more likely to have academic and behavioral problems.

- Generally, people felt there was shortage of child care options, particularly affordable services.
- They felt the new Kealakehe neighborhoods should provide or encourage child care services ranging from babysitting to summer programs in the schools.

People also expressed a more generalized fear that Kona youth are being locked out of economic opportunities in the area. Businessmen and educators observed that the young people who go away to college rarely return, and those who remain have few job opportunities. Interviewees were aware of the need for a high school and another elementary school in Kealakehe.

- Many would like the schools built right away so Kealakehe area high school students will not have to spend so much time commuting to Konawaena High School.

- Residents who work in the Kealakehe elementary and intermediate schools said these are currently overcrowded. The crowding makes regular classrooms a priority, so these schools cannot have specialized facilities, such as music rooms,.

3.3.3 Project Characteristics and Organization

Project Residents: Most of those interviewed showed concern and uncertainty about the population that would eventually live at Kealakehe. They hoped that Kealakehe housing will be within the means of young working families from West Hawaii. Various interviewees wanted the residents to include people born and raised in Kona, average resort workers, and/or first time home buyers.

Interviewees made several different predictions about the future inhabitants of the project and their role in West Hawaii:

- Some interviewees predicted that homes would be bought by mainland retirees.

- Others expected "Yuppies" and professionals to live in the project.

- The project was seen by a few as attracting needed skilled and professional workers. Other people thought the project could attract the large volume of workers required by future hotels.

- Several thought the project's residents would include mostly in-migrants from Hamakua, Hilo, and Honolulu. However, they thought these groups might not like the Kona lifestyle, and would not fit in with the larger Kona community.

- Several felt certain that resort workers would not be able to purchase homes in the Kealakehe project.

- However, several others thought resort workers could afford the Kealakehe homes. A few were concerned that problems allegedly frequent among resort employees, notably stress and drug use, would occur at the Kealakehe project.

Project Governance: One of the most frequent comments people made about the housing proposal was that they wanted the housing to be a source of pride to residents. They felt quality building and good governance would help to instill pride in homeownership, which would in turn assure good maintenance and appearance.

Many Kona residents said the key to keeping the Kealakehe neighborhoods desirable is strong, mandatory community associations which would enforce subdivision standards. Prohibitions on abandoned vehicles, animals, noise, and unsightliness were mentioned as valuable. People suggested such associations are the only way to adjudicate housing-based conflicts.

Several people wanted to see the project handled by a developer who is sensitive to the social needs of the new residents. They felt an exceptional developer with a more caring attitude and a post-construction phase commitment to the area would make it a desirable place to live.

Project Financing: Most Kona interviewees thought special financing should be made available to insure that the average family needing housing in Kona could afford to buy a Kealakehe house. They said they would like to see subsidized mortgages, assistance with down payments, and provisions for temporary loss of income. Once project residents were given a chance to buy a house, it was predicted that they would do everything in their power to keep up payments.

Kona residents wanted a fair system for qualifying home buyers. Such a system would take into account unique factors of the Kona workforce such as seasonality and income from tips. People were concerned that if qualifications are too rigid, many area residents will not qualify.

Many interviewees wanted to see the affordable units at the project made available to owner-occupants, not investors. They supported controls against private rentals or sublets. They wanted strict buyback provisions to keep the housing affordable and to give the State a share of any appreciation.

A smaller number of residents suggested that the State lease the property, rather than making it fee simple, in order to lower prices. They proposed a lease-to-buy program with the same buyback and shared appreciation considerations as proposed for fee-simple homes.

Project Design: People said they wanted a creative approach to design. They did not want conventional street grids or rows and rows of identical housing. They would like to see the new neighborhoods laid out with considerations for open areas, adequate room between units and ample setbacks of the units from the streets.

Most of the key informants expressed a concern about the mix of housing units of differing prices in the project. They wanted the lowest priced housing not to be isolated and stigmatized as a low-income area.

Many residents often used other Kona housing developments as a point of reference when describing what they would like to see built at Kealakehe. A number of people said they did not want the new project to look like the Pines, a recently constructed project of zero-lot-line condominium homes. Interviewees also mentioned the homes in Queen Liliuokalani Village, a leasehold subdivision on the mauka side of Palani Road in Kealakehe, as too closely spaced.

People thought the zero-lot-lined units were too much alike and could deteriorate quickly. Queen Liliuokalani Village was cited as having inadequate governance.

A few residents found the recently built Lailani rental housing project a good example of inexpensive housing. They liked the cluster design of the units and the spacious lay out of the entire project. An even smaller group found the Pines project not objectionable and said that similar densities were inevitable to keep future housing projects affordable.

Many Kona residents hoped that the lots in the proposed neighborhoods would be a minimum of 10,000 square feet, particularly if ohana zoning were allowed. A slightly smaller group found lot sizes between 5,000 and 10,000 square feet acceptable. While people believed ohana zoning would increase the density of the area beyond levels planned or desired, more people saw it as a necessity in making housing affordable than those who wished to prohibit it.

Many key informants said the proposed Kealakehe development should include housing units of various sizes. They recognized needs for units for large families and smaller units for the elderly. They also thought that rental units were necessary to serve those could not afford to buy a home. They thought some tenants might need rental subsidies.

Several people expressed concern that the rental units follow the same standards set for the rest of the project. Otherwise, poor quality rentals would have a negative impact on the market-priced housing.

Most interviewees mentioned recreational facilities as needed neighborhood amenities. Churches were also mentioned by some. External design elements proposed by a few interviewees included underground utilities and carports.

A few interviewees suggested that HFDC should sell developed lots, allowing buyers to build their own homes.

3.3.4 Concerns Related to Nearby Areas

There were some complaints and objections to the State's proposal to purchase land for the project from the Queen Liliuokalani Trust. Realtors were especially likely to suggest that if the goal of the project is low-cost housing, then it would make more sense for the State to build on the large quantity of land it already ownes in the area, rather than purchasing additional land.

Kona residents were aware that earlier plans for the Kealakehe project included selling the State's Kealakehe property makai of the Queen Kaahumanu Highway to private resort developers. The proceeds would have subsidized the cost of the housing mauka of the Highway. Several interviewees explicitly mentioned this land, commenting:

- They opposed any resort or residential development on the site;
- They wanted the area to remain open or to be used for public recreational purposes;
- They were concerned that the State's silence about the makai property could imply a continuing intention to sell the land to a private developer; and
- They wanted the proposed municipal golf course located in the makai parcel in order to occupy that area.

  (Others were not concerned with the site of the golf course. They felt that a municipal golf course was needed in Kona, and that it would serve as an attraction in marketing the proposed Kealakehe housing.)

  A further consideration raised by some the interviewees was the cost of pumping effluent from the sewer plant on the makai land across the Highway and uphill to the currently proposed golf course site.

Some concerns were raised about possible impacts of the Kealakehe project on adjacent or nearby residential areas. Residents in the existing Kealakehe subdivisions were concerned about the construction traffic coming through residential streets. They also anticipated an increase in crime due to an increase in population.

A few Kealakehe residents assumed that the existing Kealakehe multi-family housing would become more desirable due to proximity to new housing and the commercial development of the Queen Liliuokalani Trust property. However, there was also concern that existing single family homes in Kealakehe could become less desirable. Many interviewees were concerned that the project might "become a slum" which would adversely affect nearby areas as well as the project.

Residents of residential areas adjoining or near the project were concerned mostly about traffic impacts on Palani road during and after construction.

Commercial development at the <u>Honokohau Harbor</u> was expected to benefit from the increased number of boaters and others living close to the Harbor. Since there are no immediate plans for an increase in the number of boat slips, the few informants who raised this issue assumed that boaters would have to store their boats upland and bring them to the Harbor on trailers. The trailer traffic was seen as compounding traffic problems at the access to the Harbor from Queen Kaahumanu Highway.

4.0 <u>SOCIO-ECONOMIC IMPACTS</u>

4.1 INTRODUCTION

This section provides a consultant's assessment of socio-economic impacts of the Kealakehe project, in the light of anticipated trends in the economy and society of West Hawaii. Both quantifiable impacts (population and employment) and more qualitative impacts associated with the project are discussed.

The preceding section, on Community Issues and Concerns, should be considered as part of the overall assessment of social impacts. The affected community's reaction to a development is part of the impact of the project, and that community is often the best judge of qualitative impacts. The qualitative impacts discussed in this section were chosen partly on the basis of community input, partly on the basis of consultant judgment and knowledge of the West Hawaii area.

The impacts considered in this section include:

- o Quantifiable socio-economic impacts;
- o Impacts on housing and residential communities in West Hawaii; and
- o Impacts on specific areas near the project site.

In socio-economic impact assessment, an "impact" is usually defined as the difference between two possible futures: future conditions which will occur even without the project, and future conditions with the project.

West Hawaii is expected to see at least a <u>fourfold</u> increase in visitor unit inventory by 2005, and a <u>doubling</u> of the population by that date, with or without the Kealakehe project (Section 2.2). Major in-migration of workers (as well as full-time resort residents and hotel visitors), is likely to result in substantial socio-political change.

If it is assumed that the employment and population growth outlined in Section 2.2 will definitely occur, then residential development is needed to support the new population. The "impact" of the Kealakehe project is a matter of:

- o where residential development takes place in West Hawaii, not whether it takes place;
- o the availability of housing for those who wish to own, or just to live apart in, their own homes;

- whether homes are built in planned communities or in a variety of locations and clusterings; and

- the provision of homes for some -- owners of vacation homes -- who earn their income outside Hawaii and hence introduce capital to the state.

Arguably, preventing support activities could prevent tourism growth by interfering with labor supply. Few workers might move to West Hawaii without places to live or shop. However, many of the resorts already have their approvals and can be expected to proceed with development even if it is necessary to attract workers with makeshift solutions (e.g., dormitories). Building new resorts without providing support services for new population would produce extreme negative impacts on cost of living and quality of life for existing residents.

Therefore, the major socio-economic impacts of the project will involve <u>location, opportunities for homeownership, and community planning</u>.

The alternative future, for comparative purposes, would generally be an unplanned and dispersed development of homes (and other housing, such as dormitories) in and near West Hawaii.

4.2 QUANTITATIVE IMPACTS

Major quantifiable social aspects of the proposed development are population and employment. This section deals with the resident population at the project, employment associated with the project, both during construction and after buildout, and indirect and induced employment linked to the project.

4.2.1 Population

The project will be built out over about 20 years -- sooner or later depending partly on demand for affordable housing in West Hawaii. A market assessment has shown that a range of 3,620 to 5,530 units could be absorbed at Kealakehe by about the year 2010 (KPMG Peat Marwick, 1989).

Table 9 shows the number of units in three major segments (affordable rental, affordable ownership, and market units), and the population expected on-site. The column showing population at full occupancy indicates that about 10,000 to 15,100 persons could be at the project site if all units were occupied -- an unlikely event, even at peak times such as Christmas. A more realistic approximation is shown in the right-hand column, which takes occupancy levels into account.

TABLE 9: POPULATION AT THE KEALAKEHE PROJECT AT BUILDOUT

Unit Type	Number of Units (1)	Household Size (2)	Population With Full Occupancy	Average Occupancy Percentage (3)	Number of Occupants
Affordable Ownership Units	1,800 to 2,100	2.9	5,220 to 6,090	95%	4,960 to 5,790
Affordable Rental Units	690 to 1,160	2.9	2,000 to 3,360	95%	1,900 to 3,200
Market Units	1,130 to 2,270	2.5	2,830 to 5,680	59%	1,670 to 3,350
All units	3,620 to 5,530	2.7	10,050 to 15,130	83%	8,530 to 12,340

NOTES:

(1) Number of units from KPMG Peat Marwick, 1990, exhibit V-C.

(2) Household size estimated on the basis of County trends and market assessment recommendations for unit sizes and pricing.

(3) Average occupancy from (a) assumption of a 5% vacancy rate; (b) assumptions that 50% of the market units will be used as vacation homes by non-Hawaii residents, and that vacation homes will be occupied only 25% of the time. Vacation home percentage derived from analysis of a total of 125 North Kona sales in 1989 (single-family homes costing $200,000 to $300,000, and condominiums costing $150,000 to $250,000 -- excluding the Keauhou resort area).

The expected population at the Kealakehe project site is likely to reach about 8,500 to 12,300 after buildout.

Part-time residents from outside Hawaii are assumed to own approximately 50% of the market units, based on an analysis of recent North Kona sales. Since these occupants are less likely to be in their homes than others, they only account for about 6% to 7% of the total on-site population.

4.2.2 Employment

Employment associated with a project such as Kealakehe includes:

- o Construction jobs, which are generated for a limited period;
- o Operational jobs, which are presumed to last the lifetime of the project; and
- o Indirect and induced jobs in the larger State economy, created as the development and project workers buy goods and services from other establishments.

  Indirect and induced jobs are estimated using a model of the State economy. It can be used to calculate the employment effects of any project or enterprise.

Construction Employment: As Table 10 shows, project construction is estimated as generating a total of 3,830 to 5,570 direct jobs over the entire construction period. The actual average number of construction jobs in any given year is expected to be in the range of 190 to 280 jobs, while the number of jobs on-site will be somewhat smaller.

(Estimates of construction employment are averages -- the size and composition of the workforce on a project will vary during the course of construction. Also, the length of time over which construction will occur is not yet certain for the Kealakehe project, so annual figures depend on an approximation for this figure.)

The indirect and induced jobs generated by construction of the project are calculated as amounting to roughly 8,000 to 12,000 jobs over the construction phase, of which about 3,000 to 5,000 could be located in Hawaii County -- yielding an estimated annual average of 170 to 250 indirect and induced jobs in Hawaii County. The total direct, indirect, and induced jobs for project construction would then average about 360 to 530 in Hawaii County annually.

TABLE 10: CONSTRUCTION EMPLOYMENT, KEALAKEHE PROJECT

Assumptions:

(1) Total construction cost will be $420 million to $610 million (1989 dollars) over the entire construction phase (according to general estimates, not based on detailed engineering for the site, provided by Belt Collins & Associates, January 17, 1990).
(2) The ratio of construction jobs to construction spending in the State of Hawaii for 1988 -- nearly $110,000 per job -- will continue.
(3) While the length of the construction phase has not been set, it is assumed to last about 20 years.
(4) About 80% of the construction workforce is, on average, on-site.
(5) Construction costs for infrastructure, golf course, and commercial center are assumed not to depend on the number of houses built, and will total $113 million.
(6) To calculate indirect and induced employment, multipliers for single-family construction are used for residential construction, and for "other construction" for all other construction work.
(7) Indirect and induced jobs are estimated for the State economy. The County share of such employment is estimated as 40% (based on Anderson et al., 1975).

Direct Construction Jobs:

Project size	3310 units	5260 units
Construction Spending	$420,000,000	$612,000,000
Total Construction Jobs	3,830	5,570
Average Annual Construction Jobs	190	280
Average Annual On-Site Construction Jobs	150	220
Indirect and Induced Jobs		
Direct Jobs on Residential Construction	2,800	4,540
Direct Jobs on Other Construction	1,030	1,030
Indirect + Induced Jobs, Residential	6,410	10,400
Indirect + Induced Jobs, Other Const.	2,030	2,030
Indirect + Induced Jobs (Statewide)	8,440	12,430
Hawaii County Share, Indirect + Induced Jobs	3,380	4,970
Total Direct, Indirect, and Induced Jobs (Statewide)	12,270	18,000

SOURCE: 1982 Input-Output Model, Hawaii State Department of Business and Economic Development, Research and Economic Analysis Division, 1989.

Operational Employment: On-site jobs will be created as the residential and other components in the project are developed. After buildout, the project is estimated as providing about 370 to 470 direct jobs, as shown in Table 11.

Jobs created when people who would live in Hawaii in any event move to a new place cannot be treated as new impacts of developing that site. Those impacts of project operations can be specified by identifying the extent to which non-residents' income supports on-site operations.

Table 12 shows non-residents' share in project operational jobs and uses State multipliers to calculate the total direct, indirect, and induced jobs associated with project operations -- some 50 to 80 jobs -- due to the flow of capital to Hawaii from outside.

4.3 IMPACTS ON HOUSING AND RESIDENTIAL AREAS IN WEST HAWAII

The project will affect both the West Hawaii housing stock and, by offering a development organized in response to perceived needs for residential communities near Kailua-Kona, residential life in the area. In this section, indications of the extent of the housing crisis are surveyed, and impacts of the project on housing stock and residential life are analyzed.

4.3.1 The Housing Crisis in West Hawaii

During the 1980's, the West Hawaii housing inventory grew more slowly than did the resident population, meaning that more people must share living quarters. From 1980 - 1988, population increased by more than 48% (Table 4). However, County figures in Table 13 indicate that, even by March 1989, the total West Hawaii housing unit inventory had increased by only 26%. In the rest of Hawaii County, proportionate growth in housing units more closely matched growth in population.

Furthermore, Hawaii Visitors Bureau data indicate that nearly 2,000 of the 16,000 West Hawaii housing units are actually condominiums for visitor use. (Condominiums in resort areas may be made available for visitor use during peak travel years, then revert to long-term residential rentals when tourism declines.) An unknown number of West Hawaii single-family homes may also now be reserved for visitor rentals or second homes.

The value of single-family housing construction has increased in recent years, but not as fast as the entire Big Island construction industry. Figure 4 shows that single-family construction spending has been little affected by economic ups and downs, while multifamily construction was more responsive to industry, and general economic, trends until 1985. In recent years, multifamily housing construction has dwindled.

TABLE 11: DIRECT OPERATIONS EMPLOYMENT AT BUILDOUT, KEALAKEHE PROJECT

A. ASSUMPTIONS

1. Neighborhood commercial center will include a supermarket, one to two fast food outlets, a gas station, and two shops.
2. Golf course will have a clubhouse with dining room, and a small pro shop.
3. With continuing high employment, residents' need for child care will be great. Both family providers and child care centers are assumed to be located on the project site.

B. DIRECT EMPLOYMENT

Area Industry (1)	Subtotals 3,310 homes	 5,260 homes	Industry Totals 3,310 homes	 5,260 homes	
Neighborhood Commercial Center					
Retail Trade			100	125	(2)
Eating and Drinking			55	55	
Auto Repair			6	6	
Golf Course					
Amusement Services			30	30	
grounds:	20	20			
golf staff:	10	10			
Eating and Drinking			5	5	
Residential and Community Areas					
Personal Services			43	70	
Child care:	27	39			
Elderly/special needs care:	3	5			
Housecleaning:	13	26			
Other Industries:			32	64	(3)
Education (4)			97	143	
School employees	94	138			
After School Program	3	5			(5)
TOTAL			368	468	

NOTES:

(1) Industries are as listed in State Input-Output Model.
(2) Includes jobs at stores, 8 jobs at gas station.
(3) Landscaping and maintenance/security for market units.
(4) Public school staff needed to serve project residents' children. Staff ratio based on 1989-90 Hawaii District staffing. Estimate covers all grades, although only elementary and high school students are likely to attend schools on-site.
(5) Estimate excludes regular DOE employees.

TABLE 12: DIRECT, INDIRECT, AND INDUCED EMPLOYMENT IMPACTS, OPERATIONAL PHASE AT BUILDOUT

INDUSTRY	DIRECT JOBS	NON-RESIDENT SHARE (1)	INDUSTRY MULTIPLIER	DIRECT, INDIRECT, AND INDUCED EMPLOYMENT
Retail Trade	100 to 125	6.0%	1.57	9 to 12
Eating and Drinking				
Comm. center	55	6.0%	1.89	6
golf course	5	15.2%	1.89	1
Auto Repair	6	6.0%	1.49	1
Amusement Services	30	15.2%	1.49	7
Personal Services (Housecleaning)	13 to 26	12.5%	1.82	3 to 6
Other Industries	32 to 64	50.0%	1.61	26 to 52
Education	97 to 143	0.0%	0.00	0

TOTALS (3,310 homes) (5,260 homes)				53 to 84

NOTES:

(1) Non-resident share based on:
- -- vacation units' inhabitants as % of project population (6%).
- -- vacation units' share in number of market units (50%)
- -- amount of time vacation units are in use, as % of time all market units are in use (13%).
- -- visitor use of golf course (according to KPMG Peat Marwick (1990) market assessment, 70 rounds of 460 per day -- 15.2%).

(2) Industry multipliers from 1982 State Input-Output Model. Unpublished tabulations, Hawaii State Department of Business and Economic Development, Research and Economic Analysis Division, 1989.

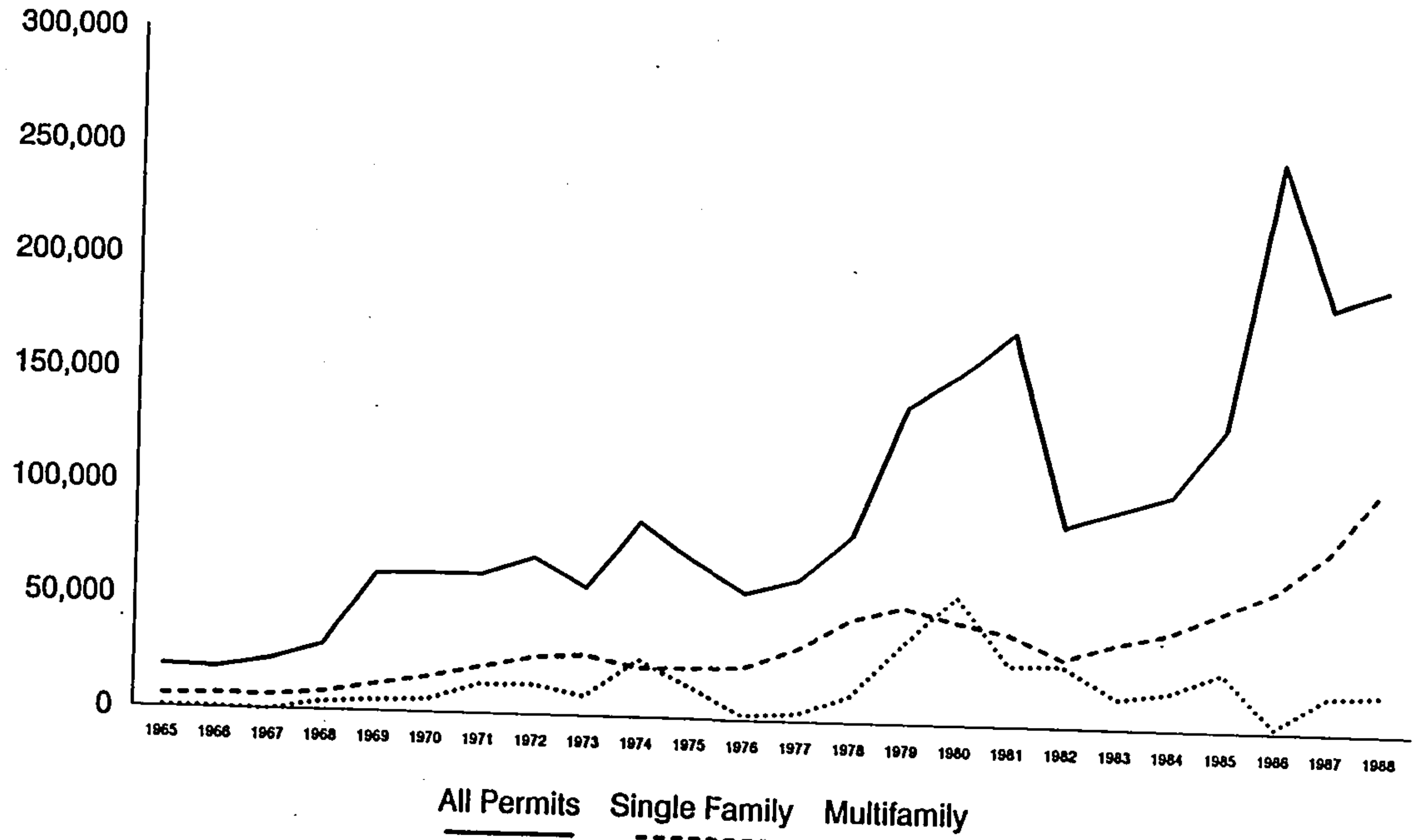
TABLE 13: HOUSING UNIT INVENTORY, COUNTY OF HAWAII AND WEST HAWAII DISTRICTS, 1980 AND 1989

	1980	1989	% Change, 1980-1989
WEST HAWAII			
North Kona			
-- Single-Family	4,105	5,322	29.6%
-- Duplex	122	146	19.7%
-- Multi-Family	2,934	4,109	40.0%
-- Other	379	N/A	
-- District Total, All Units	7,540	9,577	27.0%
South Kona			
-- Single-Family	1,631	1,974	21.0%
-- Duplex	28	34	21.4%
-- Multi-Family	48	88	83.3%
-- Other	15	N/A	
-- District Total, All Units	1,722	2,096	21.7%
North Kohala			
-- Single-Family	1,092	1,235	13.1%
-- Duplex	12	14	16.7%
-- Multi-Family	7	7	0.0%
-- Other	11	N/A	
-- District Total, All Units	1,122	1,256	11.9%
South Kohala			
-- Single-Family	1,692	2,236	32.2%
-- Duplex	10	84	740.0%
-- Multi-Family	511	653	27.8%
-- Other	5	N/A	
-- District Total, All Units	2,218	2,973	34.0%
TOTAL STUDY AREA			
-- Single-Family	8,520	10,767	26.4%
-- Duplex	172	278	61.6%
-- Multi-Family	3,500	4,857	38.8%
-- Other	410	N/A	
-- TOTAL, ALL UNITS	12,602	15,902	26.2%
REST OF COUNTY			
-- TOTAL, ALL UNITS	22,370	26,287	17.5%
HAWAII COUNTY			
-- TOTAL, ALL UNITS	34,972	42,189	20.6%

NOTE: "N/A" -- Category no longer used by County.

SOURCE: Data file, Land Use Inventory, County of Hawaii Planning Department, March 1989

FIGURE 4: CONSTRUCTION TRENDS, HAWAII COUNTY, 1965 - 1988



NOTE: Values are in thousands of dollars.

SOURCE: Bank of Hawaii, 1989.

Further indications that the supply of housing for residents in West Hawaii is severely limited are:

- West Hawaii homes in 1988 had an average resale price at least $65,000 more than the average resale price for the rest of the island. Prices throughout the island increased in 1989, but West Hawaii retained its lead (Pang, 1989).

- The average price of residential properties in all West Hawaii districts was over $200,000 in 1989 -- over twice the amount which would be affordable for a family with a median income.

- As shown in Table 14, 1980 housing costs were roughly 50% higher in West Hawaii, except for North Kohala, than in East Hawaii, suggesting that West Hawaii residents have struggled with a lack of affordable housing for years.

- The supply of units for rent to residents diminished during most of the 1980's, until there were nearly no vacancies in West Hawaii in 1987. More rental housing has become available since 1987 (KPMG Peat Marwick, 1990).

- Rental prices have increased steadily by about 10% per annum since 1980 in both Hilo and Kailua.

- Vacant rental units were also in short supply back in 1980. The percentage of vacant rentals in South Kona, South Kohala and North Kohala was much lower than the vacancy percentage county-wide. North Kona's higher vacancy rate was due to the large number of units used by the visitor market. (See Table 14.)

The current shortage of affordable housing is well known to West Hawaii residents, who call the need "critical", "severe", and "drastic." They cited several telling examples:

- No houselots near Kailua are available for under $100,000.

- Recently, only three fee simple homes were listed in the greater Kailua area for less than $200,000.

- Kona area low- to moderate-income rental projects are filled, and have waiting lists.

- At one rental complex, the prospective tenants at the top of the waiting list have been there for at least six months to a year.

TABLE 14: HOUSING STOCK AND CHARACTERISTICS -- STATE AND COUNTY OF HAWAII, AND WEST HAWAII DISTRICTS, 1970 AND 1980

	COUNTY OF HAWAII		NORTH KONA		SOUTH KONA		SOUTH KOHALA		NORTH KOHALA	
	1970	1980	1970	1980	1970	1980	1970	1980	1970	1980
TOTAL YEAR-ROUND HOUSING UNITS	18,939	33,954	1,975	6,894	1,131	2,052	798	1,959	941	1,121
	%	%	%	%	%	%	%	%	%	%
vacant (total)	9.0	13.9	27.4	33.3	6.4	9.7	18.5	24.3	6.6	8.8
vacant for sale	0.6	1.3	3.2	3.2	0.0	2.9	0.1	2.9	0.7	0.3
vacant for rent	2.0	5.5	8.3	18.9	0.3	2.1	1.9	4.1	1.1	1.8
TOTAL YEAR-ROUND OCCUPIED UNITS	17,260	29,237	1,431	4,602	1,059	1,853	650	1,483	879	1,022
TENURE	%	%	%	%	%	%	%	%	%	%
owner-occupied	56.9	60.6	44.7	55.1	36.9	52.7	48.8	59.3	66.6	67.7
renter-occupied	43.1	39.4	55.3	44.9	63.1	47.3	51.2	40.7	33.4	32.2
SELECTED CONDITIONS										
lacking some or all plumbing	17.1	6.4	26.3	7.3	55.8	28.4	15.4	2.0	17.6	7.3
1.51 or more persons/room	6.5	5.0	14.1	6.1	13.1	10.1	8.2	5.3	9.7	3.1
PERSONS/HOUSEHOLD	3.61	3.09	3.36	2.92	3.71	3.14	3.51	3.07	3.75	3.16
1980 MEDIAN RENT (renter-occupied)	N/A	$223	N/A	$331	N/A	$200	N/A	$307	N/A	$153
1980 MEDIAN VALUE* (owner-occupied)	N/A	$70,300	N/A	$114,000	N/A	$102,600	N/A	$95,700	N/A	$64,200

Notes * Median values are for non-condominium housing units.
N/A: "Not Available."

Sources U.S. Bureau of the Census, 1970 Census of Population and Housing--Census Tracts--Honolulu, Hawaii, PHC(1)-88; 1980 Summary Tape File 1-A; State of Hawaii, 1973, Community Profiles for Hawaii.

- According to some Kona Realtors, there are sub-unit rentals in 50% to 80% of the homes in certain neighborhoods.

- One realtor observed that 70% of all potential single family home buyers are looking for homes with rental units.

- Some see certain neighborhoods as overcrowded because the original buyers' households now contain their grown children and grandchildren.

- Many residents know of single-family houses in which three or more families live, or one-bedroom apartments sheltering or families with four or more children.

- The Hawaii Tribune Herald reported that County officials and advocates for the homeless estimate as many as 800 people in the County lack permanent shelter (Harada-Stone, 1989).

The lack of affordable housing has meant some people must work more than one job, or live in overcrowded conditions, which can generate other social problems. Social service professionals recognized housing problems as a major cause of stress in families with domestic problems. In such families:

- Adults become overwhelmed by the demands of work schedules, with no time to supervise their children;

  - Some adults grow more irritable and the stress may bring out anger that leads to abusive acts; or

  - They may drink to relax, and may become abusive when they are drunk.

- Children are unsupervised and may be exposed to the dangers dues to substandard housing or inadequate plumbing; and

- Children are often absent from school, ill-fed, and ill-clothed;

- Often such children become major family caretakers; and

- Respiratory infections and head lice circulate easily among residents of crowded households, leading to higher rates of infection.

In the past, stress was more likely to be seen in families with large mortgages. Now, with higher rents, the same stress is seen in renters.

Social service professionals said the lack of affordable housing affects severely special needs groups such as the disabled and mentally ill, who would benefit from independent living situations.

4.3.2 Expected Housing Trends

Proposals for housing developments in West Hawaii would, if all were built, yield over 21,000 new housing units, not including the project (KPMG Peat Marwick, 1990). Many of these developments have no permits as yet, and it is likely that fewer units will be built in the next twenty years or so.

Affordable housing commitments by resort developers would, when the resorts and the associated housing are built, yield over 3,000 units for low-income, moderate-income, and gap group families. Also, about 3,650 of the housing units in proposed developments are targeted as affordable units.

The total demand for new housing in West Hawaii is projected as about 25,150 units by 2010 (Table 5) -- more than is likely to be built in all the projects proposed so far. Also, the need for affordable units for homeowners is great -- if housing ownership patterns continued as they have in recent years, the number of families owning their own homes in West Hawaii would be about 4,000 below that mandated by the State, according to the market assessment for this project (KPMG Peat Marwick, 1990).

New private residential projects may well account for a much part of construction spending than in recent years in West Hawaii (Figure 3), but these projects are not likely to meet the demand for new housing, especially for affordable units.

4.3.3 Impacts on Housing Markets

By adding thousands of units to the West Hawaii housing supply, the project is likely to have a stabilizing effect on the price of housing and rentals. By providing units for families with low, moderate, and gap-group incomes, the project will address needs of existing West Hawaii residents -- it will:

- Give many families a chance to own their own homes;
- Encourage less crowding in existing households; and
- Help to decrease stress and social problems that can accompany crowded living conditions.

Impacts on project residents' incomes will vary. Renters are likely to benefit from lower rents and/or a decrease in the rate of appreciation of rents. Many new homeowners will pay more for housing than they would in rental housing, but they will be gaining equity.

The project will most obviously benefit its residents. Others who will also be affected by a larger housing supply include in-migrants and commuters:

- More rentals for low- and moderate-income families can encourage working in-migrant couples (from other counties of Hawaii, or outside Hawaii) to stay in the area, leading to lower transience among new in-migrants;
- New in-migrants attracted by visitor sector jobs will be more likely to find appropriate housing in the future than they have in recent years;
- Some of the "working homeless" -- commuters from other parts of Hawaii County who work in West Hawaii but live in their cars during the work week -- are likely to find better shelter; and
- As West Hawaii's affordable housing supply increases, commuters and new West Hawaii employees from elsewhere in Hawaii will move to West Hawaii in increasing numbers.

4.3.4 Impacts on West Hawaii Residential Areas

The creation of a large-scale planned community in West Hawaii will affect residential life in the larger West Hawaii area both directly and by example:

- The project's community association and enforcement of controls on building and use violations (such as illegal rentals) will serve as a model for other neighborhoods;
- With an increased housing supply, the demand for illegal rental units and the need for families to double up will decrease, leading to lowered population density in some neighborhoods; and
- If the community's rules allow licensed child care providers to operate in residential and/or community areas, the project can meet growing needs among West Hawaii families for child care and can set an example for community support of regulated child care arrangements.

  (Demand for both family-based and center-based child care is growing in West Hawaii (personal communication, Heidi Lehmann, West Hawaii Co-ordinator, PATCH, January 23, 1990). With increasing labor force participation, the demand is likely to become much stronger in the future.

Also, with many in-migrants in the future population, the proportion of families in West Hawaii that can depend on grandparents and the like for child care will be lower than the Statewide average.)

4.4 IMPACTS ON NEARBY AREAS AND ACTIVITIES

4.4.1 Residential Areas

As West Hawaii's population grows, residents of existing neighborhoods will see residential areas grow, and new residential areas created, where there now is open space.

With a large-scale residential project located in Kealakehe, residents of existing Kealakehe neighborhoods and adjacent neighborhoods are likely to see their surroundings as changing markedly the project will make those neighborhoods part of a large residential area. The Keahuolu project for a new urban center will also have an impact, bringing existing and projected residential areas close to the regional center.

By increasing the nearby area's population, the project is likely to bring mixed impacts:

- According to residents, increased traffic congestion on Palani Road is highly likely. (An independent expert consultant will report on this issue.)

- With greater population, the frequency of crime and domestic disturbances in the nearby area is likely to increase. However, the proposed mauka/makai road will reduce the travel time between the police station and the Palani Road subdivisions, improving police response time.

- The project's commercial area will include stores and services of use to residents, so nearby residents will no longer have to go down Palani Road to Kailua for their shopping.

- Public facilities, infrastructure, and services developed in or in connection with the project may benefit nearby residential areas as well. The location of a high school at Kealakehe, for example, will greatly reduce commuting time for students living north of Kailua-Kona.

  Again, a municipal golf course, while of benefit to golfers living throughout West Hawaii, will be especially convenient for nearby residents.

The project is likely to have little impact on housing values in the immediate area, if prudent planning is exercised and community standards are upheld. In particular:

- By locating homes with larger lots near existing market-price subdivisions, and by mixing product types within the project, the project will avoid creating the low-income "slum" that some area residents fear could be created near them.

- Improved access to public facilities on the project site, such as the proposed high school, is likely to add to the value of area homes.

4.4.2 Industrial and Commercial Areas

Queen Liliuokalani Trust (QLT) Property: Existing, planned and proposed commercial areas are located on QLT land south of the project:

- The Kona Industrial Subdivision is a 67-acre, 52-parcel area located makai of Queen Kaahumanu Highway. First developed in 1966, it is now undergoing a transformation from industrial and service tenants to retail shops, offices and restaurants.

- Expansion of the subdivision onto 100 acres of land to the north is already planned.

- QLT's proposed Keahuolu lands project includes the creation of large new commercial areas dedicated to retail use and, eventually, general business expansion. These areas will be located on both sides of Queen Kaahumanu Highway.

The Kealakehe residential project's impact on businesses at these sites is generally positive. A large residential population in the immediate vicinity would help to support retail, amusement, and service establishments.

Increased traffic flow on Queen Kaahumanu Highway -- likely if the QLT commercial areas attract many customers -- would have a negative impact on these sites. Road improvements are accordingly planned as part of the Keahuolu Lands project. (Drivers making left turns into and out of the existing QLT commercial area now experience delays.) The project is likely to provide some pedestrian traffic, reducing slightly the number of cars travelling to these commercial areas, and so is expected to have a mildly positive impact on this issue.

Industrial Areas North of Kealakehe: Several landholders with property mauka of Queen Kaahumanu Highway, north of Kealakehe, intend to continue or gradually develop light industrial and commercial uses of their properties. (Lanihau Corporation, McClean Trust, and Isemoto/SJA/Taylor lands are adjacent to the Kealakehe site.)

Since the areas will not be relying on retail shoppers, the impact of the nearby Kealakehe resident population should be small. It is unlikely that the industrial uses of the properties will occur along their Kealakehe boundary (Helber, Hastert & Kimura, 1990). Development of the McClean and Isemoto properties is expected to occur along a feeder road reaching the Highway about 800 feet north of the project boundary.

4.4.3 The Proposed New Urban Center

Queen Liliuokalani Trust is proposing to develop 1,135 acres of its land along the Kealakehe southern boundary. Their plans include 350 acres of housing at the higher elevations, adjacent to existing Kealakehe homes and across Palani Road from Queen Liliuokalani Village. Between Queen Kaahumanu Highway and the proposed QLT housing, the Trust would like to develop a new regional center serving all of West Hawaii with shopping, office and governmental facilities.

The impact of the Kealakehe residential project on the QLT urban center would be a steady supply of shoppers, doctors' patients, workers and seekers of government service. Kealakehe residents will be in such close proximity that many would be likely to use the center facilities beyond regular working hours.

Kealakehe project residents will likely be able to reach QLT facilities via secondary roads and sidewalks. Such access would encourage the use of the QLT center by Kealakehe residents without cars, lessening the impact of the center on major roadways.

4.4.4 Makai Areas near the Kealakehe Project

Honokohau Harbor and Beach: Development of the Kealakehe residential project will increase the number of users of the Honokohau boat harbor, commercial area, and shoreline, since these will be easily accessible to residents. As a result:

- Demand for boat slips will increase. Since no plans for basin enlargement are definite, boat owners living in the Kealakehe project will likely keep their boats on trailers. Increased use of Queen Kaahumanu Highway to transport boats is likely.

- The existing commercial area and an additional 20 parcels being developed by the State will benefit from increases in the nearby population of potential customers and workers.

- Honokohau Beach is now used by fishermen and nudists along with others. Increased use by Kealakehe and other residents may limit current uses.

The Remainder of the State's Makai Land: No plans for the use of the remaining State makai land in Kealakehe have been set, except for the new sewage treatment plant and a proposed shoreline road that would parallel the Queen Kaahumanu Highway from the Harbor to Kailua. The road would likely be used regularly by project residents travelling to shoreline recreational areas and Kailua village.

4.4.5 Other Nearby Property and Activities

Adjacent Pasture Land: The Lanihau Corporation and Palani Rand run cattle on two parcels adjacent to the northern boundary of Kealakehe at the mid-level elevation. Incidents of trespassing, causing conflict between ranchers and residents, are likely when pasture land is located next to residential areas. Landowners hope that fencing can keep hunters, children, dogs, and others out of the area (personal communication, James Greenwell, Jr., President, Lanihau Management Corporation, January 12, 1990).

Nearby Shoreline Recreational Space: The growth in population at Kealakehe will mean an increased demand on the Old Airport State Park. The Park is now the only major park in the Kailua-Kona area and its open space and limited sports facilities will be more easily accessible to Kealakehe residents using the new mauka/makai road through Kealakehe and the proposed shoreline road.

Increased use of the Harbor area, Old Airport Park and the QLT property makai of the highway will mean more people will be closer to the Trust's family camping program at Papawai Beach. The program may be impacted slightly by the presence of more people along the shoreline, more neighborhood lighting, and increased noise. (However, the Kealakehe project's contribution to that impact is minor.)

4.5 SOCIAL IMPACTS OF GOLF COURSE DEVELOPMENT

By providing a public golf course, the project will offer West Hawaii residents a less expensive alternative to resort courses. Demand from residents is projected as generating high levels of play on the course (KPMG Peat Marwick, 1990).

Only limited locational impacts of golf course development are evident. Its placement could minimize potential difficulties with the siting of a residential development adjacent to industrial areas, if necessary. Golf course frontage would increase the value of adjacent lots, providing additional subsidies for affordable housing and encouraging the development of a wide range of units in the project's product mix.

APPENDIX A: LIST OF PEOPLE INTERVIEWED FOR REPORT

(Note that those interviewed provided their comments as individuals and not as representatives of their organizations. Organizational affiliations are provided only to indicate some of the networks and interests of those interviewed.)

Pamela Burla Acoba	Realtor, Ron Burla and Associates
Robert Aeder	President, Kona Heavens Homeowners Association
Joe Almeida	General Manager, Kona Palisades
Joseph W. Augustine	Realtor, dh Realty, Inc.
Fanny Au Hoy	Curator, Hulihee Palace Member, Hawaiian Civic Clubs
Alan Beall	Restaurant developer
Teresa Nakama Bellah	Clerk typist, Kamehameha Investment Corporation
Scott Berg	Owner, Scott's Pet and Feed Shop, Scott's Knife Center Kona Acres resident
Ian Birnie	District Manager, Harbors Division, Department of Transportation
John F. Burns	Owner, McDonald's Restaurants
Thea Brown	Owner, Honokohau Marine Services
Connie Charles	Executive Director, Kona Kohala Chamber of Commerce
Jill T. Chavez	Branch Manager, Pioneer Federal Savings and Loan
Keola Childs	Developer
Irma Chillingworth	Member: Hawaiian Civic Club, Ahahui Kaahumanu Group, Daughters of Hawaii Founder, West Hawaii Today

(Continued)

Lisa Choquette	Owner, Dive Makai Treasurer, The Ocean Recreation Council of Hawaii
Jeanne Comer	Member, Hawaii Planning Commission Queen Liliuokalani Village Resident
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TRAFFIC IMPACTS

TRAFFIC IMPACT ASSESSMENT REPORT

for

KEALAKEHE PLANNED COMMUNITY

Kealakehe, Hawaii

July 1990

Prepared for:

State of Hawaii Housing Finance & Development Corporation

Prepared by:

Pacific Planning & Engineering, Inc.
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EXECUTIVE SUMMARY

Pacific Planning & Engineering, Inc. (PPE) was engaged to undertake a study to identify and assess Year 2010 traffic impacts resulting from the State of Hawaii Housing Finance and Development Corporation's (HFDC) proposed Kealakehe Planned Community project. The report focuses on the following intersections:

- Queen Kaahumanu Highway with Kealakehe Parkway
- Queen Kaahumanu Highway with Palani Road
- Palani Road with Mamalahoa Highway
- Mamalahoa Highway with Kealakehe Parkway Extension

This report presents the findings and recommendations from the traffic study.

PROJECT DESCRIPTION

The State of Hawaii HFDC is proposing the development of the Kealakehe Planned Community which will be completed by the year 2010. The project is a master planned community which will include housing, recreational uses, schools, public facilities, and commercial areas. Also included in the project site is a 196-acre area located immediately east (mauka) of the Queen Kaahumanu Highway which is reserved for development by the County of Hawaii. This area will be primarily an effluent disposal area for the County's Kealakehe Sewage Treatment Plant which is presently under construction on the west (makai) side of the highway. The total master planned area encompasses approximately 960 acres located between Palani Road and Queen Kaahumanu Highway.

The Kealakehe Planned Community is served internally by two proposed arterial roadways. The first roadway is an extension of the existing Kealakehe Parkway. The existing Kealakehe Parkway will be realigned to the south and the extension will extend west to east from Queen Kaahumanu Highway to Mamalahoa Highway. The Kealakehe Parkway Extension is planned to be a four to six lane arterial roadway within a 120-foot right-of-way.

The second arterial roadway, called the Mid-Level roadway, bisects the project site and extends north to south. It is proposed by the County of Hawaii to serve as a major arterial with a 120-foot right-of-way paralleling Queen Kaahumanu Highway and extending from Palani Road to the northern end of the project site.

Road "A" will be a two-lane roadway that will run in the north-south direction. This roadway will provide access to Palani Road for vehicles in the project site .

The master plan proposes the development of approximately 618 acres of the project site for residential land uses, with a total of 4,379 housing units. These single family and multi-family units are distributed among fourteen villages with an average village size of just over 300 units. Each village will feature a mix of residential units with 60% affordable and 40% market priced.

A 196-acre site situated on the lower portion of the project area is proposed for transfer to the County of Hawaii for development of an 18-hole public golf course and effluent disposal area for the County sewage treatment plant being constructed makai of Queen Kaahumanu Highway. The proposed golf course area includes a three-acre club house site which is readily accessible from major roadways and the surrounding community.

The proposed master plan includes three separate parks, each approximately four acres in size, and two environmentally sensitive areas that are proposed to be set aside as natural open space preserves.

Two school sites are proposed for development within the community. One school is proposed to be an elementary school which will serve up to 900 students and be operated by the State Department of Education. The other is to be a public high school which can accommodate a maximum of 1,700 students.

In the vicinity of the existing police station, makai of the Kealakehe landfill is a 30 acre area designated for a Civic Center. It is proposed that the Civic Center include the existing police station, a fire station, county government office building, a judicial complex serving West Hawaii, and similar public buildings.

Also proposed in the master plan are two 3-acre sites which have been set aside for quasi-public facilities and would consist of a church/day-care center complex and three commercial areas proposed to be developed as three community shopping centers.

CONCLUSIONS AND RECOMMENDATIONS

The Kealakehe Planned Community Project, when completed in 2010, will have a major impact on Queen Kaahumanu Highway and Palani Road.

Due to the extensive growth projected in the West Hawaii region over the next twenty years travel demand and travel patterns in the year 2010 will clearly not reflect those of today. The change in the distributions of jobs and population will result in directional changes in traffic along the major arterials in the area such as Queen Kaahumanu Highway.

Even without the project in 2010, Queen Kaahumanu Highway, Mamalahoa Highway and Palani Road will be over capacity. Queen Kaahumanu Highway will need to be widened to four lanes in the vicinity between Palani Road and Keahole Airport. Palani Road will also need to be widened to four lanes, as well as Mamalahoa Highway between Palani Road and Kaimi Nani Drive. The signalized intersection of Palani Road and Queen Kaahumanu Highway will also be over capacity and will need to be converted to a grade separated interchange. The intersection of Palani Road and Mamalahoa Highway will need to be signalized when warranted. The minor intersections along Palani Road that access the existing subdivision such as Kealakaa Street will also need to be signalized when warranted.

It was assumed that the four-lane, mauka-makai Kealakehe Parkway running between Queen Kaahumanu Highway and Mamalahoa Highway would be constructed along with the project. It would serve as the major access road to both Queen Kaahumanu and Mamalahoa Highways for the Kealakehe community. With the capacity available with Kealakehe Parkway and its alternative route to and from Queen Kaahumanu with comparable travel times, traffic along Palani Road will not be greatly affected by the project.

Due to the impact of the traffic volumes generated by the Kealakehe Planned Community development, the following are recommended:

1. A grade separated interchange should be constructed at the intersection of Queen Kaahumanu Highway and Kealakehe Parkway due to the requirement of the State Department of Transportation for non-interrupted flow along Queen Kaahumanu Highway.

2. Signalized intersection at Mamalahoa Highway and Kealakehe Parkway.

3. The Kealakehe Parkway extension between Queen Kaahumanu and Mamalahoa Highways should be constructed as a four-lane roadway. Depending on the number of intersections accessing the project, additional improvements such as the following may be necessary:

    a. Signalize the major intersections along Kealakehe Parkway when warranted.

    b. Auxiliary lanes may be necessary along Kealakehe Parkway and the minor streets, i.e. left turn storage lanes.

PROJECT DESCRIPTION

The State of Hawaii Housing Finance and Development Corporation (HFDC) is proposing the development of the Kealakehe Planned Community which will be completed by the year 2010. The project is a mixed-use master planned community which will include housing, recreational uses, schools, public facilities, and commercial areas. Also included in the project site is a 196 acre area located immediately east (mauka) of the Queen Kaahumanu Highway which is reserved for development by the County of Hawaii. The area will be primarily an effluent disposal area for the County's Kealakehe Sewage Treatment Plant which is presently under construction on the west (makai) side of the highway.

The total master planned area encompasses approximately 960 acres located between Palani Road and Queen Kaahumanu Highway. Figure 1 and Figure 2 shows the project location and roadway network in the vicinity. Table 8 in the section "Projected Traffic Conditions" shows a summary of the proposed developments for the project.

PROJECT ROADWAYS

The Kealakehe Planned Community is served internally by two proposed arterial roadways. The first roadway is an extension of the existing Kealakehe Parkway. The existing Kealakehe Parkway will be realigned to the south and the extension will extend west to east from Queen

Kaahumanu Highway to Mamalahoa Highway. The Kealakehe Parkway Extension is planned to be a four to six lane arterial roadway within a 120-foot right-of-way.

The second arterial roadway, called the Mid-Level roadway, bisects the project site and extends north to south. It is proposed by the County of Hawaii to serve as a major arterial with a 120-foot right-of-way paralleling Queen Kaahumanu Highway and extending from Palani Road to the northern end of the project site.

Road "A" will be a two-lane roadway that will run in the north-south direction. This roadway will provide vehicles in the project site access to Palani Road.

PROJECT LAND USES

The master plan proposes the development of approximately 618 acres of the project site for residential land uses, with a total of 4,379 housing units. These units are distributed among fourteen villages with an average village size of just over 300 units. Each village will feature a mix of residential units with 60% affordable and 40% market priced. The affordable units are targeted for the elderly, assisted (very low income and lower income), and gap-group (moderate income) families and persons. The market units are targeted for families and persons of upper moderate income and those earning incomes greater than 140% of the area's median income.

Of the 4,379 residential units, 3,035 units will be single family units intended for sale. These units, which include both affordable and market units, are distributed throughout the fourteen villages on a total of approximately 506 acres of land with an average density of six units per acre. Affordable and market units are scattered within each village rather than clustered to ensure a heterogeneous distribution.

Multi-Family units for sale total 486 units with a general density of 12 units per acre and will occupy a total of 41 acres. Most of the multi-family units are distributed in clusters from two to four acres in size with one five-acre cluster. More than half of the total number of units are market units situated in small clusters fronting the public golf course fairways and clubhouse and the remaining units are situated in small clusters near major public facilities such as schools and shopping areas.

To accommodate the elderly and lower income, 858 units on 72 acres have been set aside as multi-family rental units. These units are clustered in areas averaging about 7 acres and are located adjacent to schools, commercial areas, parks and recreation areas.

A 196-acre site situated on the lower portion of the project area is proposed for transfer to the County of Hawaii for development of an 18-hole public golf course and effluent disposal area for the County sewage treatment plant being constructed makai of Queen Kaahumanu Highway. As presently designed, the proposed sewage treatment plant will require a minimum of 150 acres for the disposal of effluent derived from the treatment process. The proposed golf course area includes a three acre club house site near the central lobe of three lobes. This site is accessible from major roadways and the surrounding community.

The proposed master plan includes three separate parks, each approximately four acres in size. The first park is located at the mauka end of the planned community in Village #2 adjacent to the existing multi-family development along Kealakehe Street. A second park is located near the intersection of the Mid-Level roadway and Kealakehe Parkway in Village #6 adjacent to two multi-family unit projects. The third park is situated in Village #14 near Palani Road. Adjacent to the second park is a proposed three acre recreation center site. It will be located at the corner of Kealakehe Parkway and the Mid-Level roadway.

There are two areas that are proposed to be set aside as natural open space preserves. One is a twenty-one acre area located in the northeastern corner of the project area. It contains a number of unique archaeological sites that have been proposed for preservation. The second preserve consists of a five acre site about midway between the property boundaries near the 550 foot elevation.

Two school sites are proposed for development within the community. One ten acre site, for an elementary school, is located near the project's southern property boundary and is to be operated by the State Department of Education. The proposed facility will serve up to 900 students, and provide space for play courts, a library, dining room and administrative building. A public high school is proposed on forty-five acres on the makai side of the Mid-Level roadway, south of Kealakehe Parkway. The high school is expected to accommodate a maximum of 1,700 students within 75 classrooms and will include facilities for administrative offices, a dining hall, library, physical education building, gymnasium, football/soccer and baseball fields, and tennis courts.

In the vicinity of the existing police station, makai of the Kealakehe landfill is a 30 acre area designated for a Civic Center. It is proposed that the Civic Center include the existing police station, a fire station, county government office building, a judicial complex serving West Hawaii, and similar public buildings such as a public library and federal post office.

Two three-acre sites have been set aside for quasi-public facilities, which would consist of a church/day care center complex. The first site is located in Village #4 between the proposed Elementary school and a preservation site. The second site is located within Village #7 near the entrance of Kealakehe Parkway into the project area.

Three commercial areas are proposed to serve the Kealakehe Planned Community. One area is a 20-acre site located at the intersection of Kealakehe Parkway and Queen Kaahumanu Highway. This site is expected to be developed as a community shopping center and will include a major grocery store and department store as well as specialty shops and consumer oriented retail outlets. The other two three acre areas are expected to be smaller neighborhood commercial centers. The first is located at the northern border of the property at the point where the Mid-Level roadway enters the project area. The second will be located near Palani Road.

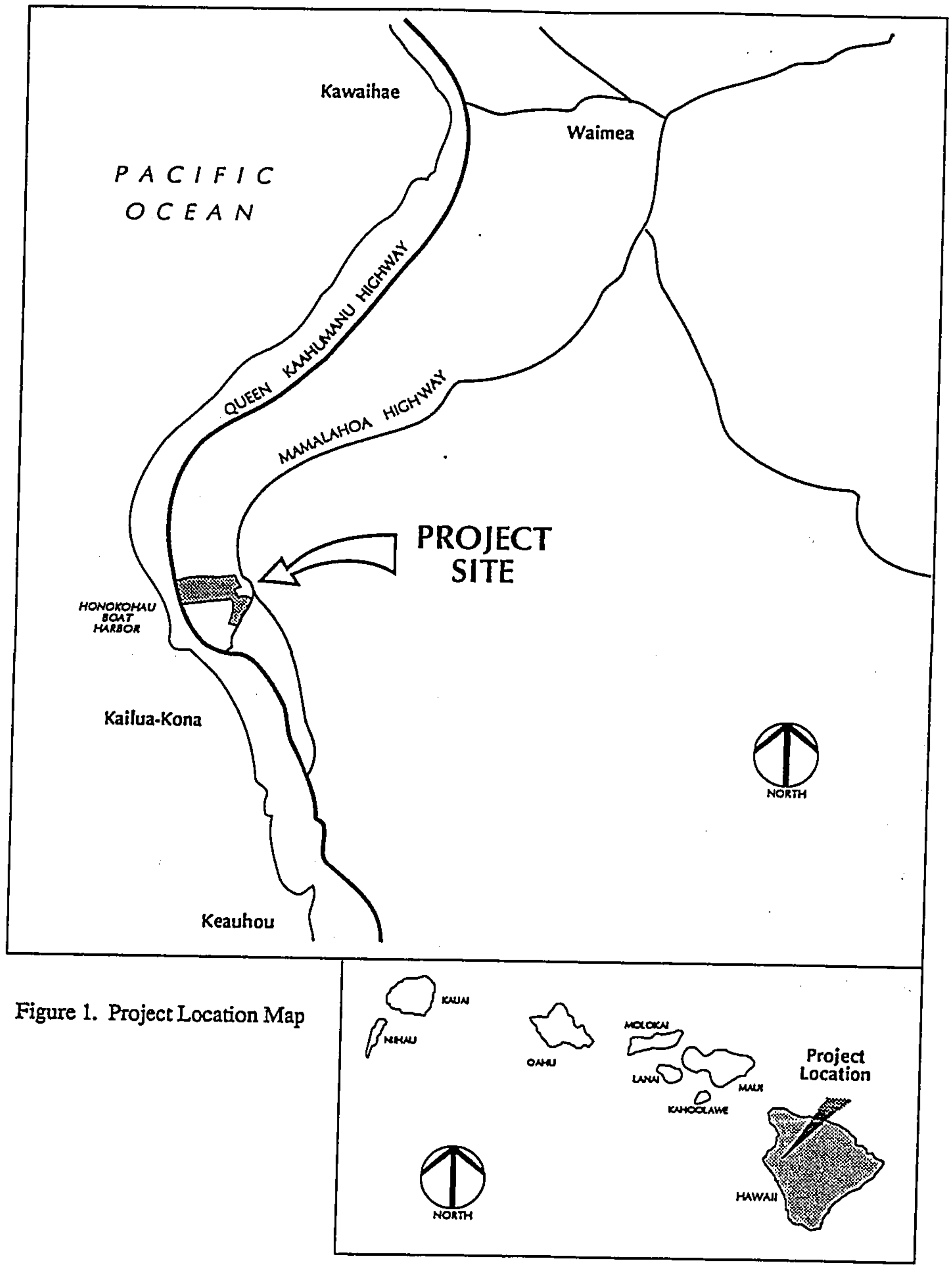

Figure 1. Project Location Map

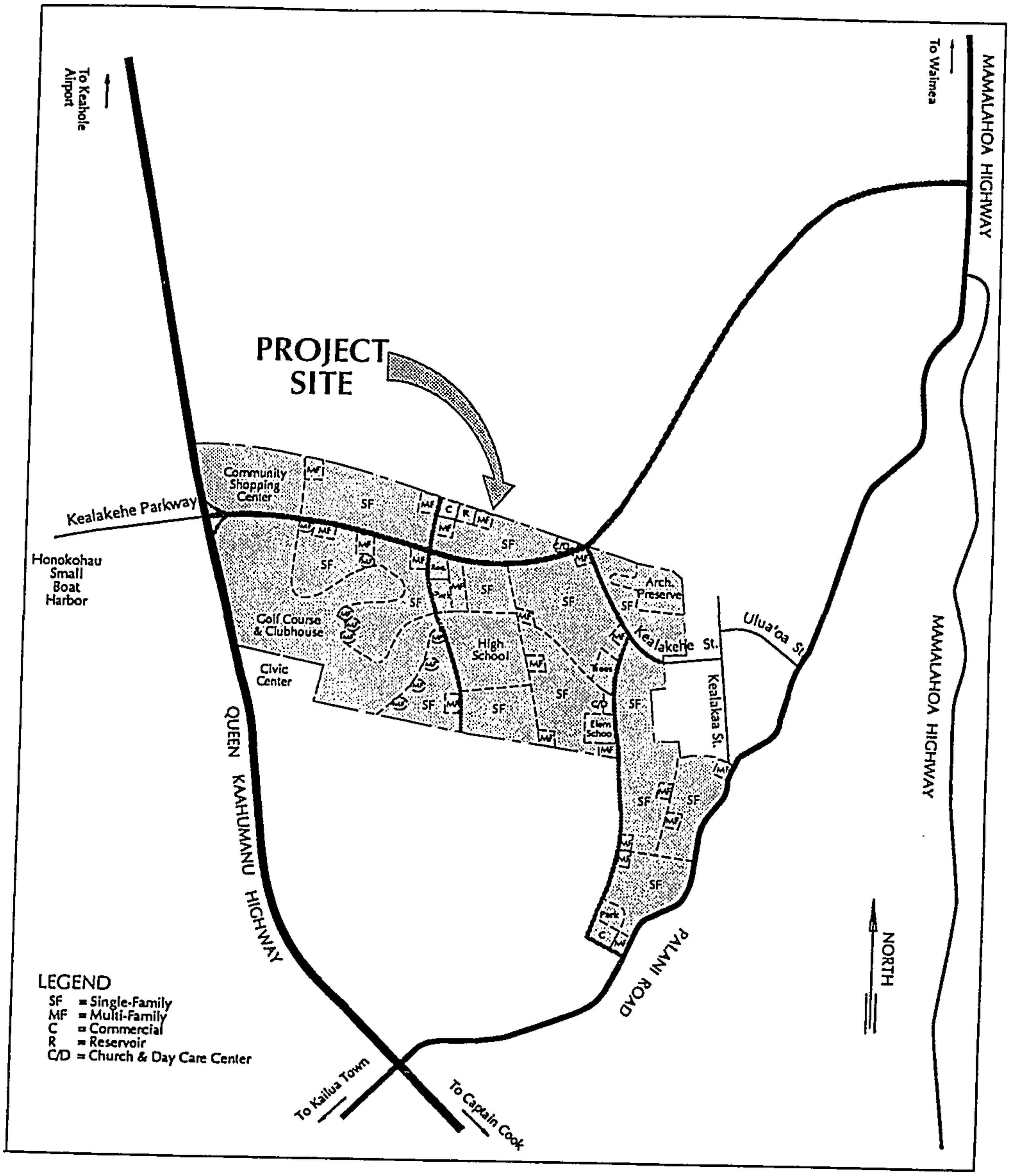

Figure 2. Project Site Plan

EXISTING CONDITIONS

A survey of existing conditions and surrounding land uses was conducted to baseline reference for assessing the future traffic impact of the proposed project. The survey included the existing land uses in the general area, roadway facilities and existing traffic conditions.

EXISTING LAND USES

The project site is located in the Kealakehe district and is owned by the State of Hawaii. The site consists predominantly of undeveloped land composed primarily of lava terrain with some brush and shrubs.

The Kealakehe Landfill is currently located on the western portion of the project site mauka of Queen Kaahumanu Highway. The Amfac Distribution Center is located along Queen Kaahumanu Highway near the Kealakehe Landfill on the project site. The Kona Police Station, which serves the Kona district, is also located along Queen Kaahumanu Highway north of the landfill and distribution center.

Much of the land surrounding the project site consists of lava fields with a few developments immediately surrounding the project area. Developments mauka of the project site along Palani Road include residential subdivisions, and an Elementary and Intermediate school which serves the neighboring communities. On the makai side of the project site is the Honokohau Small Boat Harbor. To the north of the project site are other residential subdivisions and Kaloko Industrial Park. On the south side of the project site lies Keahuolu district.

Located along Queen Kaahumanu Highway further north of the Kealakehe district, Keahole Airport is a major air carrier airport which serves the West Hawaii region. Beyond the airport, along the coastline makai of Queen Kaahumanu Highway, are various resort developments in the South Kohala District.

The Kona Industrial Subdivision is located south of the project site, makai of Queen Kaahumanu Highway and beyond the industrial subdivision is Kailua-Kona Town which consists of resorts and hotels, shopping malls, businesses and beaches for recreational use.

EXISTING ROADWAY FACILITIES

The major roadways in the North Kona region are Queen Kaahumanu Highway, Palani Road, and Mamalahoa Highway. Queen Kaahumanu Highway and Mamalahoa Highway are parallel facilities.

Queen Kaahumanu Highway is the main highway in the Kona region running in a north-south direction along the coastline between Kailua-Kona and Kawaihae. It is a State maintained two-lane undivided highway having a 24 foot-wide pavement and variable speed limits of 35 to 55 mph. The major intersections along Queen Kaahumanu Highway are channelized with left-turn storage lanes, deceleration and acceleration lanes.

Queen Kaahumanu Highway forms a 4-way signalized intersection with Palani Road at the main entrance of Kailua-Kona Town. This major intersection is widely utilized in the Kona region. The posted speed limit for Queen Kaahumanu Highway is reduced to 35 mph near this intersection. For southbound vehicles along Queen Kaahumanu Highway there is a 370 foot left-turn and 440 foot right-turn storage lane and for northbound vehicles, a 710 foot left-turn and 480 foot right-turn storage lane. The intersection also has right-turn acceleration lanes, and 220 foot left-turn storage lanes for vehicles along Palani Road entering and exiting Kailua Town. Queen Kaahumanu Highway and Palani Road both have 7 foot paved shoulders at the intersection.

Mamalahoa Highway is a two-lane roadway running in a north-south direction parallel to Queen Kaahumanu Highway which serves the higher elevated areas between Waimea and North Kona. This State highway was built over a former horse-and-buggy trail, and is a winding sub-standard roadway with a pavement width varying between 18 and 24 feet.

Palani Road is a two-lane roadway running in a northeast direction from Kuakini Highway on the coastline of Kailua Town mauka to Mamalahoa Highway. It serves as the major mauka-makai connector road between Queen Kaahumanu Highway and Mamalahoa Highway in the North Kona Region. Palani Road is a Hawaii County maintained road having 12 foot wide lanes and a posted speed limit of 25 mph. Palani Road currently serves as the main vehicular access road for the existing Kealakehe and surrounding residential subdivisions.

Kealakaa and Ulua'oa Street are relatively new two-lane roadways maintained by Hawaii County primarily serving the Kealakehe subdivision area. Both roads are located makai of Palani Road and form unsignalized T-intersections with Palani Road. They both have speed limits of 25 mph. Kealakaa Street has 18 foot wide paved lanes, and generally runs in a north-south direction. Kealakaa Street is widely used for school related traffic because Kealakehe Intermediate and Elementary schools are located near its intersection with Palani Road. Ulua'oa Street generally runs in a mauka-makai direction and has 16 foot wide paved lanes.

Kealakehe Parkway Road is a two-lane roadway running in a mauka-makai direction with 12 foot wide paved lanes. It forms an unsignalized T-intersection with Queen Kaahumanu Highway and travels makai to the Honokohau Small Boat Harbor. The posted speed limit is 25 mph.

EXISTING TRAFFIC CONDITIONS

A review of State DOT 1988 vehicular traffic counts for Queen Kaahumanu Highway and Palani Road near the project site indicates that the peak hours along Queen Kaahumanu Highway and Palani Road generally occur between 7:00 and 9:00 in the morning and 3:30-5:30 in the afternoon.

Manual traffic counts were taken for the intersections of Queen Kaahumanu Highway with Palani Road and Kealakehe Parkway Road, and Palani Road with Kealakaa Street and Ulua'oa Street on January 16 and 17, 1990. Manual counts were also taken on May 15 and 16, 1990 at the intersection of Mamalahoa Highway with Palani Road, and on May 2 and 3, 1990 at the intersection of Queen Kaahumanu Highway with Kaiwi Street.

These recent field counts are used as a baseline condition with which future estimated traffic volumes are compared. Figures 3 and 4 show the present volumes and movements of vehicular traffic at the study intersections. The recorded traffic counts are shown in Appendix B.

Manual counts were taken of passenger cars, trucks, buses, bicycles, motorcycles and pedestrians by turning movements and approaches. During the field counts on January 16, 1990, the weather was cloudy with slight rain, and the road pavement was wet. During the field counts on January 17, 1990, the weather was clear and the road pavement dry. The following observations were also noted during the counts on both days:

1. At the signalized intersection of Queen Kaahumanu Highway with Palani Road, drivers were observed using the paved shoulder for making right-turns accessing or exiting Queen Kaahumanu Highway.

2. At the intersection of Palani Road with Kealakaa Street, drivers travelling northbound on Palani Road were observed using the paved shoulder to bypass vehicles making left-turns onto Kealakaa Street.

Field counts of the Palani Street-Mamalahoa Highway intersection were taken on May 15 and 16, 1990. During the field counts on May 15, 1990, the weather was cloudy with a light rain. On May 16, 1990, during the field counts, the skies were clear and the pavement was dry.

Observed Traffic Conditions

The following observations were noted during the counts on both days:

1. Some drivers travelling on Palani Road, Kailua bound, turned left into the Waimea bound lane of Mamalahoa Highway.

2. Buses blocked Kailua bound through traffic on Palani Road at bus stops causing vehicles to overtake in the oncoming traffic lane.

3. Vehicles travelling on Palani Street Kailua bound would use the shoulder to pass vehicles waiting to make a left turn onto Mamalahoa Highway.

The vehicular 24 hour traffic counts for each approach of the study intersections taken by the Department of Transportation in 1988 are shown in Figure 5.

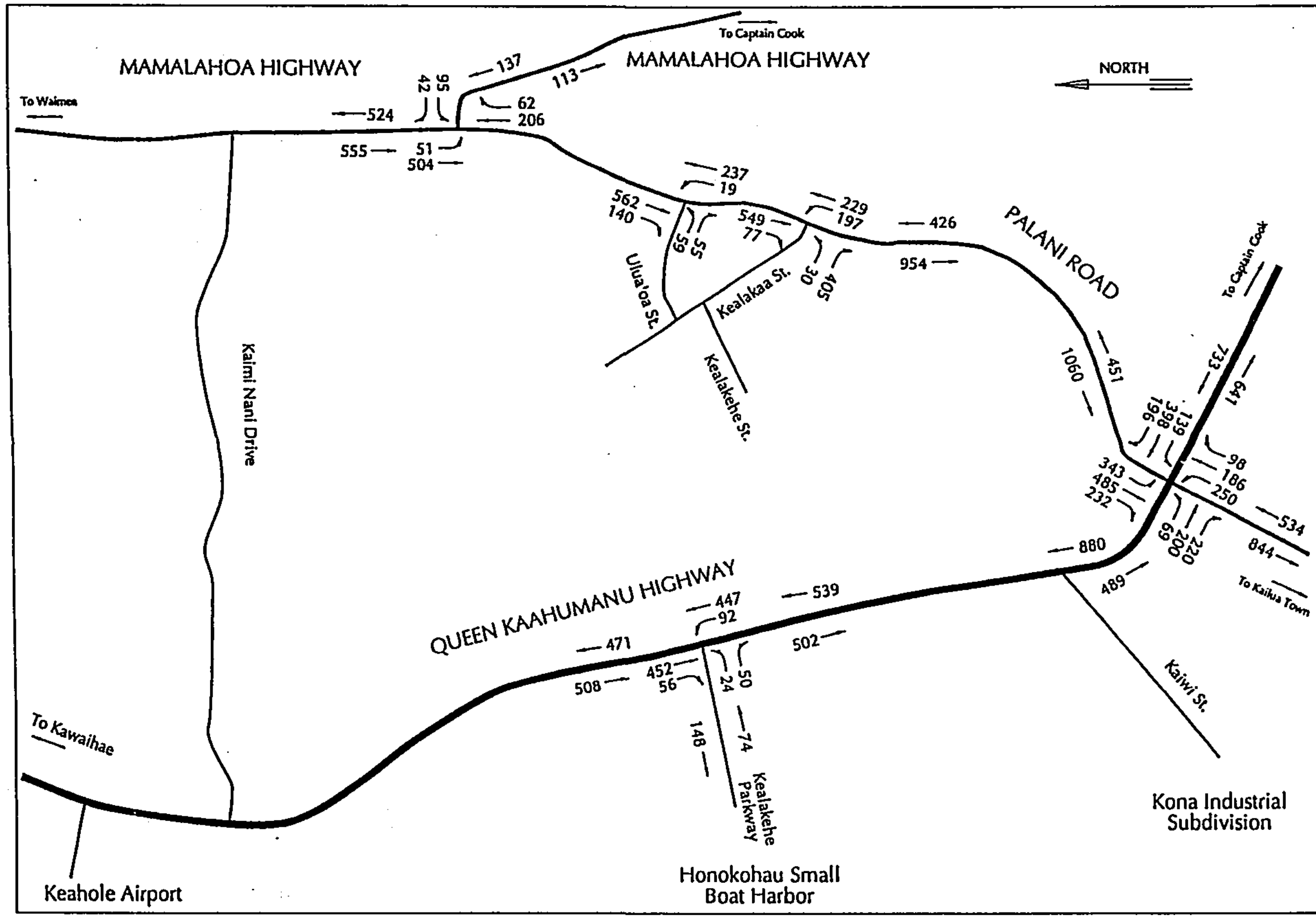

Figure 3. Existing Morning Peak Hour Volumes

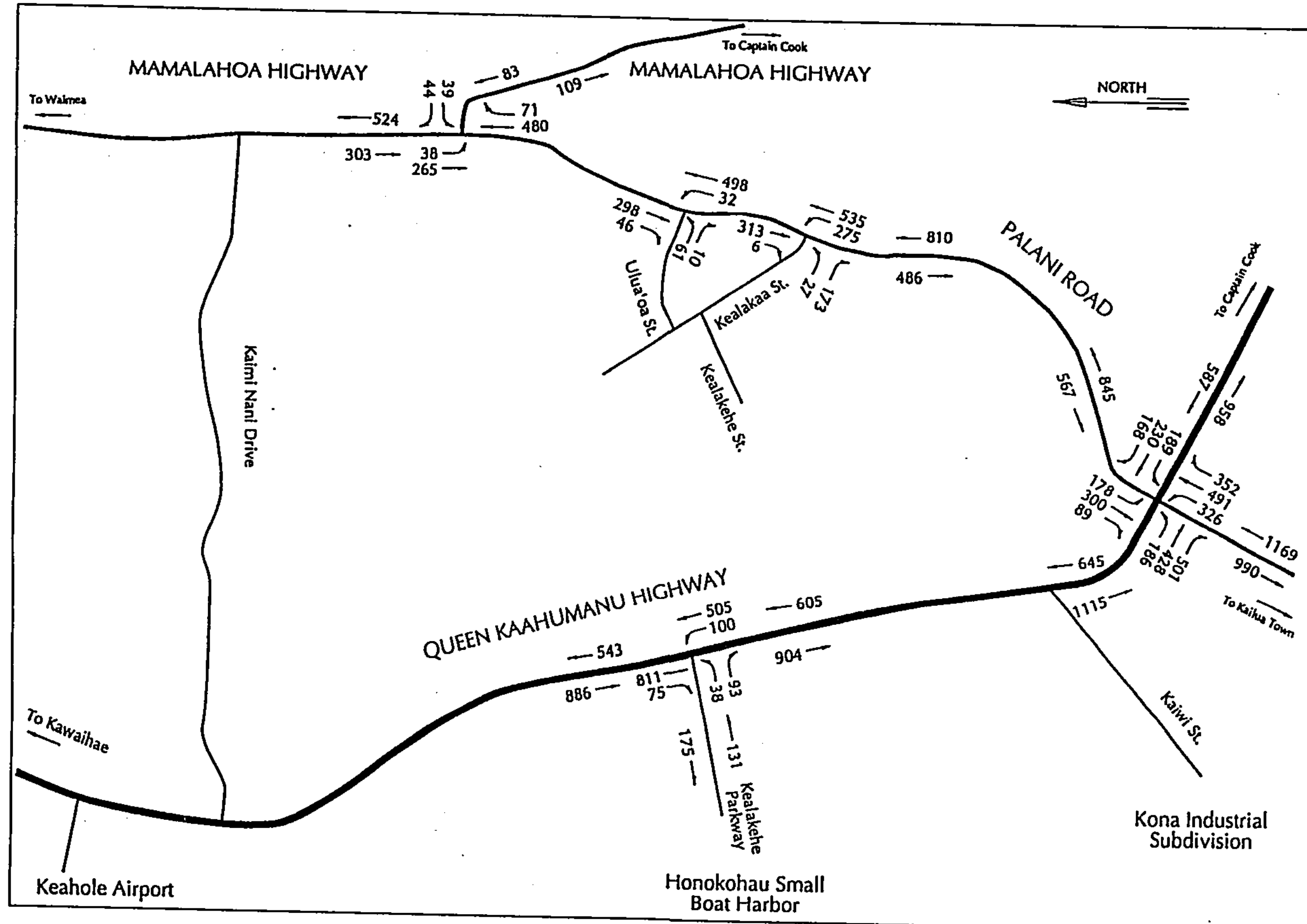

Figure 4. Existing Afternoon Peak Hour Volumes

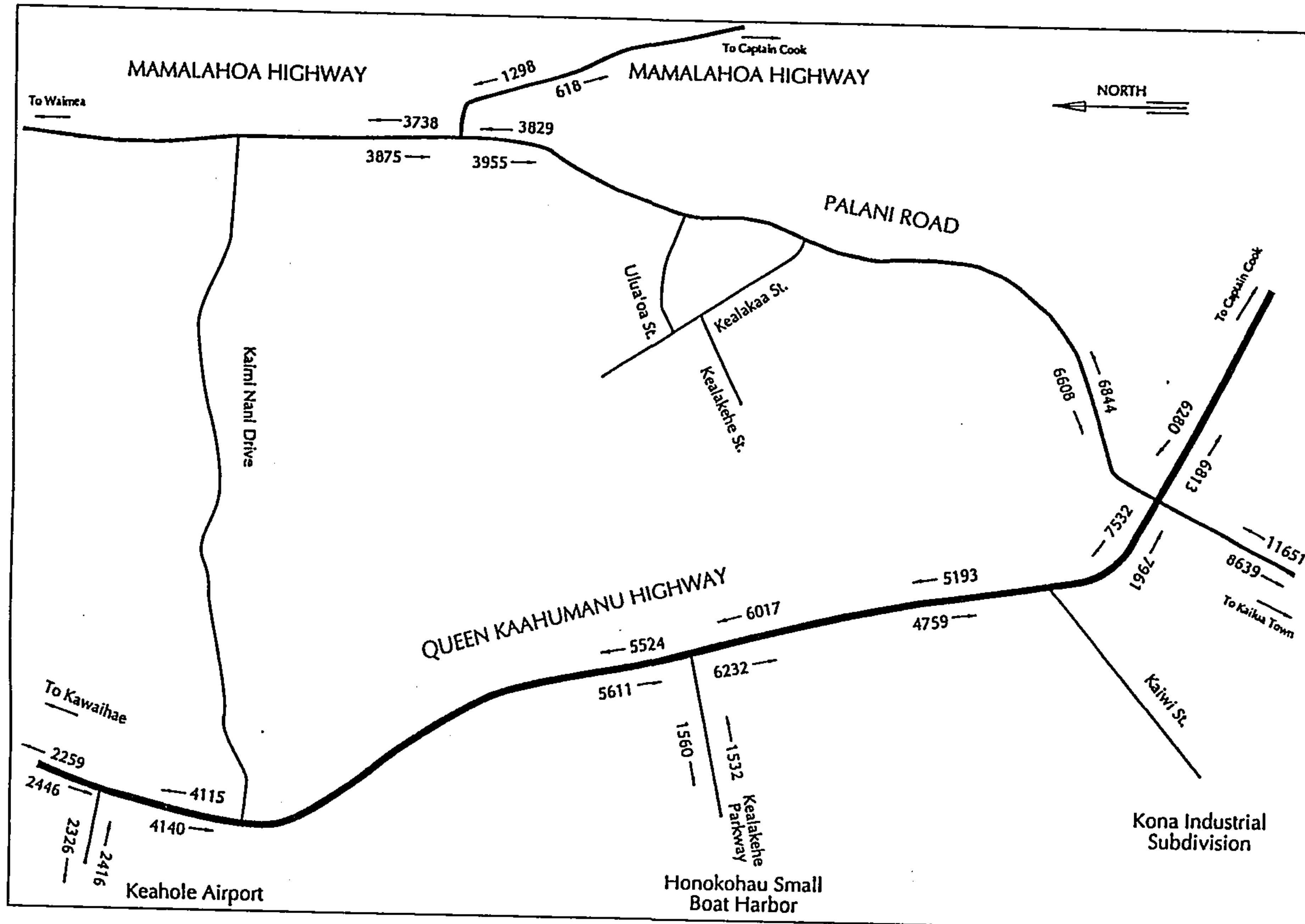

Figure 5. Existing 24-Hour Traffic Volumes

PRESENT LEVEL-OF-SERVICE

Based on the survey of existing conditions, traffic volumes at the study intersections were analyzed to determine the present level-of-service of the roadway network.

The capacity of existing roadways was estimated using procedures contained in the Highway Capacity Manual (HCM), Special Report 209 (1985). Intersection level-of-service (LOS) analysis was performed using the analysis methods for unsignalized and signalized intersections. In addition, level-of-service analysis for two-lane rural highways was also performed using the methods described in the HCM. A detailed explanation of each level of service category for all methods are provided in Appendix A.

The level-of-service for unsignalized intersections is determined by the amount of unused reserve capacity of a lane with the potential capacity limited by the size and frequency of gaps in conflicting traffic. Level-of-service ranges between A to F with LOS A representing little or no delays and LOS F representing extreme delays.

Level-of-service for signalized intersections is the quantitative measurement describing the operational conditions within a traffic stream, and defined in terms of average delay per vehicle in seconds. Delay is a measure of driver discomfort, freedom to maneuver, traffic interruptions, safety, and lost travel time. Level-of-service for signalized intersections also vary from LOS A to LOS F, however, these levels range from 5 seconds delay (LOS A) to over 60 seconds of delay (LOS F).

Analysis of Unsignalized Intersections

The results of level-of-service analysis for existing traffic conditions at *unsignalized* study intersections is shown below in Table 1. Through traffic and right turns from major streets are not analyzed in the HCM unsignalized intersection analysis, since these movements are generally not affected by other traffic flows.

Table 1. Existing Level-of-Service - Unsignalized Intersections

Turning Movement			AM Peak	PM Peak
Queen Kaahumanu Highway and Kealakehe Parkway				
Queen Kaahumanu Highway				
	Northbound	LT	A	C
Kealakehe Parkway				
	Eastbound	LT	D	E
		RT	A	C
Palani Road and Kealakaa Street				
Palani Road				
	Northbound	LT	B	A
Kealakaa Street				
	Eastbound	LT	D	D
		RT	D	A
Palani Road and Ulua'oa Street				
Palani Road				
	Northbound	LT	A	A
Ulua'oa Street				
	Eastbound	LT	C	D
		RT	A	A
Palani Road and Mamalahoa Highway				
Palani Road				
	Southbound	LT	A	A
Mamalahoa Highway				
	Westbound	LT	D	C
		RT	A	A

At the intersection of Queen Kaahumanu Highway with Kealakehe Parkway, drivers experience less delays during the morning peak hour than during the afternoon peak hour. While northbound drivers turning left from Queen Kaahumanu onto Kealakehe Parkway experience little or no delays (LOS A) during the morning peak hour, they experience LOS C, or average delays, during the afternoon peak hour. The same situation holds true for the drivers turning right from Kealakehe Parkway onto Queen Kaahumanu Highway. Vehicles turning left onto Queen Kaahumanu Highway from Kealakehe Parkway experience long delays (LOS D) during the morning peak hour and experience very long delays during the afternoon peak hour.

The intersection of Palani Road with Kealakaa Street operates with short delays to long delays during the morning peak hour. Vehicles turning left from Palani Road experience short delays (LOS B) while vehicles exiting Kealakaa Street experience long delays (LOS D). During the afternoon peak hour, vehicles turning left onto Palani Road experience LOS D (long delays) while vehicles turning right from Kealakaa Street into Palani Road and vehicles turning left into Kealakaa Street experience LOS A which means that they experience little or no delays.

At the intersection of Palani Road with Ulua'oa Street, vehicles turning left into Ulua'oa Street and vehicles turning right onto Palani Road experience little or no delays (LOS A) during both the morning and afternoon peak hours. Drivers turning left from Ulua'oa Street experience average delays (LOS C) during the morning peak hour and experience long delays (LOS D) during the afternoon peak hour.

The intersection of Palani Road with Mamalahoa Highway experiences from little or no delays to long delays. During the morning peak hour, drivers turning left from Mamalahoa Highway experience LOS D or long delays while drivers for the other movements experience little or no delays (LOS A). During the afternoon peak hour, drivers turning left from Mamalahoa Highway experience average delays (LOS C) while the other movements continue to experience little or no delays (LOS A).

Analysis of Signalized Intersections

The results of the operational analysis for the *signalized* intersection of Queen Kaahumanu Highway with Palani Road during the existing morning and afternoon peak hours are shown on Table 2.

Table 2. Existing Level-of-Service - Intersection of Queen Kaahumanu Highway and Palani Road

Movements	AM Peak	PM Peak
Queen Kaahumanu Highway		
Northbound	E	E
Southbound	E	E
Palani Road		
Eastbound	E	F
Westbound	E	F

The results of the analysis indicate that presently the intersection of Queen Kaahumanu Highway with Palani Road is operating at capacity during the morning peak hour with a LOS E indicating extremely long traffic delays for drivers. During the afternoon peak hour, the intersection operates at capacity with a LOS E indicating extremely long traffic delays. Vehicle approaches along Queen Kaahumanu Highway have a LOS E while approaches along Palani Road operate over capacity with a LOS F.

<u>Analysis of Two-Lane Highways</u>

This analysis method determines the level-of-service of specific sections on rural highways. The service flow rates of Queen Kaahumanu Highway, Mamalahoa Highway, and Palani Road were analyzed using the Two-Lane Rural Highway analysis from the Highway Capacity Manual[1].

Level-of-service for two-lane rural highways addresses the mobility and accessibility drivers have, and are described by average travel speed, percent time delay and utilization of capacity. The primary measure is percent time delay reflecting both mobility and access, and is defined as the average percent of time that all vehicles are delayed while travelling in platoons due to the inability to pass.

Level-of-service is classified into six categories ranging from LOS A to LOS F (summarized in Appendix A). The LOS for Rural Highways is not comparable to the LOS for Signalized or Unsignalized Intersections. The results of the analysis is shown in Table 3.

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[1] Highway Capacity Manual, Special Report 209, 1985 Edition, by the Transportation Research Board

The analysis indicates that on Queen Kaahumanu Highway, between Keahole Airport and Kealakehe Parkway, drivers notice an increase of platoon formation, platoon size, and frequency of passing impediment (LOS C) during the morning peak hour and during the afternoon peak hour, passing becomes extremely difficult (LOS D). In the section of the highway between Kealakehe Parkway and Kailua-Kona, drivers during the morning and afternoon peak hours experience, LOS D and LOS E, respectively.

Table 3. Existing Level-of-Service - Two Lane Rural Highway

	AM Peak			PM Peak		
	Capacity	Flow Rate	LOS	Capacity	Flow Rate	LOS
Queen Kaahumanu Highway						
Keahole Airport - Kealakehe Parkway	2447	850	C	2524	1391	D
Kealakehe Parkway - Palani Road	2472	1119	D	2527	1677	E
Palani Road						
Queen Kaahumanu Hwy - Ulua'oa St.	1423	1643	F	1354	1394	F
Kealakaa Street - Mamalahoa Hwy	1423	1188	E	1354	971	E
Mamalahoa Highway						
Palani Road - Kaimi Nani Drive	1607	1240	E	1706	899	E

Palani Road was analyzed on the segments between Queen Kaahumanu Highway and Ulua'oa Street, and between Kealakaa Street and Mamalahoa Highway. The results of the analysis shows that for the segment between Queen Kaahumanu Highway and Ulua'oa Street, the roadway operates with heavily congested flow with traffic demand exceeding capacity (LOS F) during the morning and afternoon peak hours. The capacity values are based on studies of similar conditions. The measured volumes indicate a situation which exceeds most traffic volumes experienced in similar conditions.

For the segment on Palani Road between Kealakaa Street and Mamalahoa Highway, drivers experience LOS E (percent time delay is greater than 75 percent) during the morning and afternoon peak hours. For the section along Mamalahoa Highway between Palani Road and Kaimi Nani Drive, drivers also experience LOS E during both peak hours. The results indicate that drivers along Queen Kaahumanu Highway generally experience LOS C or D between Keahole Airport and Palani Road during the morning and afternoon peak hours.

PROJECTED TRAFFIC CONDITIONS

The Island of Hawaii is currently experiencing considerable growth in population and employment with the majority of growth concentrated in the West Hawaii region (the West Hawaii region includes the South Kohala, and North and South Kona Districts).

By the year 2010, 37% of the residential units on the island of Hawaii will be located in the North Kona District. South Hilo will have 26% of the island's residential units and South Kohala will have 13%. Of the three districts projected to have the most residential units, two (South Kohala and North Kona) are located in the West Hawaii region. North Kona will also have the most resort condominiums (66.5% of the island total) and hotel units (51.9% of the island total) by 2010. South Kohala follows with 32% of the island's resort condominiums and 40% of the hotel units.

FUTURE LAND USES

Future traffic forecasts without and with the project were forecasted for the year 2010 when the project is expected to be completed and fully occupied.

The forecasted growth in population and employment for Hawaii was obtained directly from projections by the County of Hawaii. The projections provide estimates of population and employment growth for each judicial district from the baseline year 1987 until the year 2010. The forecasts are shown below in Tables 4 and 5. According to the County of Hawaii, in 1987, there was a population of approximately 114,300 people and 46,100 jobs on Hawaii. By the year 2010, these totals are projected to rise to 206,100 people and 85,025 jobs, an increase of 80% and 84%, respectively. This will result in a corresponding increase in the traffic.

Table 4. Population Forecasts for Hawaii

District	1987	2010	Growth	% Growth
Puna	19,003	39,865	20,862	110%
South Hilo	45,303	55,520	10,217	23%
North Hilo	1,495	1,500	5	0%
Hamakua	5,303	8,085	2,782	52%
North Kohala	3,602	8,470	4,868	135%
South Kohala	7,097	22,300	15,203	214%
North Kona	20,503	52,620	32,117	157%
South Kona	7,293	10,660	3,367	46%
Ka'u	4,700	7,080	2,380	51%

As indicated in Table 4, the Puna, South Hilo, South Kohala and North Kona Districts are forecasted to have the most population growth. North Kona is expected to have the greatest growth, with a growth of over 32,000 people, (157%).

Table 5. Employment Forecasts for Hawaii

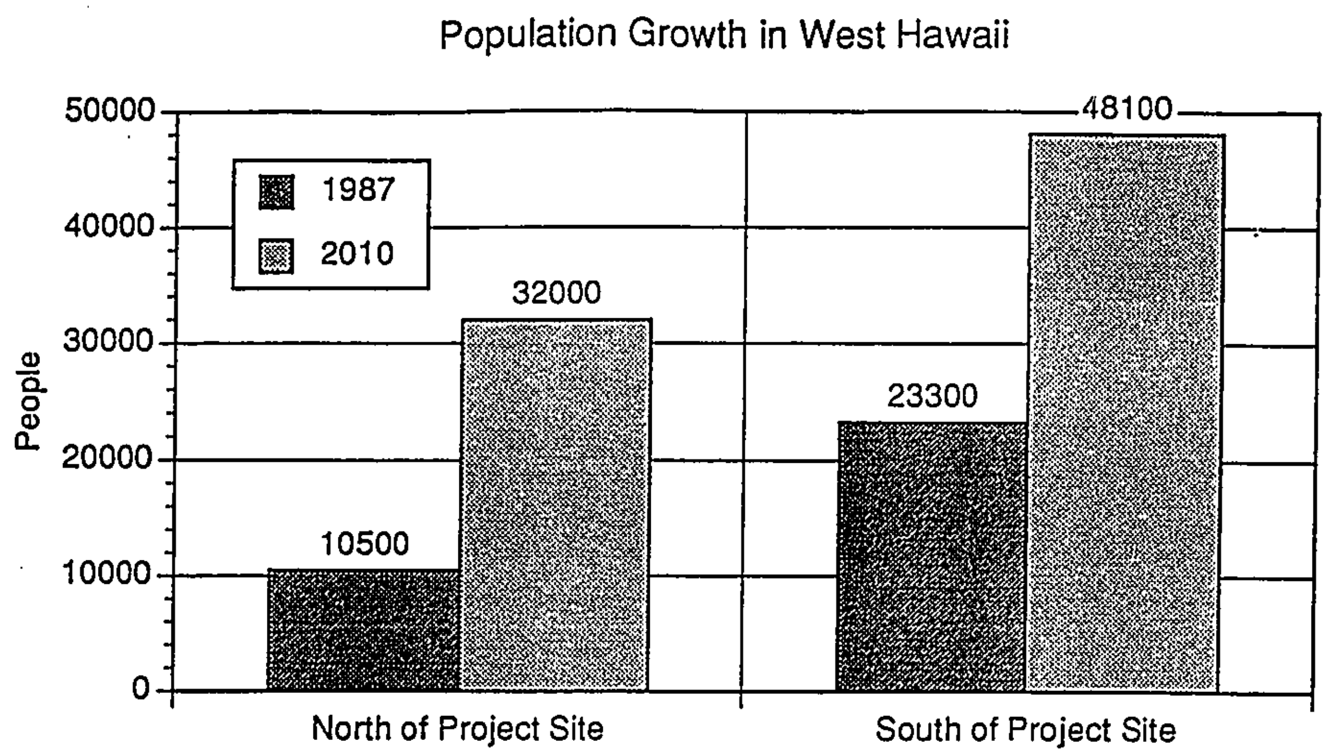
District	1987	2010	Growth	% Growth
Puna	4,407	6,990	2,583	59%
South Hilo	18,797	25,244	6,447	34%
North Hilo	288	212	-76	-26%
Hamakua	2,023	2,725	702	35%
North Kohala	786	1,290	504	64%
South Kohala	4,246	15,333	11,087	261%
North Kona	13,276	26,189	12,913	97%
South Kona	302	4,459	4,157	1376%
Ka'u	1,974	2,583	609	31%

As indicated by Table 5, the South Kohala, and North Kona districts are projected to have a dramatic increase in employment. South Kohala is forecasted to have a growth of over 11,000 jobs (261%) and North Kona is expected to increase employment by almost 13,000 jobs, (97%). North Hilo is the only district expected to have a decrease in jobs (76 jobs or a 26% decrease).

As a result of the forecasted growth of the West Hawaii region, a large area was used to model the traffic pattern created by this growth. The South Kohala, North Kona and South Kona districts will have the most impact on the planned community due to their close proximity to the project site and because of their large forecasted growth. The considerable growth in the West Hawaii region will create a tendency for more people to travel between the South Kohala and Kona Districts changing the general traffic pattern in the area.

The population of the areas north of the project site (South Kohala and areas in North Kona north of the project site) will increase from approximately 10,500 people in 1987 to over 32,000 people in 2010, an increase of 21,500 people. South of the project site (South Kona and areas south of the project site in North Kona), there was a 1987 population of 23,300 people and a forecasted population of over 48,100 people, an increase of 24,800 people by 2010. (See Figure 6.) Total population growth in the North and South Kona and South Kohala Districts would equal 46,300 people. Employment in the area will also increase dramatically by 2010.

In 1987 there were approximately 4,500 jobs in the areas north of Kealakehe and 13,300 jobs south of Kealakehe. Of the forecasted 2010 employment in these three districts, approximately 21,100 jobs will be located north of the Kealakehe Planned Community and 22,300 jobs will be located to the south. The net effect of these forecasts is an increase of 16,600 jobs north of the project and 9,000 jobs south of the project site. Since there will be a larger increase in population below the project and a larger increase in employment north of the project, it is expected that there will be an increased likelihood of travel between these districts in 2010. (See Figure 7.)



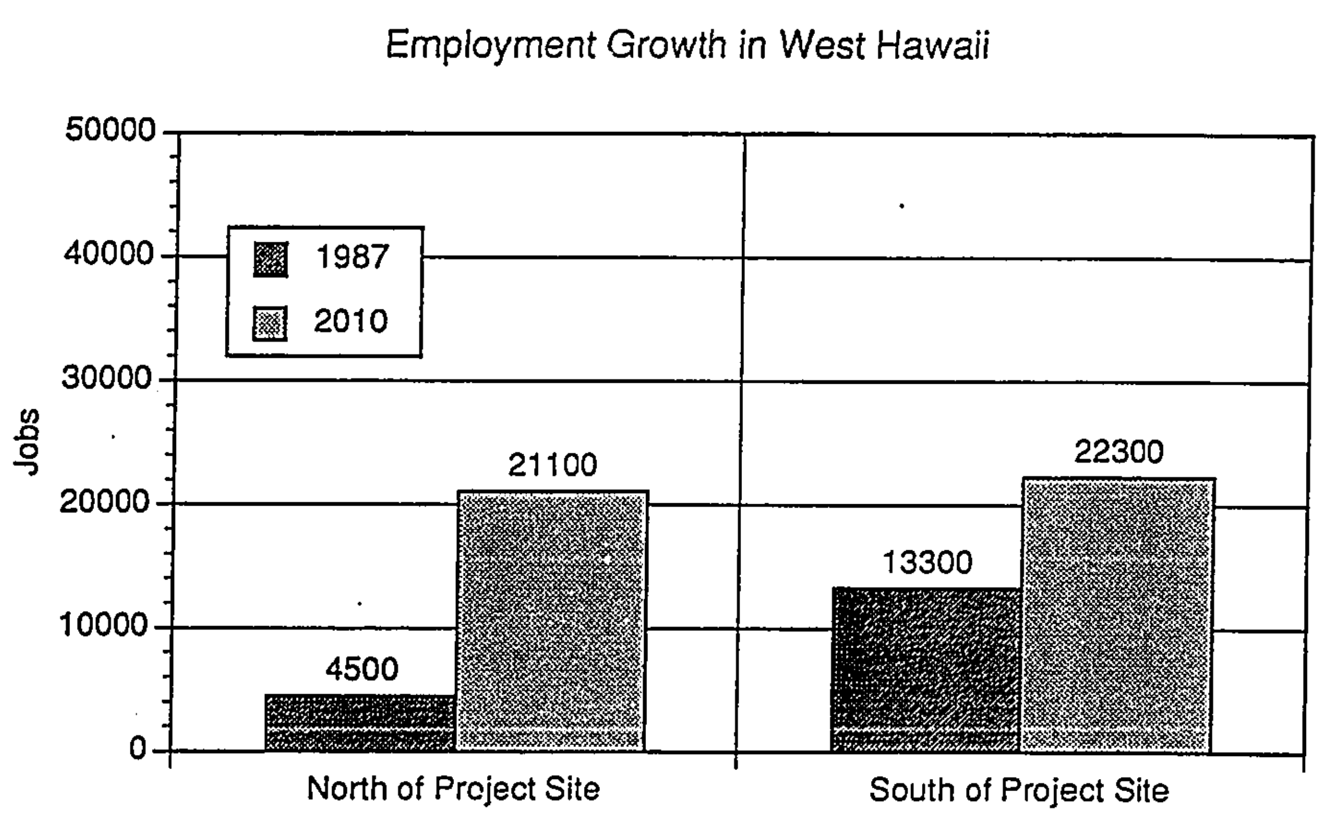


Figure 6. Population & Employment Growth in West Hawaii

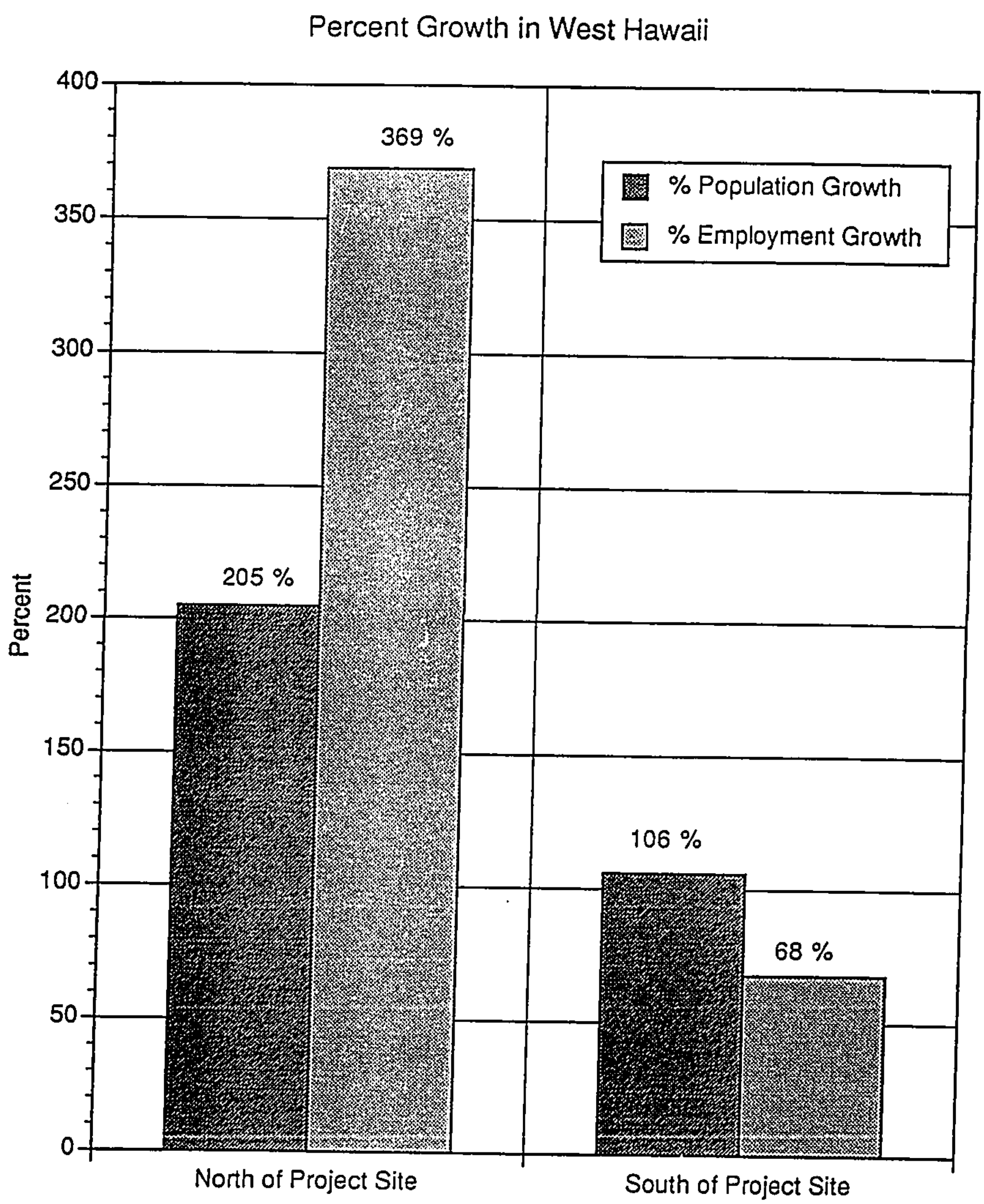


Figure 7. Percent Growth in West Hawaii

FUTURE ROADWAY FACILITIES

Currently, the County of Hawaii is planning to expand existing roadways and building new roadways to accommodate the expected growth in the region between Keahole and Kailua. According to the Draft Keahole To Kailua Development Plan dated September 1989, by R. M. Towill Corporation, two of the major roadways being planned are the Palani Bypass Road and the Queen Kaahumanu Highway Expansion.

The Palani Bypass Road is proposed to connect with the existing Palani Road near Kailua town and bypass and the residential areas Palani Road serves near Kealakehe. The Bypass Road will then connect with Palani Road near the intersection of Palani Road with Mamalahoa Highway. The proposed Palani Bypass Road is planned to be a minor arterial road with a right-of-way width of 100 feet, length of 2.6 miles, and have 4 to 6 lanes.

Queen Kaahumanu Highway is planned for expansion of 7.8 miles in the approximate area between Keahole Airport and just south of Palani Road. The existing two lane Queen Kaahumanu Highway is proposed to be expanded to be a 6 lane divided major arterial with a right-of-way width between 150 to 300 feet.

The Kealakehe Planned Community is served by two proposed arterial roadways. The first roadway is an extension of the existing Kealakehe Parkway. The existing Kealakehe Parkway will be realigned to the south and the extension will extend west to east from Queen Kaahumanu Highway to Mamalahoa Highway. The Kealakehe Parkway Extension is planned to be a 4 to 6 lane arterial roadway within a 120-foot right-of-way.

The second arterial roadway, called the Mid-Level roadway, bisects the project site and extends north to south. It is proposed by the County of Hawaii to serve as a major arterial with a 120-foot right-of-way paralleling Queen Kaahumanu Highway and extending from Palani Road to the northern end of the project site.

Road "A" will be a two-lane roadway that will run in the north-south direction. This roadway will provide vehicles in the project site access to Palani Road.

Collector roads will serve to provide access to the various developments within the Kealakehe Planned Community.

TRAFFIC FORECASTS

In order to forecast traffic in the study area, the Island of Hawaii was divided into zones. Since the State of Hawaii has divided the island into 190 Traffic Assignment Zones (TAZ) for an island wide study, these same zones were used for this study. The land uses for each district were based on information provided by the County of Hawaii who also used the TAZ zones as a framework for their land use forecasts.

Forecasting for the project was done using a computer model. The model was constructed to simulate the general roadway network of the island of Hawaii and a more detailed roadway network for the Kona subarea. The network in the computer model consists of centroids, which represent land areas such as Puna, Hilo, and Kailua-Kona; nodes, which represent intersections; and links, which represent the roadways. Each centroid, node, and link has its own respective attributes.

Centroid attributes consist of the number of retail and non-retail employment, the number of dwelling units and intrazonal travel time which the model uses to determine the amount of trips produced by or attracted to that particular centroid. The node attributes consist of through, left and right turning penalties which is meant to simulate the waiting time a driver experiences when going through or turning at an intersection. Link attributes consist of travel time and capacity which is used to simulate the size and quality of a roadway.

The computer model accomplishes its forecast by first determining the number of vehicle trips that begin and end in each zone. This step in the model is called "trip generation". The number of trips that begin in a zone is called that zone's "trip production". The number of trips that end in a zone is called that zone's "trip attraction".

The model separately determines trip productions and trip attractions for three purposes: home-based work (people travelling to and from home to work); home-based nonwork (people travelling to non job related activities from home); and nonhome-based (people running errands from places other than home). Trip productions and trip attractions are estimated for a full weekday.

The model divides a trip into two legs: (1) going to a destination, and (2) returning from the destination. It estimates trip productions and attractions for both legs at once. Trip attractions are calculated from the following relationship:

$$A_{ik} = b_k E_i^r + c_k E_i^h + d_k H_i$$

where

A_{ik} = trip attraction of zone i for purpose k;
b_k, c_k, d_k = trip attraction parameters for purpose k;
E_i^r = retail employees in zone i;
E_i^n = nonretail employees in zone i; and
H_i = dwelling units in zone i.

Table 6. Trip Attraction Rates [2]

Purpose	Retail Employees	Non Retail Employees	Dwelling Units
Home-based Work	1.7	1.7	0.0
Home-based Nonwork	10.0	0.5	1.0
Nonhome-based	2.0	2.5	0.5

[2] source: NCHRP report 187, p. 15

Trip productions are found by first finding the total number of trips produced in a zone for the three trip purposes and the allocating this total to each purpose.

Trip productions are calculated using the following relationship:

$$P_{ik} = P_{it} w_{ik}$$

where

P_{ik} = Production of zone i for purpose k;
P_{it} = total trips produced in zone i;
w_{ik} = factor for trip purpose k

$w_{ik} = w_{uk} / 100$ for $k = 1, 2, 3$
(percentage of total production that should be allocated to purpose 1, 2, or 3; see Table 7.)

Table 7. Trip Production Parameters [3]

Parameter	Size of Urban Area (1,000's) 100-250
Average Trip Production	10.0
Home-based Work Percent	20.0
Home-based Nonwork Percent	57.0
Nonhome-based Percent	23.0

[3] source: NCHRP report 187, p. 13-14 and ITE Trip Generation Manual

Trips generated by the future land uses from each zone were based on the dwelling units, resort units, and employment in each zone.

The second step in the forecast is to determine for each purpose the number of person trips that go from any given "origin" zone to any given "destination" zone. Two such zones are referred to as an "O-D pair". An O-D pair receives a relatively large allocation of trips if (1) the trip productions in the origin zone are large, (2) the trip attractions in the destination zone are large or (3) the travel time between the zones is small. This step in the gravity model is called "trip distribution".

Trips produced in one zone were distributed to other zones using the gravity model. This model is based on the assumption that all trips "produced" from one zone are attracted to all other zones in direct proportion to the "attractions" in these zones and in inverse proportion to the spatial separation or travel impedance between the zones. Attractions which would motivate people to make trips include employment, shopping, and recreation. Travel impedance is related to human behavior and is based on estimated travel times between zones. The more difficult the trip (long distance to travel or long travel time) the less likely a driver would make the trip.

The gravity model method can be mathematically expressed as:

$$T_{ij} = P_i \frac{A_j F_{ij}}{\sum_{j=1}^{n} A_j F_{ij}}$$

where,

T_{ij} = trips produced in zone i, and attracted to zone j;
P_i = total trip production at i;
A_j = total trip attraction at j;
F_{ij} = friction factor for trip interchange ij;
i = origin zone number, i=1, 2, 3,...n;
n = number of zones

The computer model was used to derive an initial trip distribution table. This table was then adjusted manually outside of the computer model based on knowledge of the West Hawaii area that the computer model could not implement in its calculations. The manually adjusted trip table was then reinserted into the model.

The third step in the traffic forecast is to determine which roadway links will be used by the traffic traversing between the O-D pair. This step is called "trip assignment". Trip assignment places traffic on a specific route on the roadway network that a driver will take from origin to destination. Assignment to the roadways are done based on the shortest path and the capacity of the roadways between the O-D pair.

Due to the tourism oriented economy of West Hawaii, the distribution of tourist traffic was treated specially in the computer model. A trip distribution table was manually derived based upon projected resort and hotel developments around the Island of Hawaii and imported into the computer model separately. The main generators and attractors for tourist traffic were Keahole Airport, South Kohala and Kailua-Kona.

Project Generated Traffic

Vehicle trips generated by the Kealakehe project was calculated manually using the ITE Trip Generation Report. The project traffic was then inserted into the computer model in addition to the ambient traffic which the computer had generated. This allowed for sufficient control and detail in determining the project generated traffic. Table 8 shows the trips generated by the project during the morning and afternoon peak hours.

Table 8. Trip Generation for Kealakehe Project

Land Use	Size	Units	Morning Enter	Morning Exit	Afternoon Enter	Afternoon Exit
Residential development						
Single Family Market	1270	DU	220	595	747	439
Single Family Affordable	1535	DU	262	707	893	524
Single Family Market (120%-140%)	230	DU	46	126	150	88
Multi Family Market	258	DU	29	105	105	57
Multi Family Affordable	228	DU	26	92	93	50
Multi Family Rental	858	DU	98	347	350	189
Total Residential Trips	**4379**	**DU**	**681**	**1972**	**2388**	**1347**
Shopping Center Development						
Community Center	218	1000 sf	195	84	443	500
Neighborhood Center	64	1000 sf	124	52	338	352
Total Shopping Center Trips	**282**	***1000 sf***	**319**	**136**	**781**	**852**
School Development						
Elementary School	900	students	119	79	6	8
High School	1700	students	437	236	26	44
Total School Trips	**2600**	**students**	**556**	**315**	**32**	**52**
Recreational Development						
Recreational Center	10	employees	40	27	31	47
Community Park	8	acres	10	20	14	12
Public Golf Course	200	parking	52	9	10	42
Total Recreational Trips			**102**	**46**	**55**	**101**
Other Developments						
Church	40	1000 sf	4	2	6	6
Day Care	30	1000 sf	180	160	178	192
Civic Center	1000	employees	488	60	216	480
Total Other Trips			**672**	**222**	**400**	**678**
TOTAL PROJECT GENERATED TRIPS			**2330**	**2691**	**3606**	**3030**

TOTAL TRAFFIC WITHOUT AND WITH PROJECT

Table 9 shows the existing and forecasted turning movements with and without the project for the morning peak hour at the study intersections. Table 10 shows the existing and forecasted turning movements with and without the project for the afternoon peak hour. For the without project condition, it was assumed that Kealakehe Parkway would not exist and was therefore excluded from the without project scenario.

The ambient traffic volumes were generated, distributed and assigned by the computer model with Kealakehe totally excluded except for the existing residential development. This was used to obtain forecasts for the daily traffic in *2010 without project* case. These values were then factored down to 8% to derive the peak hour volumes which were then directionally split by the model to determine am and pm peak hour volumes *without* project, and are shown in Figures 8 and 9.

The traffic generated by the Kealakehe project was calculated using ITE Trip Generation, inserted into the computer model which then assigned the traffic to the links to obtain with project daily traffic volumes. Am and pm peak hour volumes *with project* were derived in the same manner as mentioned above, and are shown in Figures 10 and 11.

Table 9. Morning Peak Hour Forecast Traffic

Turning Movement		Existing Traffic 1990	Without Project 2010	With Project 2010
Queen Kaahumanu Highway at Kealakehe Parkway				
Queen Kaahumanu Highway				
Northbound	LT	92	200	220
	TH	447	2010	1690
	RT	N/A	N/A	500
Southbound	LT	N/A	N/A	930
	TH	452	1350	910
	RT	56	100	50
Kealakehe Parkway				
Eastbound	LT	24	70	50
(Honokohau Harbor)	TH	N/A	N/A	70
	RT	50	120	220
Westbound	LT	N/A	N/A	470
(Project Rd)	TH	N/A	N/A	60
	RT	N/A	N/A	1010
Queen Kaahumanu Highway at Palani Road				
Queen Kaahumanu Highway				
Northbound	LT	139	310	230
	TH	398	1250	1370
	RT	196	320	610
Southbound	LT	69	150	70
	TH	200	820	610
	RT	220	390	290
Palani Road				
Eastbound	LT	250	550	670
	TH	186	510	530
	RT	98	210	210
Westbound	LT	343	510	610
	TH	485	1230	1640
	RT	232	290	100

N/A - Not Applicable

Table 9. Morning Peak Hour Forecast Traffic (continued)

Turning Movement		Existing Traffic 1990	Without Project 2010	With Project 2010
Palani Road at Mamalahoa Highway				
Palani Road/Mamalahoa Highway				
Northbound	TH	206	710	500
	RT	62	40	80
Southbound	LT	51	95	140
	TH	504	1325	560
Mamalahoa Highway				
Westbound	LT	95	75	100
	RT	42	60	95
Mamalahoa Highway at Kealakehe Parkway				
Mamalahoa Highway				
Northbound	LT	N/A	N/A	100
	TH	524	770	630
Southbound	TH	555	1420	470
	RT	N/A	N/A	460
Kealakehe Parkway				
Eastbound	LT	N/A	N/A	770
	RT	N/A	N/A	100

N/A - Not Applicable

Table 10. Afternoon Peak Hour Forecast Traffic

Turning Movement		Existing Traffic 1990	Without Project 2010	With Project 2010
Queen Kaahumanu Highway at Kealakehe Parkway				
Queen Kaahumanu Highway				
Northbound	LT	100	100	220
	TH	505	1280	1390
	RT	N/A	N/A	400
Southbound	LT	N/A	N/A	1530
	TH	811	2400	1170
	RT	75	70	50
Kealakehe Parkway				
Eastbound	LT	38	80	50
	TH	N/A	N/A	70
	RT	93	100	220
Westbound (Project Rd)	LT	N/A	N/A	620
	TH	N/A	N/A	60
	RT	N/A	N/A	400
Queen Kaahumanu Highway at Palani Road				
Queen Kaahumanu Highway				
Northbound	LT	189	240	240
	TH	230	900	900
	RT	168	250	250
Southbound	LT	186	550	510
	TH	428	1080	1090
	RT	501	610	630
Palani Road				
Eastbound	LT	326	460	460
	TH	491	1010	1010
	RT	352	500	590
Westbound	LT	178	290	290
	TH	300	760	760
	RT	80	230	230

N/A - Not Applicable

Table 10. Afternoon Peak Hour Forecast Traffic (continued)

Turning Movement		Existing Traffic 1990	Without Project 2010	With Project 2010
Palani Road at Mamalahoa Highway				
Palani Road/Mamalahoa Highway				
Northbound	TH	480	1245	640
	RT	71	95	80
Southbound	LT	38	15	140
	TH	265	835	440
Mamalahoa Highway				
Westbound	LT	39	70	110
	RT	44	85	90
Mamalahoa Highway at Kealakehe Parkway				
Mamalahoa Highway				
Northbound	LT	N/A	N/A	40
	TH	524	1360	540
Southbound	TH	303	830	620
	RT	N/A	N/A	890
Kealakehe Parkway				
Eastbound	LT	N/A	N/A	300
	RT	N/A	N/A	100

N/A - Not Applicable

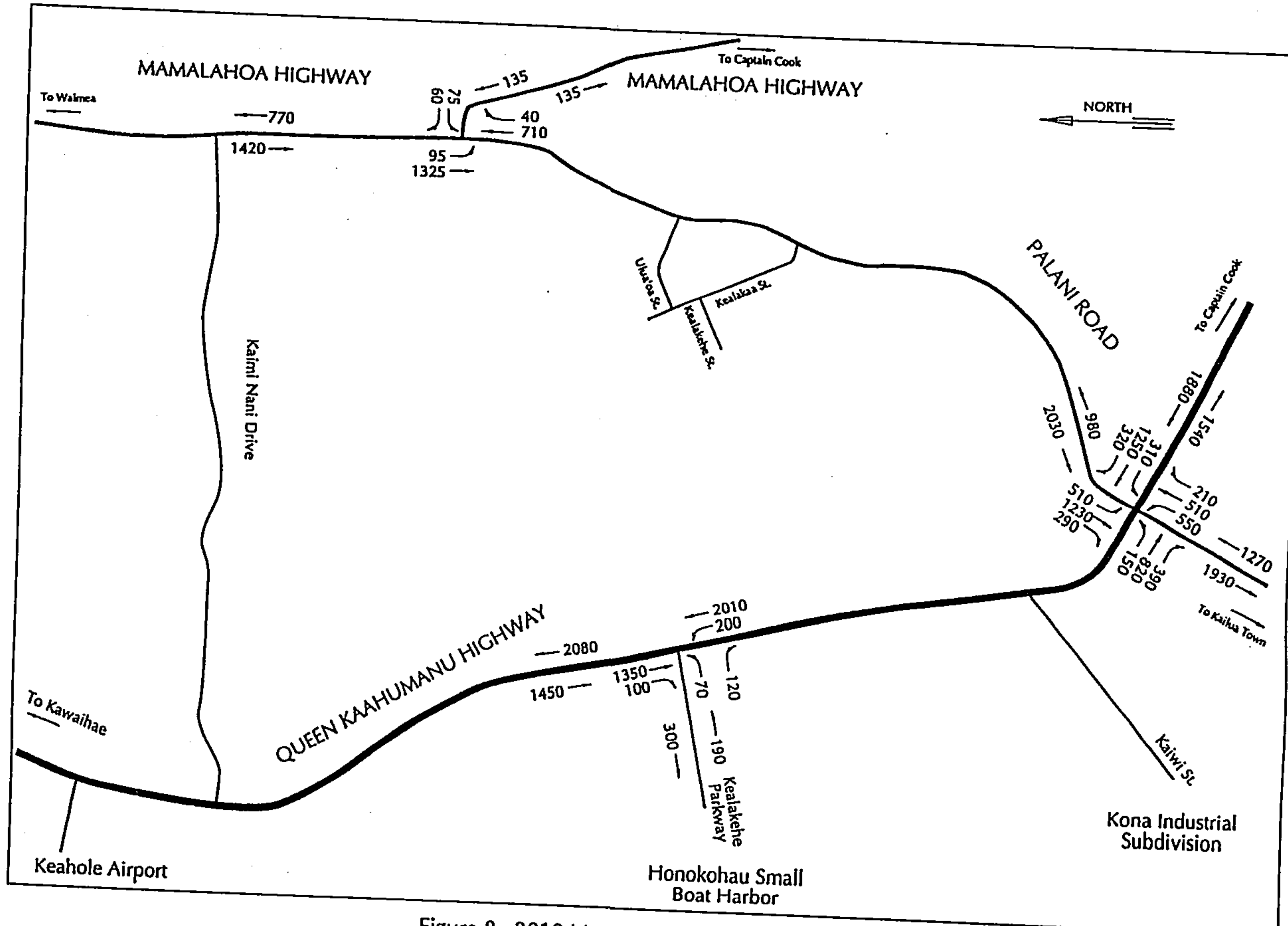


Figure 8. 2010 Morning Peak Hour Volumes Without Project

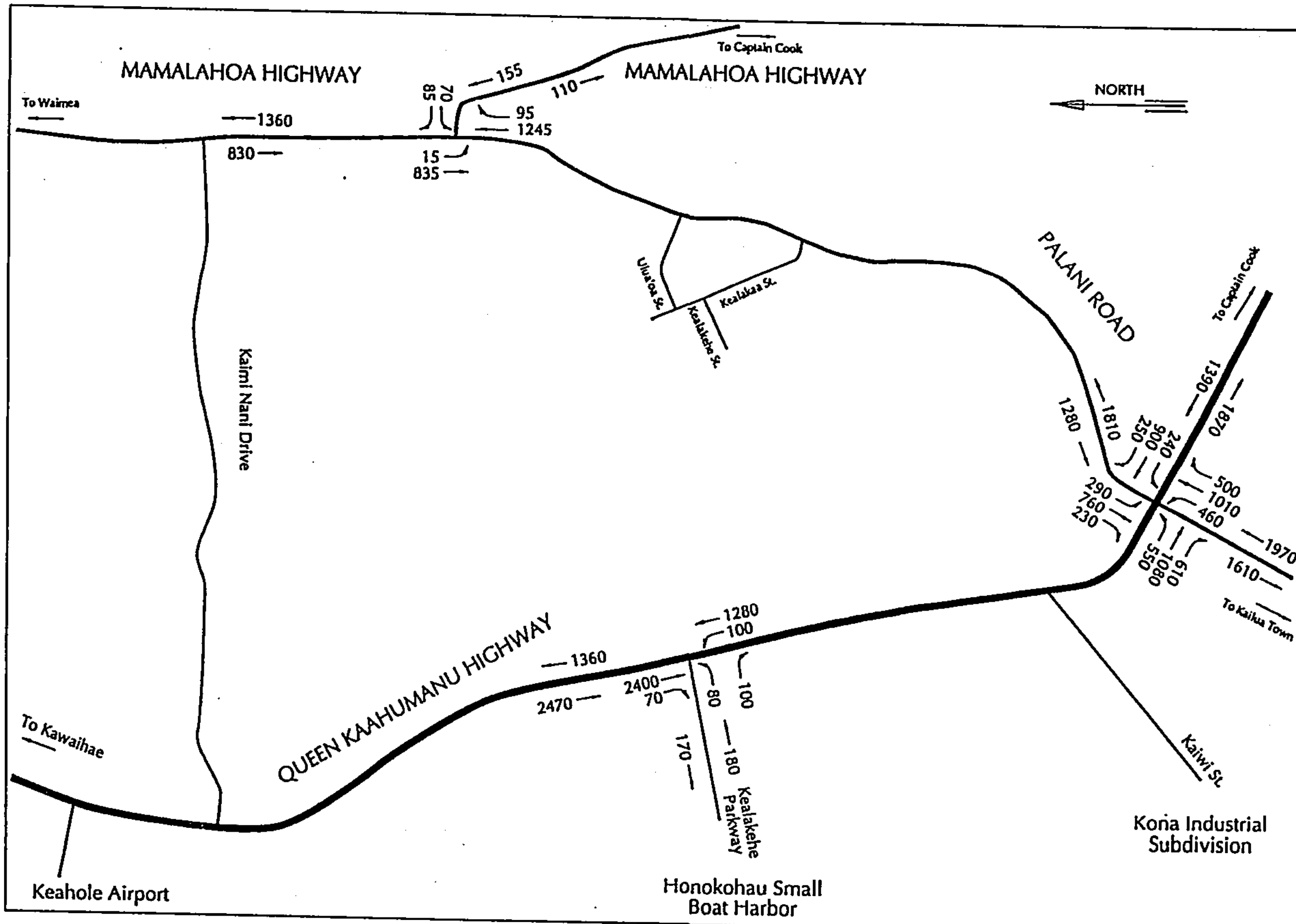


Figure 9. 2010 Afternoon Peak Hour Volumes Without Project

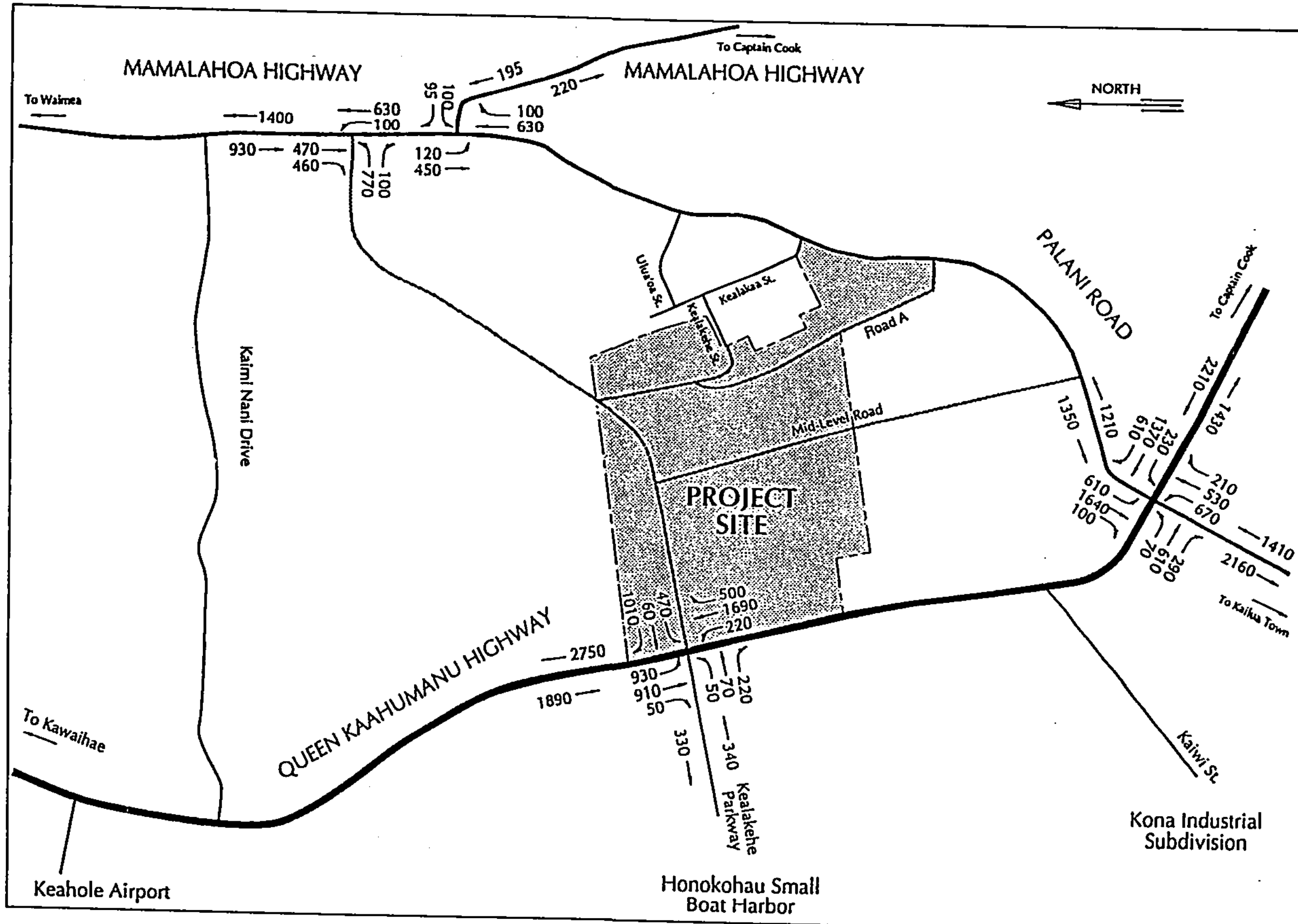


Figure 10. 2010 Morning Peak Hour Volumes With Project

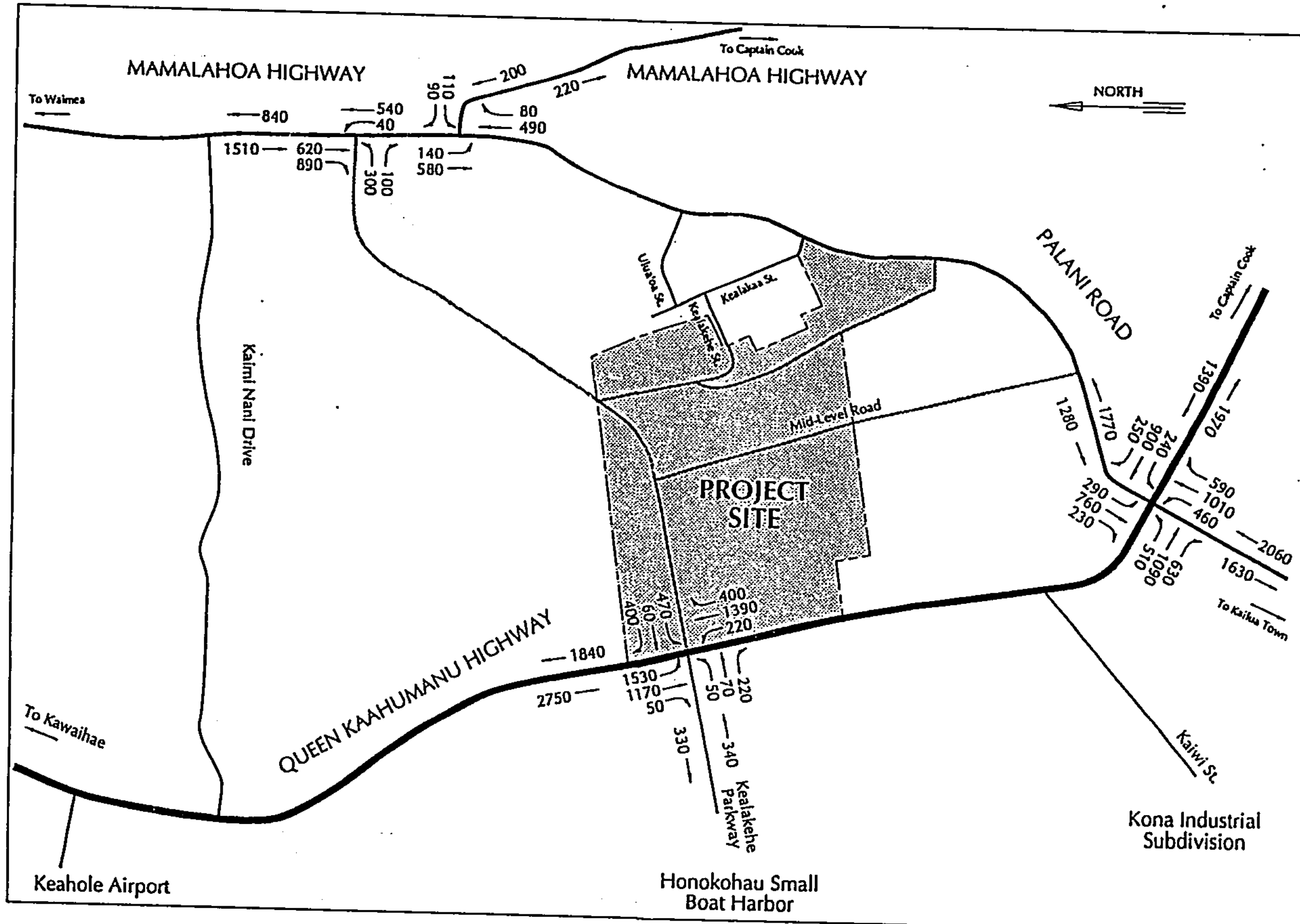


Figure 11. 2010 Afternoon Peak Hour Volumes With Project

TRAFFIC IMPACT ANALYSIS

As background, it is important to note that population and employment in the West Hawaii Area is projected to more than double by the year 2010. This will cause a corresponding increase in traffic in the area. Even without the Kealakehe Planned Community, roadway facilities will not have the capacity to handle forecast traffic volumes at an acceptable level-of-service (as shown in the following analysis). Therefore, extensive roadway network improvements are necessary. Due to the expected lack of adequate roadway facilities by the year 2010, traffic impacts were measured by the capacity analysis method.

Traffic impacts resulting from the Kealakehe Planned Community project were measured by determining first the improvements required to accommodate forecast traffic *without the project* for the year 2010 then determining the additional improvements required to accommodate traffic *with the project*. The additional improvements are a measure of the impact of the project.

Highway capacity, intersection capacity, and level-of-service (LOS) were used to determine the needed improvements for without and with project. Highways were sized (number of lanes) using LOS D as the minimum acceptable LOS, intersections were sized to operate under capacity when signalized, and unsignalized intersections were signalized if minor streets encountered extreme delays. At major intersections where signalization was deemed unacceptable, grade separated interchanges were considered.

It is important to differentiate between future roadway improvements that would be necessary to mitigate traffic growth from planned developments and those improvements required to mitigate impacts from the Kealakehe Planned Community project . The required roadway improvements are listed under the subsequent sections titled: "2010 Roadway Network Without Project," and "2010 Roadway Network With Project."

2010 ROADWAY NETWORK WITHOUT PROJECT

Even without the project, extensive roadway improvements will be necessary to handle the projected future traffic from other planned developments in the West Hawaii area. The following improvements (or of similar magnitude) are required based on our analysis of the forecast traffic without the project to the year 2010:

- Widen Queen Kaahumanu Highway to 4 lanes between Palani Road and the Keahole Airport,
- Widen Palani Road to 4 lanes between Mamalahoa Highway and Queen Kaahumanu Highway,
- Widen Mamalahoa Highway to 4 lanes between Kaimi Nani Street and Palani Road,
- Signalize the intersection of Mamalahoa Highway and Palani Road when warranted,

- Provide a grade separated interchange at the intersection of Queen Kaahumanu Highway and Palani Road, and

- Signalize intersection of Queen Kaahumanu/Kealakehe Parkway until a frontage road is in place to connect to Kealakehe Parkway. (This is to conform with State DOT policy regarding uninterrupted traffic flow condition along Queen Kaahumanu Highway.)

Highway Analysis

The following roadways were analyzed using methods from the HCM to determine the roadway facilities necessary to accommodate forecast 2010 traffic without the project:

- Queen Kaahumanu Highway,
- Mamalahoa Highway, and
- Palani Road.

The results of the highway analysis are shown in Table 11.

Table 11. Level-of-Service - Highway Analysis

	Existing Roadway Existing Conditions		Existing Roadway Without Project		With Roadway Improvements Without Project		With Roadway Improvements With Project	
	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
	Queen Kaahumanu Hwy. (2-lane)				Queen Kaahumanu Hwy. (4-lane)			
Keahole Airport & Kealakehe Parkway								
Northbound	C	D	F	F	C	B	D	C
Southbound	C	D	F	F	B	D	C	D
Kealakehe Parkway & Palani Road								
Northbound	D	E	F	F	B	B	C	B
Southbound	D	E	F	F	B	B	B	B
	Palani Road (2-lane)				Palani Road (4-lane)			
Mamalahoa Highway & Ulua 'oa Street								
Northbound	E	E	F	F	C	C	B	B
Southbound	E	E	F	F	C	B	B	B
Kealakaa Street & Queen Kaahumanu Highway								
Eastbound	F	F	F	F	B	D	C	D
Westbound	F	F	F	F	D	C	C	C
	Mamalahoa Highway (2-lane)				Mamalahoa Highway (4-lane)			
Palani Road & Kaimi Nani Drive								
Northbound	E	E	F	F	A	B	B	A
Southbound	E	E	F	F	B	A	A	B
	Kealakehe Parkway (2-lane)				Kealakehe Parkway (4-lane)			
Kealakehe Parkway & Queen Kaahumanu Highway								
Eastbound	n/a	n/a	n/a	n/a	n/a	n/a	C	D
Westbound	n/a	n/a	n/a	n/a	n/a	n/a	C	B

Queen Kaahumanu Highway

1990 Existing Traffic on Existing 2 Lane Queen Kaahumanu: As described in the "Existing Conditions" chapter, the existing LOS on Queen Kaahumanu Highway is LOS C and LOS D during the morning and afternoon peak hours, respectively, between Keahole Airport and Kealakehe Parkway. Between Kealakehe Parkway and Palani Road, Queen Kaahumanu drivers during the morning and afternoon peak hours experience LOS D and LOS E, respectively.

2010 Forecast Traffic Without Project on Existing 2 Lane Queen Kaahumanu: Without the project by the year 2010, the level of service is expected to drop to LOS F during the morning and afternoon peak hours. The demand will exceed the capacity and there will be heavily congested flow. Since Queen Kaahumanu would operate at LOS F with two lanes, it was assumed that this highway would be a four lane highway by 2010.

2010 Forecast Traffic Without Project on 4 Lane Queen Kaahumanu: With Queen Kaahumanu widened to 4 lanes by 2010, the highway will generally operate at LOS B during the morning and afternoon peak hours between Keahole Airport and Palani Road. The only exception would be southbound drivers between the Airport and the Parkway will experience LOS D during the afternoon peak hour.

Palani Road

1990 Existing Traffic on Existing 2 Lane Palani: The existing LOS along Palani Road, between Queen Kaahumanu Highway and Ulua'oa

Street, is LOS F during the morning and afternoon peak hours. The roadway operates with heavily congested flow with traffic demand exceeding capacity during both peak hours. For the segment along Palani Road between Kealakaa Street and Mamalahoa Highway, drivers experience LOS E during the morning and afternoon peak hours.

2010 Forecast Traffic Without Project on Existing 2 Lane Palani: Without the project by the year 2010, the level of service is expected to operate at LOS F during both morning and afternoon peak hours between Mamalahoa to Queen Kaahumanu. Since Palani would operate at LOS F with two lanes, it was assumed that this highway would be a four lane highway by 2010.

2010 Forecast Traffic Without Project on 4 Lane Palani: With Palani widened to 4 lanes by 2010, the road will generally operate at LOS C during the morning and afternoon peak hours between Uluaoa and Mamalahoa. Between Kealakaa Street and Queen Kaahumanu the road will operate at LOS D for eastbound drivers during the afternoon peak hour and LOS D for westbound drivers during the morning peak hour. The other movements along the road would operate at LOS B or C.

Mamalahoa Highway

1990 Existing Traffic on Existing 2 Lane Mamalahoa: For the section of Mamalahoa Highway between Palani Road and Kaimi Nani Drive, drivers currently experience LOS E during both peak hours.

2010 Forecast Traffic Without Project on Existing 2 Lane Mamalahoa: Without the project by the year 2010, the level of service is expected to be LOS

F during the morning and afternoon peak hours. The demand will exceed the capacity and there will be heavily congested flow. Since Mamalahoa would operate at LOS F with two lanes, it was assumed that this highway would be a four lane highway by 2010.

2010 Forecast Traffic Without Project on 4 Lane Mamalahoa: With Mamalahoa widened to 4 lanes, the highway will operate at LOS A or B during the morning and afternoon peak hours in 2010.

Intersection Analysis

The following intersections were analyzed using methods from the HCM to determine the intersection requirements necessary to accommodate forecast 2010 traffic without the project:

- Queen Kaahumanu Highway and Kealakehe Parkway,
- Queen Kaahumanu Highway and Palani Road,
- Mamalahoa Highway and Palani Road, and
- Palani Road and Minor Streets (Uluaoa Street and Kealakaa Street).

The intersection analysis of traffic impacts for 2010 forecasted traffic *without the project* was based on intersection approaches with increased laneage. Queen Kaahumanu Highway, Mamalahoa Highway, and Palani Road were identified as needing four lanes in the preceding highway analysis. The results of the intersection analysis are shown in Table 12.

TABLE 12. INTERSECTION IMPROVEMENTS

	Queen Kaahumanu Highway with Kealakehe Parkway	Queen Kaahumanu Highway with Palani Road	Mamalahoa with Palani Road	Mamalahoa with Kealakehe Parkway
Existing Conditions	**1. Unsignalized Intersection** Minor Street LOS E	**1. Signalized Intersection** Intersection LOS E	**1. Unsignalized Intersection** Minor Street LOS D	**Not Applicable**
2010 Without Project (All Roadways 4-lane)	**1. Unsignalized Intersection** Minor Street LOS F Therefore, signalize intersection **2. Signalized Intersection** Operates Under Capacity However due to DOT policy, connection to frontage road system may be required to provide uninterrupted flow.	**1. Signalized Intersection** Intersection LOS F Therefore, 4-lane Queen K Hwy and Palani Rd needed **2. Signalized with 4 lanes** Operates Over Capacity Therefore, 6-lane Queen K Hwy and Palani needed However due to DOT policy, and intersection size, Grade Separated Interchange possible alternative **3. Grade Separated Interchange w/ 4-lane roadways** Ramp LOS D or better	**1. Unsignalized Intersection** Minor Street LOS F Therefore, signalize intersection **2. Signalized Intersection** Operates Under Capacity	**Not Applicable**
2010 With Project (All Roadways 4-lane)	**1. Signalized Intersection with Kealakehe Parkway Extension** Operates Over Capacity However due to DOT policy, and potential intersection size, Grade Separated Interchange possible alternative **2. Grade Separated Interchange w/ 4-lane roadways** Ramp LOS D or better	**1. Grade Separated Interchange w/ 4-lane roadways** Ramp LOS D or better	**1. Signalized Intersection** Operates Under Capacity	**1. Unsignalized Intersection w/ 4 lane roadways** Minor Street LOS F **2. Signalized Intersection** Operates Under Capacity

Queen Kaahumanu and Kealakehe Parkway

1990 Existing Traffic on Existing Unsignalized Intersection: Currently, Kealakehe Parkway is a T-intersection. Drivers along Queen Kaahumanu currently encounter little delays due to traffic turning into and out off Kealakehe Parkway. This intersection is channelized with a left turn storage lane. However, drivers exiting the minor street encounter long delays.

2010 Forecast Traffic Without Project, Unsignalized Intersection with Four Lanes on Queen Kaahumanu: Without the project, Kealakehe Parkway intersection will remain a T-intersection with no mauka leg. Northbound drivers along Queen Kaahumanu attempting left turns into Kealakehe Parkway are expected to encounter very long delays (LOS F) due to heavy traffic along Queen Kaahumanu heading to Kailua-Kona. Drivers exiting the minor street are also expected to encounter long to extreme delays (LOS F). Since the minor street would operate with extreme delays, it was assumed that this intersection would be signalized when warranted but prior to 2010:

> As a signalized intersection, analysis results indicate that this intersection would operate under capacity with the following improvements:
>
> 1. Fully channelize intersection,
> 2. Left turn storage lane along Queen Kaahumanu Highway,
> 3. Acceleration and deceleration lanes along Queen Kaahumanu Highway, and
> 4. Separate left and right turn lanes exiting Kealakehe Parkway.

Although this signalized intersection will operate under capacity, *DOT policy is to provide uninterrupted traffic flow conditions along Queen Kaahumanu Highway (i.e. no signalization).* This intersection would therefore need to be grade separated with a frontage road system to provide free flow conditions for Queen Kaahumanu traffic.

Connection to a Future Frontage Road System: A grade separated interchange would minimize the delays to traffic on both Queen Kaahumanu and the Kealakehe Parkway, how much reduction of delay depends on the configuration of the interchange. However, the benefit/cost ratio of an interchange project would likely be very small, considering the amount of traffic it would serve. Therefore, it is recommended that this intersection be signalized until Kealakehe Parkway can be connected to the frontage road system to be developed by DOT. (It is assumed that the construction of the frontage roads, widening of Queen Kaahumanu will require several years, and in that period traffic signals would handle traffic at below capacity levels.

Queen Kaahumanu Highway and Palani Road

1990 Existing Traffic on Existing Signalized Intersection: Drivers at this intersection currently encounter average delays of 50 seconds per vehicle (LOS E) during the morning peak hour and 50 seconds per vehicle (LOS E) during the afternoon. This intersection is fully channelized with a left turn storage lane at each approach. The long delays are partially due to the current signal timing.

2010 Forecast Traffic Without Project, Signalized Intersection with Four Lanes on Queen Kaahumanu and Palani: Even with the additional laneage along Queen Kaahumanu and Palani, this signalized intersection would operate over-capacity during the morning and afternoon peak hours in 2010 . Therefore, additional lanes on the approaches of Queen Kaahumanu and Palani will be necessary to bring the intersection to operate below capacity.

Increase Laneage at Intersection: In order for the signalized intersection to operate under capacity the following improvements would be needed:

1. Three through lanes along Queen Kaahumanu and Palani for perhaps at least 1000 feet beyond each direction of the intersection,
2. Double left turn storage lanes along all approaches,
3. Double right turn lanes along some approaches, and
4. Fully channelize intersection.

Due to the resultant size of such an intersection and number of lanes required to operate under capacity, a grade separated interchange is a possible alternative and would be in conformance with DOT's policy of uninterrupted traffic flow along Queen Kaahumanu Highway.

2010 Forecast Traffic Without Project with Four Lanes on Queen Kaahumanu and Palani and a Grade separated Interchange: A grade separated interchange would minimize the delays to traffic on both Queen

Kaahumanu and Palani. An interchange would also satisfy DOT policy to provide free flow conditions along Queen Kaahumanu Highway (i.e. no signalization).

A detailed interchange configuration is not within the scope of this study since it will require road design analysis to take into account cost, right-of-way acquisition, and access to surrounding land uses via a DOT approved frontage road system.

Preliminary analysis indicates the LOS for single lane on and off ramps for the proposed interchange ramps would operate at LOS D or better. However, such critical questions rights-of-way or topography was not a part of this study.

Mamalahoa Highway and Palani Road

1990 Existing Traffic on Existing Unsignalized Intersection: This T-intersection is configured with Mamalahoa/Palani forming the major through movement and Mamalahoa also being the minor street. During the morning peak hour, drivers turning left from Mamalahoa onto Palani experience long delays (LOS D) while drivers for the other movements experience little or no delays (LOS A). During the afternoon peak hour, drivers all movements experience average delays (LOS C) or better.

2010 Forecast Traffic Without Project, Unsignalized Intersection with Four Lanes on Mamalahoa/Palani: Drivers attempting left-turns from Mamalahoa (minor street) onto Palani (major street) will experience extremely long delays (LOS F) during both morning and afternoon peak hours. Other movements will experience average delays (LOS C) or better. Due to the delays expected for the minor street, it was assumed that this intersection would be signalized by 2010.

Signalize Intersection when Warranted: As a signalized intersection, this intersection would operate under capacity with the following improvements:

1. Fully channelize intersection and
2. Left turn storage lane along Mamalahoa Highway (major approach).

Palani Road and Minor Streets

1990 Existing Traffic on Existing Unsignalized Uluaoa Intersection: Drivers turning left from Ulua'oa onto Palani currently experience average delays (LOS C) during the morning peak hour and experience long delays (LOS D) during the afternoon peak hour. The other turning movements experience little or no delays (LOS A) during both the morning and afternoon peak hours.

1990 Existing Traffic on Existing Unsignalized Kealakaa Intersection: Drivers turning left from Kealakaa onto Palani currently experience average delays (LOS C) during the morning peak hour and experience long delays (LOS D) during the afternoon peak hour. The other turning movements experience little or no delays (LOS A) during both the morning and afternoon peak hours.

2010 Forecast Traffic Without Project, Signalized Intersection with Four Lanes on Palani: All intersections will require signalization without the project by 2010. All minor cross street approaches would require separate left and right turn lanes onto Palani. All northbound approaches on Palani should have a left turn auxiliary lane. It is also desirable to have right turn lanes on the southbound approaches for drivers turning makai towards the project area. However, the study did not include the road design analysis of cost, geometrics, right-of-way, and topography and the above statements must consider the physical constraints as well alternative means.

2010 ROADWAY NETWORK WITH PROJECT

The Roadway Network which includes improvements required by 2010 was used as the base network to determine the additional improvements necessary for the Project. In addition to those improvements required even without the Project, the following improvements were identified based on our impact analysis of the total forecast traffic including that of the the project in the year 2010:

- Provide a four lane Kealakehe Parkway,
- Signalize the intersection of Mamalahoa Highway and future Kealakehe Parkway, and
- Provide a grade separated interchange at Queen Kaahumanu Highway and Kealakehe Parkway.

Highway Analysis

The following roadways were analyzed using methods from the HCM to determine the impact and possible roadway improvements necessary to accommodate forecast 2010 traffic with the project. The traffic impact results are shown in Table 11.

- Queen Kaahumanu Highway,
- Mamalahoa Highway,
- Palani Road, and
- Kealakehe Parkway.

Queen Kaahumanu Highway

2010 Forecast Traffic With Project on 4 Lane Queen Kaahumanu: With Queen Kaahumanu widened to 4 lanes, the highway will continue to operate at LOS D *or better* during the morning and afternoon peak hours between Keahole Airport and Palani Road.

Palani Road

2010 Forecast Traffic With Project on 4 Lane Palani: With Palani widened to 4 lanes, the road will continue to operate at LOS D *or better* during the morning and afternoon peak hours.

Mamalahoa Highway

2010 Forecast Traffic With Project on 4 Lane Mamalahoa: With Mamalahoa widened to 4 lanes, the highway will continue to operate at LOS A or B during the morning and afternoon peak hours.

Kealakehe Parkway

2010 Forecast Traffic With Project on 2 Lane Parkway: With a two lane Parkway, the highway will operate at LOS F during the morning and afternoon peak hours. Therefore, it was assumed that this highway would be a four lane highway by 2010.

2010 Forecast Traffic With Project on 4 Lane Parkway: With a four lane Parkway in 2010, the highway will operate at LOS D during the morning and afternoon peak hours.

Intersection Analysis

The following intersections were analyzed using methods from the HCM to determine the intersection traffic impacts and improvements necessary to accommodate forecast 2010 traffic with the project:

- Queen Kaahumanu Highway and Kealakehe Parkway,
- Queen Kaahumanu Highway and Palani Road,
- Mamalahoa Highway and Palani Road,
- Palani Road with Minor Streets (Uluaoa Street, Kealakaa Street, and Road A, and
- Mamalahoa Highway and Kealakehe Parkway.

The 2010 Roadway Network Without Project Improvements were used as the base network to determine the additional improvements necessary with the Project. The traffic impact results of the are shown in Tables 12.

Queen Kaahumanu and Kealakehe Parkway

2010 Forecast Traffic With Project, Grade Separation with Four Lanes on Queen Kaahumanu: Due to the volume of vehicles generated by the Kealakehe Planned Community, a connection to Queen Kaahumanu Highway is needed. Since DOT policy is to provide free flow conditions along Queen Kaahumanu Highway (i.e. no signalization), this intersection would need to be grade separated. The Parkway would divert a portion of traffic from Palani Road onto the Parkway, reducing the volume of traffic on portions of Palani.

A grade separated interchange would minimize the delays to traffic on both Queen Kaahumanu and the Kealakehe Parkway, the size of reduction depends on the configuration of the interchange. Preliminary analysis of an assumed diamond interchange indicates LOS D or better operation.

Queen Kaahumanu Highway and Palani Road

2010 Forecast Traffic With Project with Four Lanes on Queen Kaahumanu and Palani and a Grade separated Interchange: Even without the project, major improvements are required. Because of DOT policy (i.e. a signalized intersection is not acceptable for the long term), a grade separated interchange at Queen Kaahumanu and the Palani is assumed, with reduced vehicle delays.

With the project, preliminary analysis of a possible diamond interchange indicates ramp operation at LOS D or better in 2010.

Mamalahoa Highway and Palani Road

2010 Forecast Traffic With Project, Signalized Intersection with Four Lanes on Mamalahoa/Palani: Signalization is required even without the project. With the project, this intersection would operate under capacity.

Mamalahoa Highway with New Kealakehe Parkway

2010 Forecast Traffic With Project, Unsignalized Intersection with Four Lanes on Mamalahoa and Parkway: (Does not exist without the project.) With four lanes on Mamalahoa and Kealakehe Parkway, drivers attempting left-turns from the extended Kealakehe Parkway onto Mamalahoa Highway will experience extremely long delays (LOS F) during both morning and afternoon peak hours. Drivers turning left from Mamalahoa Highway onto Kealakehe Parkway will experience average delays (LOS C) during the morning peak hour while drivers attempting right-turns from Kealakehe Parkway will experience little delays (LOS B). During the afternoon peak hour, drivers attempting right-turns from Kealakehe Parkway and left-turns from Mamalahoa Highway will both experience very long delays (LOS D). Due to the delays expected for the minor street (Kealakehe Parkway), this intersection will require signalization.

2010 Forecast Traffic With Project, Signalized Intersection with Four Lanes on Mamalahoa/Parkway: With signalization, this intersection would operate under capacity with the following improvements:

1. Fully channelize intersection,
2. Provide exclusive right and left turn lanes exiting Kealakehe Parkway onto Mamalahoa, and
3. Provide left turn storage lane along Mamalahoa.

Palani Road and Minor Streets Serving the Project

All intersections will require signalization without the project by 2010. All minor cross street approaches would require separate left and right turn lanes onto Palani. All northbound approaches on Palani should have a left turn auxiliary lane. It is also desirable to have right turn lanes on the southbound approaches for drivers turning makai towards the project area. However, the study did not include the road design analysis of cost, geometrics, right-of-way, and topography and the above statements must consider the physical constraints as well alternative means.

CONCLUSIONS AND RECOMMENDATIONS

The Kealakehe Planned Community Project, when completed in 2010, will have a major impact on Queen Kaahumanu Highway and Palani Road.

A much greater impact will arise without the project. Extensive growth projected in the West Hawaii region over the next twenty years will result in population and employment increasing to 100% or more. Major infrastructure needs exist to handle such growth. Traffic volumes and travel patterns in the year 2010 will be different than those of today. The predicted change in the location and amount of jobs and population (as envisioned by the County land use forecasts) will result in directional changes in traffic along the major arterials in the area such as Queen Kaahumanu Highway.

Even without the project in 2010, Queen Kaahumanu Highway, Mamalahoa Highway and Palani Road will be over their capacities to handle predicted traffic demand with drivers encountering intersection congestion and delays. Queen Kaahumanu Highway will need to be widened to four lanes (or similar magnitude project) in the vicinity between Palani Road and Keahole Airport. Palani Road will also need to be widened to four lanes (or similar magnitude project), as well as Mamalahoa Highway between Palani Road and Kaimi Nani Drive.

The signalized intersection of Palani Road and Queen Kaahumanu Highway will also be over capacity and will need to be either vastly widened or converted to a grade separated interchange. The intersection of Palani

Road and Mamalahoa Highway will need to be signalized when warranted. The minor intersections along Palani Road that access the existing subdivision such as Kealakaa Street will also need to be signalized even without the project.

It was assumed that a four-lane, mauka-makai Kealakehe Parkway running between Queen Kaahumanu Highway and Mamalahoa Highway would be constructed along with the project's development. It would serve as the major access road to both Queen Kaahumanu and Mamalahoa Highways for the Kealakehe community. Therefore, with the construction of Kealakehe Parkway, traffic along Palani Road will not be significantly affected by the project because of the assumed driver choice of the routes' relative travel times.

Due to the impact of the traffic volumes of the Kealakehe Planned Community development, the following actions are deemed necessary:

1. A grade separated interchange at the intersection of Queen Kaahumanu Highway and Kealakehe Parkway due to traffic demand and the requirement of the State Department of Transportation for non-interrupted flow along Queen Kaahumanu Highway.

2. Signalized intersection at Mamalahoa Highway and Kealakehe Parkway.

3. The Kealakehe Parkway extension between Queen Kaahumanu and Mamalahoa Highways should be constructed as a four-lane roadway. Depending on the number of intersections accessing the project, additional improvements such as the following may be necessary:

a. Signalize the intersections along Kealakehe Parkway when warranted.

b. Auxiliary lanes, primarily left turn storage lanes may be necessary along Kealakehe Parkway and the minor streets.

It is important to note that the feasibility of projects identified in this report has not been studied, and no recommendation regarding a specific project is implied. What is recommended is the need to consider projects of similar magnitude generally identified herein. Alternative actions should also be investigated for costs, benefits, and impacts. Major questions such as topography, costs, rights-of-way, environmental impacts, and other issues need to be fully investigated in the required and/or standard planning, design, and construction procedures.

APPENDIX A

LEVEL-OF-SERVICE DEFINITIONS
FOR
INTERSECTIONS
AND
HIGHWAYS

DEFINITION OF LEVEL-OF-SERVICE FOR SIGNALIZED INTERSECTIONS

Level of service for signalized intersections is defined in terms of *delay*. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. Specifically, level-of-service criteria are stated in terms of the average stopped delay per vehicle for a 15-minute analysis period.

Level-of service A describes operations with very low delay, i.e., less than 5.0 sec per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

Level-of-service B describes operations with delay in the range of 5.1 to 15.0 sec per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for LOS A, causing higher levels of average delay.

Level-of-service C describes operations with delay in the range of 15.1 to 25.0 sec per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear in this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.

Level-of-service D describes operations with delay in the range of 25.1 to 40.0 sec per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or a high v/c ratios (volume of cars to capacity of intersection). Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

Level-of-service E describes operations with delay in the range of 40.1 to 60.0 sec per vehicle. This is considered to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle length, and high v/c ratios. Individual cycle failures are frequent occurrences.

Level-of-service F describes operations with delay in excess of 60.0 sec per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with oversaturation, i.e., when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.00 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

REFERENCE: Highway Capacity Manual (Special Report 209, 1985)

DEFINITION OF LEVEL-OF-SERVICE FOR UNSIGNALIZED INTERSECTIONS

For unsignalized intersections, the traffic most impacted will be the minor or cross-street with the stop or yield control. The major roadway will have the right-of-way. The level-of-service is the amount of delay expected for the average vehicle desiring to cross or enter the major road. The following gives a general description of the measure.

The concept of levels of service is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level of service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Six levels of service are defined for each type of facility for which analysis procedures are available. They are given letter designations, from A to F, with level-of-service A representing the best operating conditions and level-of-service F the worst.

Level-of-Service definitions--In general, the various levels of service are defined as follows for uninterrupted flow facilities:

Level-of-service A represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

Level-of-service B is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

Level-of-service C is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

Level-of-service D represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

Level-of-service E represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuver. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

Level-of-service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go wave, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of the vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and level-of-service F is an appropriate designation for such points.

These definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them.

REFERENCE: Highway Capacity Manual (Special Report 209, 1985)

DEFINITION OF LEVEL-OF-SERVICE
FOR
TWO-LANE RURAL HIGHWAYS

Level of service for two-lane rural highways addresses both mobility and accessibility concerns. The primary measure of service quality is percent time delay, with speed and capacity utilization used as secondary measures.

Level-of service A describes the highest quality of traffic service where motorists are able to drive at their desired speed. Without strict enforcement, this highest quality would result in average speeds approaching 60 mph on two-lane highways. The passing frequency required to maintain these speeds has not reached a demanding level. Passing demand is well below passing capacity, and almost no platoons of three or more vehicles are observed. Drivers would be delayed no more than 30% of the time by slow-moving vehicles.

Level-of-service B describes the region of traffic flow wherein speeds of 55 mph or slightly higher are expected on level terrain. Passing demand needed to maintain desired speeds becomes significant and approximately equals the passing capacity at the lower boundary of level-of-service B. Drivers are delayed up to 45% of the time.

Level-of-service C describes conditions where further increases in flow results in noticeable increases in platoon formation, platoon size, and frequency of passing impediment. Average speed still exceeds 52 mph on level terrain, even though unrestricted passing demand exceeds passing capacity. At higher volume levels, chaining of platoons and significant reductions in passing capacity begin to occur. While traffic flow is stable, it is becoming susceptible to congestion due to turning traffic and slow moving vehicles. Percent time delays are up to 60%.

Level-of-service D describes unstable traffic flow as two opposing traffic streams essentially begin to operate separately at higher volume levels, as passing becomes extremely difficult. Passing demand is very high, while passing capacity approaches zero. Mean platoon sizes of 5 to 10 vehicles are common, although speeds of 50 mph can still be maintained under ideal conditions. Turning vehicles and/or roadside distractions cause major shock-waves in the traffic stream. The percentage of time drivers are delayed approaches 75%.

Level-of-service E describes traffic flow conditions having a percent time delay of greater than 75 percent. Under ideal conditions, speeds will drop below 50 mph. Passing is virtually impossible and platooning becomes intense when slower vehicles or other interruptions are encountered.

Level-of-service F describes heavily congested flow with traffic demand exceeding capacity. Volumes are lower than capacity, and speeds are below capacity speed.

REFERENCE: Highway Capacity Manual (Special Report 209, 1985)

DEFINITION OF LEVEL-OF-SERVICE FOR MULTI-LANE HIGHWAYS

Level-of-service (LOS) criteria for multilane highways are defined in terms of *density*. Density is a measure which quantifies the proximity to other vehicles in the traffic stream. It expresses the degree of maneuverability within the traffic stream.

Level-of-service A describes completely free-flow conditions. The operation of vehicles is virtually unaffected by the presence of other vehicles, and operations are constrained only by the geometric features of the highway and driver preferences. Vehicles are spaced at an average of 440 ft, or 22 car-lengths, at a maximum density of 12 pc/mi/ln. The ability to maneuver within the traffic stream is high. Minor disruptions to flow are easily absorbed at this level without causing significant delays or queuing.

Level-of-service B is also indicative of free flow, although the presence of other vehicles begins to be noticeable. Average travel speeds are somewhat diminished from LOS A, but are still generally over 53 mph on sections with 70-mph design speed. Vehicles are spaced at an average of approximately 264 ft, or 13 car-lengths, at a maximum density of 20 pc/mi/ln. Minor disruptions are still easily absorbed at this level, although local deterioration in LOS will be more obvious.

Level-of-service C represents a range in which the influence of traffic density on operations becomes marked. The ability to maneuver within the traffic stream, and to select an operating speed is now clearly affected by the presence of other vehicles. Average travel speeds are reduced to about 50 mph on 70-mph design speed sections, and the average spacing of vehicles is reduced to approximately 175 ft, or 9 car-lengths, at a maximum density of 30 pc/mi/ln. Minor disruptions may be expected to cause serious local deterioration in service, and queues may form behind any significant traffic disruption. Severe or long-term disruptions may cause the facility to operate at LOS F.

Level-of-service D borders on unstable flow. Speeds and ability to maneuver are severely restricted because of traffic congestion. Average travel speeds are approximately 40 mph on 70-mph design speed sections, while the average spacing of vehicles is 125 ft, or 6 car-lengths, at a maximum density of 42 pc/mi/ In. Only the most minor of disruptions can be absorbed without the formation of extensive queues and the deterioration of service to LOS F.

Level-of-service E represents operations at or near capacity, and is quite unstable. At capacity, vehicles are spaced at only 80 ft, or 4 car-lengths, at a maximum density of 67 pc/mi/ln. This is the minimum spacing at which uniform flow can be maintained, and effectively defines a traffic stream with no usable gaps. Thus, disruptions cannot be damped or dissipated, and any disruption, no matter how minor, will cause queues to form and service to deteriorate to LOS F. Average travel speeds at capacity are approximately 30 mph.

Level-of-service F represents forced or breakdown flow. It occurs at a point where vehicles arrive either at a rate greater than that at which they are discharged or at a point on a planned facility where forecasted demand exceeds the computed capacity. While operations at such points (and on immediately downstream sections) will appear to be at capacity or better, queues will form behind these breakdowns. Operations within queues are highly unstable, with vehicles experiencing short spurts of movement followed by stoppages. Average travel speeds within queues are generally under 30 mph, with densities higher than 67 pc/mi/ln. Note that the term "LOS F" may be used to characterize both the point of the breakdown and the operating conditions within the queue. It must be remembered, however, that it is the point of breakdown that causes the queue to form, and that operations within the queue are generally not related to defects along the highway segment over which the queue extends.

REFERENCE: Highway Capacity Manual (Special Report 209, 1985)

APPENDIX B

MANUAL TRAFFIC COUNT DATA

APPENDIX B

MANUAL TRAFFIC COUNT DATA

Date: January 17, 1990

Location: Palani Road and Ulua'oa Street

	Palani Road				Ulua'oa Street	
	Northbound		Southbound		Eastbound	
Time (am)	LT	TH	TH	RT	LT	RT
7:15-7:30	4	57	125	15	11	10
7:30-7:45	4	68	147	36	14	10
7:45-8:00	4	51	173	39	13	23
8:00-8:15	7	59	111	32	16	13
8:15-8:30	4	59	131	33	16	9
8:30-8:45	3	67	83	11	17	6
Peak Hour 7:30-8:30						
Totals	**19**	**237**	**562**	**140**	**59**	**55**

Date: January 16, 1990

Location: Palani Road and Ulua'oa Street

	Palani Road				Ulua'oa Street	
	Northbound		Southbound		Eastbound	
Time (pm)	LT	TH	TH	RT	LT	RT
4:00-4:15	6	112	102	9	8	6
4:15-4:30	1	115	77	7	8	1
4:30-4:45	7	122	83	10	15	3
4:45-5:00	9	130	73	8	16	2
5:00-5:15	8	118	77	11	18	3
5:15-5:30	8	128	65	17	12	2
Peak Hour 4:30-5:30						
Totals	**32**	**498**	**298**	**46**	**61**	**10**

MANUAL TRAFFIC COUNT DATA

Date: January 17, 1990

Location: Palani Road and Kealakaa Street

	Palani Road				Kealakaa Street	
	Northbound		Southbound		Eastbound	
Time (am)	LT	TH	TH	RT	LT	RT
7:15-7:30	31	61	133	15	3	83
7:30-7:45	52	67	151	15	4	123
7:45-8:00	41	52	176	22	3	113
8:00-8:15	50	71	107	11	6	83
8:15-8:30	54	39	115	29	17	86
8:30-8:45	21	62	104	2	9	61
Peak Hour 7:30-8:30						
Totals	**197**	**229**	**549**	**77**	**30**	**405**

Date: January 16, 1990

Location: Palani Road and Kealakaa Street

	Palani Road				Kealakaa Street	
	Northbound		Southbound		Eastbound	
Time (pm)	LT	TH	TH	RT	LT	RT
4:00-4:15	55	118	96	4	9	43
4:15-4:30	50	128	87	0	8	40
4:30-4:45	62	133	73	2	7	42
4:45-5:00	78	143	74	2	7	46
5:00-5:15	85	131	79	2	5	45
5:15-5:30	67	125	67	1	5	40
Peak Hour 4:15-5:15						
Totals	**275**	**535**	**313**	**6**	**27**	**173**

MANUAL TRAFFIC COUNT DATA

Date: January 17, 1990

Location: Queen Kaahumanu Highway and Kealakehe Parkway Road

	Queen Kaahumanu Highway				Kealakehe Parkway Road	
	Northbound		Southbound		Eastbound	
Time (am)	LT	TH	TH	RT	LT	RT
7:30-7:45	26	128	100	9	4	9
7:45-8:00	17	114	139	13	7	12
8:00-8:15	26	101	109	11	6	9
8:15-8:30	26	111	97	15	5	12
8:30-8:45	23	121	107	17	6	17
8:45-9:00	17	106	99	10	8	19
Peak Hour 7:45-8:45 Totals	92	447	452	56	24	50

Date: January 16, 1990

Location: Queen Kaahumanu Highway and Kealakehe Parkway Road

	Queen Kaahumanu Highway				Kealakehe Parkway Road	
	Northbound		Southbound		Eastbound	
Time (pm)	LT	TH	TH	RT	LT	RT
3:00-3:15	29	114	150	6	10	23
3:15-3:30	24	150	176	9	9	22
3:30-3:45	23	132	186	26	8	22
3:45-4:00	32	117	214	17	9	27
4:00-4:15	21	106	235	23	12	22
4:15-4:30	30	116	165	10	9	27
Peak Hour 3:15-4:15 Totals	100	505	811	75	38	93

MANUAL TRAFFIC COUNT DATA

Date: January 17, 1990

Location: Queen Kaahumanu Highway and Palani Road

	Queen Kaahumanu Highway						Palani Road					
	Northbound			Southbound			Eastbound			Westbound		
Time (am)	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
7:00-7:15	32	112	26	14	39	31	41	56	31	73	45	20
7:15-7:30	29	122	52	12	33	52	70	98	64	70	48	18
7:30-7:45	33	106	67	15	53	38	92	115	61	52	43	28
7:45-8:00	45	80	37	25	54	77	96	128	42	62	45	26
8:00-8:15	32	90	40	17	60	53	85	144	65	66	50	26
8:15-8:30	23	88	33	20	51	62	53	108	43	65	43	28
Peak Hour	**7:15-8:15**											
Totals	**139**	**398**	**196**	**69**	**200**	**220**	**343**	**485**	**232**	**250**	**186**	**98**

Date: January 16, 1990

Location: Queen Kaahumanu Highway and Palani Road

	Queen Kaahumanu Highway						Palani Road					
	Northbound			Southbound			Eastbound			Westbound		
Time (pm)	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
3:45-4:00	62	86	41	37	118	152	26	78	25	76	86	76
4:00-4:15	48	56	51	44	103	150	46	70	23	82	121	71
4:15-4:30	56	62	41	35	111	123	39	65	22	87	109	92
4:30-4:45	48	50	37	62	103	121	43	69	23	80	130	94
4:45-5:00	37	62	39	45	111	107	50	96	21	77	131	95
Peak Hour	**4:00-5:00**											
Totals	**189**	**230**	**168**	**186**	**428**	**501**	**178**	**300**	**89**	**326**	**491**	**352**

MANUAL TRAFFIC COUNT DATA

Date: May 16, 1990

Location: Mamalahoa Highway and Palani Road

	Mamalahoa Highway Southbound		Palani Road Northbound		Mamalahoa Highway Westbound	
Time (am)	LT	TH	TH	RT	LT	RT
6:30-6:45	10	93	37	7	16	6
6:45-7:00	10	94	48	8	17	7
7:00-7:15	11	120	47	5	11	14
7:15-7:30	14	126	38	16	21	11
7:30-7:45	25	152	47	24	21	8
7:45-8:00	16	136	38	24	39	16
8:00-8:15	5	110	63	8	24	9
8:15-8:30	5	106	58	6	11	9
8:30-8:45	6	78	41	5	13	7
Peak Hour 7:30-8:30						
Totals	**51**	**504**	**206**	**62**	**95**	**42**

Date: May 15, 1990

Location: Mamalahoa Highway and Palani Road

	Mamalahoa Highway Southbound		Palani Road Northbound		Mamalahoa Highway Eastbound	
Time (pm)	LT	TH	TH	RT	LT	RT
3:30-3:45	5	6	55	16	10	6
3:45-4:00	6	10	121	13	13	10
4:00-4:15	9	16	70	13	6	16
4:15-4:30	9	7	144	26	12	7
4:30-4:45	8	8	97	13	10	8
4:45-5:00	13	15	129	18	8	15
5:00-5:15	8	14	110	14	9	14
5:15-5:30	5	13	130	21	5	13
Peak Hour 4:15-5:15						
Totals	**38**	**265**	**480**	**71**	**39**	**44**

AIR QUALITY IMPACTS

AIR QUALITY STUDY
FOR THE PROPOSED
KEALAKEHE PLANNED COMMUNITY PROJECT

KAILUA-KONA, HAWAII

Prepared for:

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July 1990

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1.0 INTRODUCTION AND PROJECT DESCRIPTION

The State of Hawaii's Housing Finance and Development Corporation (HFDC) is proposing to develop a planned community project at Kealakehe, North Kona on Hawaii Island. As indicated on the project location map presented as Figure 1, the Kealakehe Planned Community Project is located approximately 3 miles north of Kailua-Kona and 4 miles south of Keahole Airport. It encompasses nearly 1000 acres of land on the western slope of Hualalai. Elements of the proposed project include approximately 5,000 housing units (with 60 percent to be sold as affordable units), a civic center, two schools, commercial/retail facilities, roadways, sewers, electric substations, a public golf course and other infrastructure and public facilities. Development of the proposed project will occur over a 20-year period of time with full build-out expected to be completed by about the year 2010.

The purpose of this study is to describe existing air quality in the project area and to assess the potential short-term and long-term direct and indirect air quality impacts that could result from construction and use of the proposed facilities as planned. Another purpose of this study is to examine potential impacts on the project from existing nearby air pollution sources. Measures to mitigate these impacts are suggested where possible and appropriate.

2.0 AMBIENT AIR QUALITY STANDARDS

Ambient concentrations of air pollution are regulated by both national and state ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State of Hawaii AAQS are defined in

Chapter 11-59 of the Hawaii Administrative Rules. Table 1 summarizes both the national and the state AAQS that are specified in the cited documents. As indicated in the table, AAQS have been established for six air pollutants. These regulated air pollutants include: particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone and lead. National AAQS are stated in terms of primary and secondary standards. National primary standards are designed to protect the public health with an "adequate margin of safety". National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant". Secondary public welfare impacts may include such effects as decreased visibility, diminished comfort levels, or other potential injury to the natural or man-made environment, e.g., soiling of materials, damage to vegetation or other economic damage. In contrast to the national AAQS, Hawaii State AAQS are given in terms of a single standard that is designed "to protect public health and welfare and to prevent the significant deterioration of air quality".

Each of the regulated air pollutants has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentration for prolonged periods of time. The AAQS specify a maximum allowable concentration for a given air pollutant for one or more averaging times to prevent harmful effects. Averaging times vary from one hour to one year depending on the pollutant and type of exposure necessary to cause adverse effects. In the case of the short-term (i.e., 1- to 24-hour) AAQS, both national and state standards allow one exceedance per year.

State of Hawaii AAQS are in some cases considerably more stringent than comparable national AAQS. In particular, the State of Hawaii

1-hour AAQS for carbon monoxide is four times more stringent than the comparable national limit.

Under the provisions of the Federal Clean Air Act [1], the U.S. Environmental Protection Agency (EPA) is required to periodically review and re-evaluate national AAQS in light of research findings more recent than those which were available at the time the standards were originally set. Occasionally new standards are created as well. Most recently, the national standard for particulate matter has been revised to include specific limits for particulates 10 microns or less in diameter (PM-10) [2]. The State of Hawaii has not explicitly addressed the question of whether to set limits for this category of air pollutant, but national AAQS prevail where states have not set their own more stringent levels.

Hawaii AAQS for sulfur dioxide were relaxed in 1986 to make them essentially the same as national limits. It has been proposed in various forums that the state also relax its carbon monoxide standards to the national levels, but at present there are no indications that such a change is being considered.

3.0 REGIONAL AND LOCAL CLIMATOLOGY

Regional and local climatology significantly affect the air quality of a given location. Wind, temperature, atmospheric turbulence, mixing height and rainfall all influence air quality. Although the climate of Hawaii is relatively moderate throughout most of the state and most of the year, significant differences in these parameters may occur from one location to another. Most differences in regional and local climates within the state are caused by the mountainous topography.

Kealakehe, the site of the proposed project, is located near the midpoint of the western coast of the island of Hawaii. The topography of this island is dominated by the great volcanic masses of Mauna Loa (13,653 feet), Mauna Kea (13,796 feet), and of Hualalai, the Kohala Mountains and Kilauea. The island consists entirely of the slopes of these mountains and of the broad saddles between them. Mauna Loa and Kilauea, located on the southern half of the island, are still active volcanoes. The site of the proposed project occupies a portion of the lower slope of Hualalai extending from about the 50-foot level up to an elevation of about 750 feet.

Hawaii lies well within the belt of northeasterly trade winds generated by the semi-permanent Pacific high pressure cell to the north and east. Nearly the entire western coast of the island of Hawaii, however, is sheltered from the trade winds by high mountains, except when unusually strong trade winds sweep through the saddle between the Kohala Mountains and Mauna Kea and reach the areas to the lee. Due to wind shadow effects caused by the terrain, winds in the Kealakehe area are predominantly light and variable. Local winds such as land/sea breezes and/or upslope/downslope winds tend to dominate the wind pattern for the area. During the daytime, winds typically move onshore because of seabreeze and/or upslope effects. At night, winds generally are land breezes and/or drainage winds which move downslope and out to sea. Calms occur about 29 percent of the time at nearby Keahole Point.

Air pollution emissions from motor vehicles, the formation of photochemical smog and smoke plume rise all depend in part on air temperature. Colder temperatures tend to result in higher emissions of contaminants from automobiles but lower concentrations of photochemical smog and ground-level concentrations of air pollution from elevated plumes. In Hawaii, the annual and daily variation of temperature depends to a large degree on elevation above sea level, distance inland and exposure to the trade winds. Average temperatures at locations near sea level generally are warmer than those at higher elevations. Areas exposed to the trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. The project site's leeward location results in a larger temperature profile compared to windward locations at the same elevation. At the Old Kona Airport located about 2 miles to the south, average daily minimum and maximum temperatures are 67°F and 83°F, respectively. The extreme minimum temperature on record at this location is 47°F, and the extreme maximum is 93°F. Temperatures at the project site are probably about 1 to 3 degrees F cooler on average compared to the airport and show a slightly larger diurnal variation due to the somewhat elevated and inland location.

Small scale, random motions in the atmosphere (turbulence) cause air pollutants to be dispersed as a function of distance or time from the point of emission. Turbulence is caused by both mechanical and thermal forces in the atmosphere. It is oftentimes measured and described in terms of Pasquill-Gifford stability class. Stability class 1 is the most turbulent and class 6 the least. Thus, air pollution dissipates the best during stability class 1 conditions and the worst when stability class 6 prevails. In suburban, coastal areas like Kealakehe, stability class 5 or 6 is generally the highest stability class that occurs, developing during clear, calm nighttime or early morning conditions. Stability classes 1 through 4 occur during the daytime, depending mainly on the amount of cloud cover and incoming solar radiation and the onset and extent of the sea breeze.

Mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Low mixing heights can result in high ground-level air pollution concentrations because contaminants emitted from or near the surface can become trapped within the mixing layer. In Hawaii, minimum mixing heights tend to be high because of mechanical mixing caused by the trade winds and because of the temperature moderating effect of the surrounding ocean. Low mixing heights may sometimes occur, however, at inland locations and even at times along coastal areas early in the morning following a clear, cool, windless night. Coastal areas may also experience low mixing levels during sea breeze conditions when cooler ocean air rushes in over warmer land. Although there is no mixing height data for the Kealakehe area, mixing heights elsewhere in the state typically are above 3000 feet (1000 meters). Mixing heights in the Kealakehe area probably tend to be somewhat lower due to the fact that light winds often prevail and also because sea breeze conditions often develop during the daytime.

Rainfall can have a beneficial effect on the air quality of an area in that it helps to suppress fugitive dust emissions, and it may also "washout" gaseous contaminants that are water soluble. Rainfall in Hawaii is highly variable depending on elevation and on location with respect to the trade wind. The Kealakehe area being a leeward location experiences a relatively dry climate. Some of the rainfall occurs in conjunction with winter storms, and some occurs during summer afternoons and evenings as a result of the onshore and upslope movement of moisture laden marine air. At the Old Kona Airport, average annual rainfall amounts to about 24 inches but may vary significantly from one year to the next. Average annual rainfall at the project site is estimated to amount to about 25 to 30 inches depending on elevation.

4.0 PRESENT AIR QUALITY

Present air quality in the project area is mostly affected by air pollutants from natural, industrial, agricultural and/or vehicular sources. Natural sources of air pollution emissions which may affect the project area but cannot be quantified very accurately include the ocean (sea spray), plants (aero-allergens), wind-blown dust, and volcanoes. Of these natural sources of air pollution, volcanoes are the most significant. Volcanic emissions periodically plague the project area. This is especially so since the latest eruption phase of the Kilauea Volcano began in 1983. Air pollution emissions from the Hawaiian volcanoes consist primarily of sulfur dioxide. After entering the atmosphere, these sulfur dioxide emissions are carried away by the wind and either washed out as acid rain or gradually transformed into particulate sulfates. Although emissions from Kilauea are vented on the other side of a mountain barrier more than 50 miles east of the project site, the prevailing wind patterns eventually carry the emissions into the Kona area. These emissions can be seen in the form of the volcanic haze (vog) which persistently hangs over the area. The American Lung Association is currently studying the character and concentrations of volcanic air pollution in the Kona area, but to date no results of the study are available.

The major industrial sources in the project vicinity include the Keahole Power Plant, operated by Hawaii Electric Light Company, and the Kailua Landfill, operated by the County of Hawaii. Air pollution emissions from Keahole Power Plant consist mostly of sulfur dioxide and oxides of nitrogen. Emissions from the county landfill consist mainly of fugitive dust from heavy equipment operations and noxious fumes from underground fires, the latter of which has been the subject of numerous complaints from people residing and working nearby. Potential impacts on the proposed project from emissions emanating from the landfill are discussed in more detail later in this report.

Queen Kaahumanu Highway, which forms the west boundary of the project site, is the region's major arterial roadway. Some contamination from emissions exhausted by motor vehicles traversing Queen Kaahumanu Highway and other roadways nearby presently occurs, although elevated concentrations are likely confined to limited areas near intersections where and when traffic congestion occurs during poor dispersion conditions.

The State Department of Health operates a network of air quality monitoring stations at various locations around the state. Unfortunately, very little data are available for Hawaii Island, and even less are available for the Kona area specifically. As indicated in Table 2, the only existing monitoring data in the vicinity of the project site consist of sulfur dioxide and particulate measurements that were made about 12 miles to the south at Kealakekua during 1985 and 1986. During the two-year period, measurements of 24-hour average sulfur dioxide concentration at this location were consistently low with daily mean values ranging from less than 5 $\mu g/m^3$ up to 12 $\mu g/m^3$. No exceedances of the state/national 24-hour AAQS for sulfur dioxide were recorded. Twenty-four hour average particulate concentrations ranged from 4 to 28 $\mu g/m^3$; no violations of the state AAQS were measured during the 1985-86 monitoring period.

At this time, there are no reported measurements of lead, ozone, nitrogen dioxide or carbon monoxide in the project vicinity. These are primarily motor vehicle related air pollutants. Lead, ozone and nitrogen dioxide typically are regional scale problems; concentrations of these contaminants generally have not been found to exceed AAQS elsewhere in the state. Carbon monoxide air pollution, on the other hand, typically is a microscale problem caused by congested motor vehicular traffic. In traffic congested areas such as urban Honolulu, carbon monoxide concentrations have been found to occasionally exceed the state AAQS. Present concentrations of carbon monoxide in the project area are estimated later in this study based on mathematical modeling of motor vehicle emissions.

5.0 SHORT-TERM IMPACTS OF PROJECT

Short-term direct and indirect impacts on air quality could potentially occur due to project construction. For a project of this nature, there are two potential types of air pollution emissions which could directly result in short-term air quality impacts during the construction phases: (1) fugitive dust from vehicle movement and site excavation; and (2) exhaust emissions from on-site construction equipment. Indirectly, there could also be short-term impacts from slow-moving construction equipment traveling to and from the project site and from a temporary increase in local traffic caused by commuting construction workers.

Fugitive dust emissions may arise from the grading and dirt/rock-moving activities associated with site preparation once the area is cleared. The emission rate for fugitive dust emissions from construction activities is difficult to estimate accurately because of its elusive nature and because the potential for its generation varies greatly depending upon the type of soil at the construction site, the amount and type of earth-disturbing activity taking place, the moisture content of exposed soil in work areas, and the wind speed. The EPA [3] has provided a rough estimate for uncontrolled fugitive dust emissions from construction activity of 1.2 tons per acre per month under conditions of "medium" activity, moderate soil silt content (30%), and precipitation/evaporation (P/E) index of 50. Uncontrolled fugitive dust emissions from project construction would probably be somewhere near this level or possibly lower due to the rocky nature of the soil in the area. In any case, State of Hawaii Air Pollution Control Regulations [4] stipulate that emissions of fugitive dust from construction activities cannot be visible beyond the property line. Thus, an effective dust control plan for the project construction phase is essential.

Adequate fugitive dust control can usually be accomplished by the establishment of a frequent watering program to keep bare-earth surfaces in work areas from becoming significant dust generators. In some cases, other control measures such as limiting the area that can be disturbed at any given time and/or using wind screens may be necessary. Control regulations also require that open-bodied trucks be covered at all times when in motion if they are transporting materials likely to give rise to airborne dust. Paving of parking areas and/or establishment of landscaping as early in the construction process as possible can also lower the potential for fugitive dust emissions.

On-site mobile and stationary construction equipment will also emit some air pollutants in the form of engine exhausts. The largest of this equipment is usually diesel-powered. Nitrogen oxides emissions from diesel engines can be relatively high compared to gasoline-powered equipment, but the standard for nitrogen dioxide is set on an annual basis and is not likely to be violated by short-term construction equipment emissions. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicular emissions on nearby roadways.

Indirectly, slow-moving construction vehicles on roadways leading to and from the project site could obstruct the normal flow of traffic to such an extent that overall vehicular emissions are increased, but this impact can be mitigated by moving heavy construction equipment during periods of low traffic volume. Likewise, the schedules of commuting construction workers can be adjusted to avoid peak hours in the project vicinity. Thus, most potential short-term air quality impacts from project construction can be mitigated.

6.0 LONG-TERM IMPACTS OF PROJECT

6.1 Roadway Traffic

By serving as an attraction for increased motor vehicle traffic on nearby roadways, the proposed project is considered to be an indirect air pollution source. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. They also emit nitrogen oxides, and those burning leaded gasoline contribute lead to the atmosphere. The use of leaded gasoline in new automobiles is now prohibited. As older vehicles continue to disappear from the numbers of those currently operating on the state's roadways, lead emissions are approaching zero. Nationally, so few vehicles now require leaded gasoline that the EPA is proposing a total ban on leaded gasoline to take effect immediately. Even without such a ban, reported quarterly averages of lead in air samples collected in urban Honolulu have been near zero since early 1986. Thus, lead in the atmosphere is not considered to be a problem anywhere in the state.

Federal air pollution control regulations also call for increased efficiency in removing carbon monoxide and nitrogen oxides from the exhausts of new motor vehicles. By the year 1995 carbon monoxide emissions are expected to be about 30 percent less than the amounts now emitted due to the replacement of older vehicles with newer models. Further reductions in vehicular emissions have recently been proposed by the President for areas of the country which do not currently meet AAQS, mainly through the use of alternative fuels.

6.1.1 Ambient Air Quality

To evaluate the potential long-term, indirect ambient air quality impact of increased roadway traffic associated with a project such as this, computerized emission and atmospheric dispersion models can be used to estimate ambient carbon monoxide concentrations along roadways leading to and from the project. Carbon monoxide is selected for modeling because it is both the most stable and the most abundant of the pollutants generated by motor vehicles. Furthermore, carbon monoxide air pollution is generally considered to be a microscale problem, whereas nitrogen oxides air pollution most often is a regional issue that a single development has little control over. This is reflected in the fact that the AAQS for carbon monoxide are specified on a short-term basis (1-hour and 8-hour averaging times) while the AAQS for nitrogen dioxide is set on an annual basis.

For this project, three scenarios were selected for the carbon monoxide modeling study: year 1990 with present conditions, year 2010 without the project, and year 2010 assuming the project is built and complete. To begin the modeling study, critical receptor areas in the vicinity of the project site were identified for analysis. Generally speaking, roadway intersections are the primary concern because of traffic congestion and because of the increase in vehicular emissions associated with traffic cycling: decelerating, stopping, queuing and accelerating. For this study, the four key intersections identified in the traffic study [5] were also selected for air quality analysis. These include: Queen Kaahumanu Highway at Kealakehe Parkway, Queen Kaahumanu Highway at Palani Road, Mamalahoa Highway at Kealakehe Parkway, and Mamalahoa Highway at Palani Road. Modeling of the present scenario was performed assuming the existing roadway configurations (including the assumption that there is presently through traffic only at the location of the future intersection of Kealakehe Parkway and Mamalahoa Highway). Briefly, for the future air quality modeling scenarios, the following roadway configurations were assumed based on the project traffic study:

- With or without the project in the year 2010, Queen Kaahumanu Highway will be elevated and uninterrupted at Kealakehe Parkway, and Kealakehe Parkway will be connected to a frontage road system and signalized.

- With or without the project in the year 2010, Queen Kaahumanu Highway will be elevated and uninterrupted at Palani Road where a diamond-shaped interchange will provide on/off access. Palani Road will have four through lanes, exclusive turn lanes and signals at on/off ramps.

- With the project in the year 2010, Mamalahoa Highway at Kealakehe Parkway will form a T-intersection that is signalized. Mamalahoa Highway will be four lanes wide and have left and right turn lanes. Kealakehe Parkway will also be four lanes wide and have two left and one right turn lanes. Without the project, Mamalahoa Highway will be four lanes wide at this location with no intersection.

- With or without the project in the year 2010, Mamalahoa Highway at Palani Road will each be widened to four lanes and be signalized and fully channelized; Mamalahoa Highway will also have a left turn storage lane.

The traffic impact assessment report for the project referenced above describes the present and future conditions and configurations of these intersections in more detail.

The main objectives of the modeling study were to estimate both current and projected levels of worst-case 1-hour average carbon monoxide concentrations which could then be directly compared to the national and state AAQS. The traffic impact assessment report indicates that traffic volumes generally are or will be higher during the afternoon peak hour than during the morning peak period. Worst-case emission and meteorological dispersion conditions typically occur during the morning hours at many locations. However, due to possible effects from the queuing of vehicles at intersections, both morning and afternoon peak traffic hours were examined to ensure that worst-case concentrations were identified.

The EPA computer model MOBILE4 [6] was used to calculate vehicular carbon monoxide emissions for each of the years studied. One of the key inputs to MOBILE4 is vehicle mix. Based on recent vehicle registration figures, the present and projected vehicle mix in the project area is estimated to be 91.9% light-duty gasoline-powered vehicles, 5% light-duty gasoline-powered trucks and vans, 0.5% heavy-duty gasoline-powered vehicles, 0.6% light-duty diesel-powered vehicles, 1% heavy-duty diesel-powered trucks and buses, and 1% motorcycles.

Other key inputs to the MOBILE4 emission model are the cold/hot start fractions. Motor vehicles operating in a cold- or hot-start mode emit excess air pollution. Typically, motor vehicles reach stabilized operating temperatures after about 4 miles of driving. For traffic operating within the immediate project area, it was assumed that during both the morning and the afternoon peak traffic hours about 25 percent of all vehicles would be operating in the cold-start mode and that about 5 percent would be operating in the hot-start mode. These operational mode values were estimated based on a report from the California Department of Transportation [7] and taking into consideration the likely origins of traffic in the project area. MOBILE4 idle emissions were adjusted to account for excess cold/hot-start emissions per a recent U.S. EPA memorandum [8].

Ambient temperatures of 59 and 68 degrees F were used for morning and afternoon peak-hour emission computations, respectively. These are conservative assumptions since morning/afternoon ambient temperatures will generally be warmer than this and emission estimates given by MOBILE4 are inversely proportional to the ambient temperature.

After computing vehicular carbon monoxide emissions through the use of MOBILE4, these data were then input to the latest version of the computer model CALINE4 [9]. CALINE4 was developed by the California Transportation Department to simulate vehicular movement and atmospheric dispersion of vehicular emissions. It is designed to predict 1-hour average pollutant concentrations along roadways based on input traffic and emission data, roadway/receptor geometry and meteorological conditions.

Input peak-hour traffic data were obtained from the traffic study cited previously. The traffic volumes given in the traffic study for the future scenario include project traffic as well as traffic from other growth that is expected to occur in the area by the year 2010. Traffic queuing estimates were made based on the project traffic study, Transportation Research Board procedures [10], U.S. EPA guidelines [11], and traffic observations at the subject intersections.

Model roadways were set up to reflect actual roadway geometry, physical dimensions and operating characteristics. Model receptor sites were located within a few meters from the edge of the roadways near the intersections studied assuming sidewalks are or will be present. All receptor heights were placed at 1.5 meters above ground to simulate levels within the normal human breathing zone.

Input meteorological conditions for this study were defined to provide "worst-case" results. One of the key meteorological inputs is atmospheric stability category. For these analyses, atmospheric stability category 6 was assumed for morning scenarios and stability category 4 was assumed for afternoon cases. These are the most conservative stability categories that can be used for estimating pollutant dispersion at suburban or undeveloped locations. A surface roughness length of 150 cm was assumed with a mixing height of 300 meters. Worst-case wind conditions were defined as a wind speed of 1 meter per second with a wind direction resulting in the highest predicted concentration.

Existing background concentrations of carbon monoxide in the project vicinity are believed to be at relatively low levels. Hence, background contributions of carbon monoxide from sources or distant roadways not directly considered in the analysis were accounted for by adding a background concentration of 0.1 ppm to all predicted concentrations for the 1990 scenarios. Due to the expected significant development that is predicted to occur in the Kona area within the next several years, a background value of 0.5 ppm was used for all 2010 scenarios.

Table 3 summarizes the final results of the modeling study in the form of the estimated worst-case 1-hour morning and afternoon ambient carbon monoxide concentrations. These results can be compared directly to the state and the national AAQS. Estimated worst-case carbon monoxide concentrations are presented in the table for three scenarios: year 1990 with existing traffic, year 2010 without project traffic and year 2010 with project traffic. The locations of these estimated worst-case 1-hour concentrations all occurred at or very near the indicated roadway intersections.

All morning peak hour concentrations estimated for the existing case were higher than the afternoon peak values except at the Queen Kaahumanu Highway/Kealakehe Parkway intersection. As indicated in the table, the estimated present (1990) worst-case 1-hour carbon monoxide concentration in the project area, 21.0 mg/m^3, occurred during the morning peak hour near the intersection of Queen

Kaahumanu Highway and Palani Road. This is one of the busiest intersections in the Kona area at the present time. Worst-case 1-hour values at the other locations in the project vicinity that were studied were less than 5 mg/m^3.

In the year 2010 without the proposed project, worst-case concentrations are predicted to be much reduced even with the increase in traffic that is predicted. A worst-case 1-hour concentration of 11.6 mg/m^3 was estimated to occur during the morning peak traffic hour near the Palani Road interchange at Queen Kaahumanu Highway, the same location and time as the highest concentration for the existing case. Values at the other locations studied for this scenario ranged between about 2 and 5 mg/m^3 during the morning peak hour. Afternoon peak-hour concentrations were about 10 to 15 percent lower than the morning worst-case values.

Predicted 1-hour worst-case concentrations for the 2010 with project scenario range from 3.6 mg/m^3 during the afternoon at Mamalahoa Highway and Palani Road to 13.0 mg/m^3 during the morning at Queen Kaahumanu Highway and Palani Road. Compared to the without project case, predicted concentrations are substantially higher near the Queen Kaahumanu Highway/Kealakehe Parkway and the Mamalahoa Highway/Kealakehe Parkway intersections due to the increased volumes of traffic the project will generate at these locations. Worst-case concentrations along Palani Road at Queen Kaahumanu Highway and at Mamalahoa Highway are predicted to be about the same or slightly lower than the without project scenario.

All estimated worst-case 1-hour carbon monoxide levels for all scenarios are within the national AAQS of 40 mg/m^3. It appears likely, however, that existing concentrations of carbon monoxide

CORRECTION

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

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All estimated worst-case 1-hour carbon monoxide levels for all scenarios are within the national AAQS of 40 mg/m^3. It appears likely, however, that existing concentrations of carbon monoxide as well as future concentrations either without or with the project may exceed the State of Hawaii 1-hour AAQS of 10 mg/m^3 on occasion in the vicinity of Queen Kaahumanu Highway and Palani Road. In the future with project case, the state 1-hour standard may also occasionally be exceeded near the intersection of Queen Kaahumanu Highway frontage roads and Kealakehe Parkway.

Worst-case 8-hour carbon monoxide concentrations were estimated by multiplying the worst-case 1-hour values by a persistence factor of 0.5. This accounts for two factors: (1) traffic volumes averaged over eight hours are lower than peak 1-hour values, and (2) meteorological dispersion conditions are more variable (and hence more favorable) over an 8-hour period than they are for a single hour. Based on monitoring data, 1-hour to 8-hour persistence factors for most locations generally vary from 0.4 to 0.8 with 0.6 being the most typical. One recent study based on modeling [12] concluded that 1-hour to 8-hour persistence factors could typically be expected to range from 0.4 to 0.5. EPA guidelines [11] recommend using a value of 0.6 to 0.7 unless a locally derived persistence factor is available. Recent monitoring data for Honolulu reported by the Department of Health [13] suggests that this factor may range between about 0.35 and 0.55 depending on location and traffic variability. Considering the location of the project and the traffic pattern for the area, a 1-hour to 8-hour persistence factor of 0.5 is probably most appropriate for this application.

The resulting estimated worst-case 8-hour concentrations are indicated in Table 4. For the 1990 scenario, the estimated worst-case 8-hour carbon monoxide concentration was 10.5 mg/m^3 at the intersection of Queen Kaahumanu Highway and Palani Road. Other locations ranged from 0.8 mg/m^3 near Mamalahoa Highway at the future Kealakehe Parkway intersection to 2.2 mg/m^3 near Queen Kaahumanu Highway at Kealakehe Parkway. The predicted maximum values for the year 2010 without and with project scenarios were 5.8 and 6.5 mg/m^3, respectively; both occurred at the Queen Kaahumanu Highway/Palani Road interchange. Other locations were in the 1 to 3 mg/m^3 range without the project and the 2 to 6 mg/m^3 with the project. Either with or without the project, the highest 8-hour concentrations in the year 2010 should be much lower than existing concentrations. Comparing the predicted values for the existing case to the AAQS, it appears that the state 8-hour standard may be exceeded in the vicinity of Queen Kaahumanu Highway and Palani Road and that the national 8-hour standard also could be exceeded once in a awhile near this intersection. Without or with the project in the year 2010, the state 8-hour AAQS may continue to be exceeded on occasion.

The results of this study reflect several assumptions that must be made concerning traffic movement and worst-case meteorological conditions. One such assumption concerning worst-case meteorological conditions is that a wind speed of 1 meter per second with a steady direction for 1 hour will occur. A steady wind of 1 meter per second blowing from a single direction for an hour is not very likely, and it may occur only once a year or less. With wind speeds of 2 meters per second, for example, computed carbon monoxide concentrations would be only about half the values given above.

6.1.2 Endangered Trees

Air pollution from automobiles can potentially damage vegetation if sufficiently high concentrations occur. This is of particular concern in the development of this project since a botanical survey of the project site has revealed the existence of 19 trees that are currently on the federal list of endangered species. All of these trees are of the species Caesalpinia kavaiensis, locally called uhiuhi. As described in the project botanical report [14], the uhiuhi is a large shrub to medium-sized tree (up to 30 feet tall) with thick, rough, dark gray bark and dark blackish-brown heartwood. The leaves are subdivided into pale green leaflets, and the flowers occur at branch tips and are pinkish-purple to brick red. In the olden days when the trees were more abundant, the Hawaiians used the strong, dark, heavy wood for spears and fishing implements. Populations of the uhiuhi have been reduced greatly today with only a few plants known to exist around the state. Much of the decline was probably due to cattle and goat grazing and to the spread of fountain grass which inhibits regeneration and increases the chances of wildfire.

The 19 uhiuhi plants located on the Kealakehe project site occur mostly between 500 and 550 feet elevation, within the proposed residential area above the location where the high school will be located and below the existing Kealakehe House Lots. A few plants were also identified at about the 400-foot elevation near the location of the proposed church/day-care center and between 150 and 200 feet near or within the proposed golf course. The plants vary in height from about 8 to 25 feet.

Vegetation reacts with air pollution over a wide range of pollutant concentrations and environmental conditions. The ability of vegetation to withstand exposure to air pollutants depends on many factors including plant species, age, nutrient balance, soil conditions, temperature, humidity, and sunlight. Air pollutants may enter plant systems by either a primary or a secondary pathway. The primary pathway involves the diffusion of gases directly into and out of plant leaves. Direct deposition of particulate matter may also occur on the outer surfaces of the leaves. The indirect pathway by which air pollutants interact with plants is through the root system. The deposition of air pollutants on soils and surface waters can cause alteration of the nutrient content of the soil in the vicinity of the plant, and thus change the soil condition causing secondary effects.

The effects of air pollution on plants range from subtle to catastrophic, depending on the pollutant, concentration level and duration of exposure. Visible symptoms include deviations from normal healthy appearance of the leaves, early leaf drop, and misshapen leaf structure. Subtle effects of air pollution involve reduced plant growth and alteration of physiological and biochemical processes, as well as changes in the reproductive cycle. The major air pollutants which are phytotoxic to plants are sulfur dioxide, nitrogen dioxide and ozone. Table 5 shows the levels of these air pollutants for short-term exposures that are estimated to cause about 5 percent injury to plants growing under sensitive conditions.

Sulfur dioxide emissions from motor vehicles are relatively insignificant, and ozone is not emitted directly. Nitrogen oxides are emitted mainly in the form of nitric oxide which may subsequently transform into the more corrosive species nitrogen dioxide after emission into the atmosphere. In clean atmospheres this transformation is slow, but in a polluted urban environment the conversion can be very rapid, especially during the daytime.

Present project plans call for the establishment of a 5-acre preservation area surrounding the cluster of eight uhiuhi trees that exist near the proposed intersection of Kealakehe Street and the new project entrance road connecting with Palani Road. The botanist's report also recommends that small one-half acre plots be established around each of the remaining eleven plants outside the 5-acre preserve. Uhiuhi trees within the preserve area will have a buffer distance of about 150 feet to the nearest roadway. Most of the remaining plants will have larger buffer distances to the nearest roadways except for two trees along the proposed extension of Kealakehe Parkway. One of these two trees will be located about 75 feet from Kealakehe Parkway and the other within about 20 feet.

Potential air pollution impacts on the uhiuhi trees resulting from nitrogen oxides emissions associated with project motor vehicle traffic were estimated using the MOBILE4 emission model and the CALINE4 dispersion model. Both of these models were described and referenced in the previous section of this report in connection with the assessment of carbon monoxide impacts on air quality. The results of the nitrogen oxides modeling analysis show that the worst-case 1-hour nitrogen dioxide concentration impacting any of the uhiuhi trees as a result of emissions from project traffic should be less than 0.2 ppm (400 $\mu g/m^3$). As shown in Table 5, even sensitive species of plants can tolerate 1-hour exposures to nitrogen dioxide of up to 3 ppm (5700 $\mu g/m^3$) or more without significant injury. Both shorter and longer term exposures from project emissions can also be expected to be well below the injury thresholds indicated in the table. Thus, any injury to the uhiuhi plants located on the project site from project-related air pollution should be nil.

6.2 Electrical Demand

The proposed project would also cause indirect emissions from power generating facilities as a consequence of electrical power usage. Peak project power demand at full build-out is not expected to exceed 8.3 megawatts. Present generating capacity on the Big Island is 161 megawatts with most of this power provided by oil-burning generating units. Average annual electrical demand of the project when fully developed is not expected to exceed about 50 million kilowatt-hours (assuming 600 kilowatt-hours per month per housing unit plus an additional one million kilowatt-hours per month usage by the schools, church, daycare center, civic center and commercial facilities). This power demand will most probably be provided mainly by oil-fired turbine generating facilities located on the island. In order to meet the electrical power needs of the proposed project, power generating facilities will be required to burn more fuel, and hence more air pollution will be emitted at these facilities. Given in Table 6 are estimates of the indirect air pollution emissions that will result from the project electrical demand assuming all power is provided by burning more fuel oil at Hawaii's oil-fired power plants. Based on the ratio of peak project power demand to total present generating capacity on Hawaii, the project power demand will result in about a 5 percent increase in emissions from the electric utility if all project power is derived from fuel oil.

6.3 Solid Waste Disposal

Solid waste generated by the project when fully completed is expected to amount to less than 42 tons of refuse (about 7 truckloads) per day. Most if not all of this refuse will likely be hauled away and either landfilled or burned at another location. If all refuse is landfilled, the only air pollution emissions associated with solid waste disposal (assuming problems similar to those which currently exist at the Kailua Landfill are avoided) will be due to exhaust fumes and fugitive dust from trucks and heavy equipment used to place the refuse in the landfill. If, on the other hand, all or part of the refuse is burned at a municipal incinerator, disposal of solid waste from the project will also result in emissions of particulate, carbon monoxide and other contaminants from the incineration facility. Table 7 gives emission factors for municipal refuse incinerators (without controls) in terms of pounds of air pollution per ton of refuse material charged. Thus, uncontrolled air pollutant emission rates in terms of pounds per year, for example, can be estimated by multiplying the emission factors given in the table by the number of tons per year of refuse that is burned. Use of emission filtration equipment will substantially reduce emissions of particulate.

7.0 IMPACTS OF KAILUA LANDFILL EMISSIONS ON PROJECT

In addition to assessing the impact of the project on the surrounding areas, the reverse problem of impacts of air pollution sources located in the surrounding area on the residents of the project is also of concern. For the Kealakehe Planned Community Project, the primary issue is the presence of the Kailua Landfill located adjacent to the project. Insofar as air quality is concerned, smoke and noxious fumes emanating from fires both above ground and underground present the greatest problem. For many years now, wastes have been transported to the landfill site and buried. As the waste within the landfill decomposes, landfill gas (LFG) is generated. LFG is typically comprised largely of methane, carbon dioxide, nitrogen and oxygen with a small fraction consisting of volatile organic compounds (VOC) and hydrogen sulfide. Spontaneous combustion may occur when the heat buildup from underground bacterial activity ignites the LFG. Hot, humid conditions and the porous volcanic strata of landfills on Hawaii enhance composting conditions and hence the probability of spontaneous combustion. Presently, the County of Hawaii plans to close the Kailua Landfill by August 1991, which is before construction of the proposed project's first increment. The threat of surface fires, such as that which occurred in early May 1990 and caused the evacuation of nearby public facilities, will presumably be eliminated when the landfill is properly closed. Subsurface fires, however, could continue to occur even after the landfill is closed due to the spontaneous combustion of buried wastes.

For the past several years, nearby residents and workers have complained to county and to state Department of Health officials about noxious emissions from the landfill. The most persistent complaints have come from the police who work at the Kealakehe police station located adjacent to the landfill. On numerous occasions, the police have complained about odor, and several officers have complained of headaches, eye irritation and respiratory problems. The problem at the police station is generally the greatest during the night when offshore winds carry the fumes in this direction. There have also been complaints from Kealakehe School and from the residents of the Kealakehe neighborhood located upslope from the landfill. These areas are primarily affected during the daytime when onshore winds prevail.

At the request of the State Department of Health, a team of investigators from the EPA was dispatched to the Kailua Landfill during December of 1987. During a three-day period, samples of smoke emanating from the landfill were collected and analyzed. Although a final report of the study still has not been received by the local authorities, the draft report [15] concluded that fumes from the facility may be a public nuisance but they do not pose a threat to public health. The draft report goes on to say, however, that "...since hazardous substances such as batteries, household chemical products (paints and pesticides) and other unknowns may be buried within the landfill, there is a potential for future hazardous releases if the burning continues unmitigated. Contaminants and concentrations will fluctuate, depending on the type of debris burning at that particular time."

The EPA study reported that the only contaminants consistently identified were toluene and benzene, which are common VOCs associated with decomposing municipal wastes. Other organic compounds commonly found in LFG samples include xylene, ethylbenzene and methylene chloride. Although there are no specific ambient air pollution standards pertaining to these substances, Threshold Limit Values (TLVs) set by the American Conference of Governmental Industrial Hygienists (ACGIH) for industrial workplaces are often used as guidelines [16]. The ACGIH TLVs generally are stated both in terms of a short-term exposure limit (TLV-STEL) and a time-weighted average (TLV-TWA). The TLV-STEL pertains to maximum allowable 15-minute average concentration, while the TLV-TWA specifies maximum allowable average concentrations for an 8-hour period (40 hours per week).

In lieu of national standards from the U.S. EPA, state and local governments are faced with the task of regulating ambient concentrations of air toxics. Although use of the TLVs directly in assessing potential impacts on public health is specifically discouraged by the ACGIH, at the present time more than 20 state and local governments use the TLVs either directly or indirectly as a basis for setting community standards in the absence of any better practical method [17]. The State of Hawaii so far has not issued guidelines pertaining to allowable community air toxic concentrations. Until such guidelines are issued, community air toxic guidelines established by the Texas Air Control Board (TACB) may at least serve as a point of reference. TACB has developed both "acute" and "chronic" community air toxic guidelines based on the ACGIH TLVs. The TACB guideline for acute exposure is based on 1 percent of the TLV-STEL and pertains to a 30-minute averaging period, whereas the guideline for chronic exposure is derived as 0.1 percent of the TLV-TWA and applies to annual average exposure. Thus, community air pollution standards are usually set much lower than the ACGIH TLVs. This is because TLVs are designed to protect only healthy adults who work 40 hours per week. Community air toxic standards, on the other hand, must also safeguard children and other sensitive subpopulations and guard against continuous exposures. Compared to other states that have regulations controlling community air toxic concentrations, the TACB guidelines are in some cases more stringent and in others more permissive.

Table 8 shows the ACGIH TLVs and the TACB Community Air Toxic Guidelines for several of the substances that are known to be present in the LFG at Kailua Landfill. The EPA study found concentrations of benzene of about 12 to 25 mg/m^3 in the fumes at the point where they emerged from underground. This is based on only very limited sampling. More extensive data pertaining to benzene concentrations in LFG at mainland locations indicates that concentrations could range higher [18][19][20]. Based on the EPA testing, benzene concentrations as they emanate from the ground at the Kailua Landfill appear to be below the TLV-TWA of 30 mg/m^3 and thus should not threaten the health of landfill workers if this is so. Concentrations at offsite locations in the surrounding area will be diluted and dispersed by the wind by the time the emissions arrive at these locations. Based on screening-level dispersion calculations for worst-case conditions and the concentrations at the landfill vents reported by EPA, it is estimated that offsite benzene concentrations should meet the TACB chronic exposure criteria.

Toluene in the fumes from smoldering vents was found to be present at a concentration of 68 mg/m^3. Again, this is based on only very limited sampling, and concentrations could range much higher. Nevertheless, the concentration reported at the Kailua Landfill is well below both the TLV-TWA and the TLV-STEL, and it is likely that even higher ranging concentrations will not exceed the ACGIH limits. The TACB guidelines for toluene could probably be achieved with a buffer distance of about 100 m (330 feet) or less.

Detectable concentrations of n-butyl mercaptan, hexane and ethyl benzene were also reported in the EPA study. Specific concentrations could not be determined with the available equipment, but it was estimated that n-butyl mercaptan and hexane concentrations were approximately in the 15 to 60 mg/m^3 range. At concentrations in this range, hexane emissions would not exceed either the TLV-TWA or the TACB Community Guidelines, but n-butyl mercaptan concentrations could potentially exceed the TLV-TWA at the landfill and also would likely exceed the TACB Community Guidelines for a distance of about 400 m (1300 ft). Since the EPA study is not very specific concerning the concentration at the source, it may be prudent to make further measurements before any definite conclusions are made or course of action is undertaken.

Aside from being a potential threat to the health of residents of the proposed project and other nearby areas, smoke and fumes from underground fires have created a nuisance odor problem for residents and workers in the Kealakehe area, particularly at the local police station. The specific contaminant or contaminants causing the problem has not been identified. However, in addition to being toxic substances when present in sufficiently high concentrations, both benzene and toluene, which are known to be emitted at the landfill, are aromatic gases that have an odor threshold below the TLV-TWA. The odor thresholds for benzene and toluene in the general population are usually taken to be about 14 and 7.5 mg/m^3, respectively [21]. Sensitive individuals, however, may smell these substances at lower concentrations. The concentrations of benzene and toluene EPA measured at the landfill vents are above the odor thresholds, but dilution and dispersion of these constituents of the LFG should render them undetectable except perhaps immediately adjacent to the landfill vents. Hence, reports of odors a mile away or farther suggest that some other substance or substances are probably involved. As discussed above, the EPA study mentions only briefly that n-butyl mercaptan was detectable in the LFG, but the concentration could not be determined accurately. The estimated concentration was 15 to 60 mg/m^3. Butyl mercaptan is known to have a strong, skunk-like odor that can be detected even at very low concentrations. Worst-case dispersion calculations of LFG with concentrations of butyl mercaptan at the source of about 30 mg/m^3 indicate that the odor could likely be detected as far away as 1.5 miles on occasion. This agrees with the distance to some of the complaints that have been received.

Fumes from the landfill will be transported in the direction of the prevailing wind vector. As discussed in Section 3, winds in the Kealakehe area typically move onshore during the daytime and offshore at night. Daytime wind frequency data for the Old Kona Airport suggest that any locations in the northeast quadrant with respect to the landfill and within the distances discussed above could be adversely affected during the daytime. Based on the EPA testing at the landfill and on screening-level dispersion estimates, the area where the proposed high school will be located as well as the proposed residential areas near the school will be far enough away so as to meet the TACB air toxic guidelines but could experience occasional odor problems. Nighttime winds move predominantly down slope from east to west and would carry the fumes over the proposed civic center area. Odor is already known to be a problem in this area, and the analysis presented above suggests that community guidelines for air toxics may also be exceeded for a few hundred feet downwind of the landfill even though the ACGIH TLVs would be met except inside the immediate landfill area.

The present study should be considered by no means an attempt to provide the final answers to the Kailua Landfill emissions question. This is a difficult problem with no simple solutions. The EPA study basically concluded that fumes from the Kailua Landfill did not present a threat to the health of nearby residents and that they represented little more than an odor nuisance. However, it appears that it may be prudent to at least obtain more and better information concerning the landfill fumes and/or the control of the fumes before developing further facilities in the adjacent areas. Some type of mitigative measures to at least reduce the odor problem will probably be necessary. Potential mitigative measures as suggested by EPA to reduce the problem of underground landfill fires include: boring holes to access hot spots and injecting fire retardant products such as foam or water; excavating of the hot spots and flushing with water; and smothering with a soil or geotextile cap. Maintaining the integrity of the soil cap and operating the landfill according to guidelines should also help to prevent fires from recurring. The shortage of suitable top soil on Hawaii, however, for use as a soil cap presents a problem that cannot be easily resolved. The present plan for the closure of the landfill has not been completed at this time. Normally, if a landfill does not have a history of subsurface fire problems, 2-foot soil cap is specified. Since the Kailua Landfill does have a history of recurring subsurface fires, additional closure measures will likely be required. A proposal has been made by a private company to mine the landfill for recyclable materials, extinguish the underground fires and cover the landfill with soil.

8.0 SUMMARY OF IMPACTS AND MITIGATIVE CONSIDERATIONS

8.1 Impacts Summary

The major short-term air quality impact will be the potential emission of significant quantities of fugitive dust during project construction phases. Uncontrolled fugitive dust emissions from construction activities are estimated to amount to about 1.2 tons per acre per month. During construction phases, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project.

The primary long-term air pollution impact from the project will arise from the increased motor vehicle traffic associated with the project. Potential increased levels of carbon monoxide concentrations along roadways leading to and from the proposed development will be the primary concern. Based on mathematical modeling of projected vehicular traffic and on atmospheric dispersion estimates of vehicular emissions, it is predicted that with the proposed project carbon monoxide concentrations in the year 2010 along roadways in the project vicinity will be higher at some locations and lower at others compared to the without project case. With the project, concentrations at the worst location (Queen Kaahumanu Highway and Palani Road) will be about the same or lower than existing levels. With or without the project, worst-case concentrations should comply within both the national 1-hour and 8-hour ambient air quality standards set by the U.S. Environmental Protection Agency. Presently, the U.S. EPA 8-hour standard for carbon monoxide may be exceeded occasionally near the intersection of Queen Kaahumanu Highway and Palani Road. The more stringent State of Hawaii ambient air quality standards for carbon monoxide may be exceeded at times during the current year and either with or without the project in the year 2010 near high-volume traffic locations within the study area. The state standards are set so low, however, they are probably exceeded at many intersections in the state that have even moderate traffic volumes. It is worth noting here that, although the national AAQS allow higher levels of carbon monoxide, the national standards were developed after extensive research with the objective of defining levels of air quality that would protect the public health with an adequate margin of safety.

Air pollution impacts on the endangered species of trees existing on the project site due to project-related automotive emissions should be nil. This conclusion is based on the fact that estimated maximum concentrations of nitrogen dioxide that will occur (less than 0.2 ppm) will be much less than the injury threshold levels for sensitive vegetation.

Some long-term impacts also could potentially occur due to indirect emissions from power generating facilities supplying the project with electricity and from the burning of waste materials generated by the project. Quantitative estimates of these impacts were not made, but it appears likely that any impacts will be relatively small since project electrical power and solid waste disposal demands will be relatively modest (although not entirely insignificant) compared to the present county demands.

Potential impacts on the project from landfill emissions will be lessened but may not be eliminated with the closure of the landfill. Recurring subsurface fires could continue to persist even after landfill operations cease. The analysis of potential impacts on the project from emissions emanating from the Kailua Landfill suggests that further study of this problem is warranted before drawing any definite conclusions. The little data that are available indicate the concentrations of some air contaminants may presently exceed both occupational health and safety standards within the landfill and community guidelines outside the landfill for a distance of a few hundred feet. Nuisance odor problems may persist for several thousand feet downwind.

8.2 Mitigative Considerations

Strict compliance with State of Hawaii Air Pollution Control Regulations regarding establishment of a regular dust-watering program and covering of dirt-hauling trucks will be required to effectively mitigate fugitive dust emissions from construction activities. Twice daily watering is estimated to reduce dust emissions by up to 50 percent. Use of wind screens and/or limiting the area that is disturbed at any given time may be required in sensitive or dust-prone areas. Paving of parking areas and establishment of landscaping early in the construction schedule will also help to control dust. Increased vehicular emissions due to disruption of traffic by construction equipment and/or commuting construction workers can be alleviated by moving equipment and personnel to the site during off-peak traffic hours.

Options available to mitigate traffic-related air pollution are to improve roadways, reduce traffic or reduce individual vehicular emissions. Long-term projections of carbon monoxide emissions from vehicular traffic associated with the completed development are based on the traffic impact study findings. It has been assumed that the roadway improvements recommended in the traffic study will be implemented to move traffic efficiently through the project area and adjacent locations. Aside from improving roadways, air pollution impacts from vehicular emissions can be mitigated by reducing traffic through the use of mass transit and car pooling and/or by adjusting local school and business hours to begin and end during off-peak times. Due to the extended completion date for the project, it is conceivable that the efficiency of motor vehicle engines and/or emission control equipment will be improved or that vehicles will be developed which burn cleaner fuels before the project reaches full build-out. If this occurs, then impacts will be less than predicted. With regard to cleaner burning fuels, vehicles burning methanol or compressed natural gas or powered by electrical motors are some of the possibilities for technological development that are currently being contemplated. Lastly, even without technological breakthroughs, it is also possible that at some point in the future the state may decide to adopt either a motor vehicle inspection and maintenance program which would ensure that emission control devices are properly maintained, and thereby reduce emissions, or more restrictive emission control standards.

Air pollution impacts on endangered species of trees on the project site can be mitigated by locating roadways as far from the trees as practicable, although air pollution estimates indicate that this should be no problem even for trees adjacent to the proposed roadways.

Indirect emissions from project electrical demand could be reduced somewhat by utilizing solar energy design features to the maximum extent possible. This might include installing solar water heaters, designing homes and building space so that window positions maximize indoor light without unduly increasing indoor heat, and using landscaping where feasible to provide afternoon shade to cut down on the use of air conditioning. Use of wind power generating units, geothermal energy, ocean thermal energy conversion and/or other alternative energy sources by the utility instead of fuel-burning facilities also would lessen indirect emissions from project electrical demand.

Most probably solid waste from the project will be buried at a landfill, and any air pollution impacts will be minimal if the landfill is operated properly. If project refuse is burned instead at a municipal incinerator, air pollution impacts could be reduced substantially if the incinerator is fitted with pollution control equipment, i.e., electrostatic precipitators or fabric filters. Conservation and recycling programs also could reduce solid waste which would reduce any related air pollution emissions proportionately. Lastly, if the new H-Power garbage-to-energy facility located on Oahu proves successful, similar facilities on the other islands may be developed before project completion. Use of solid waste to generate power offsets emissions that would otherwise occur from fossil-fueled power plants.

Potential impacts <u>on</u> the project from emissions occurring as a result of underground fires at the Kailua Landfill can only be lessened by preventing or quickly extinguishing fires as they occur. The proposal to mine the landfill for recyclable materials, extinguish the underground fires and cover the landfill with soil is probably the most comprehensive and effective solution. The alternative of closing and capping the landfill with soil may help to reduce the frequency of underground fires, but it may still be necessary to extinguish fires periodically with boring and fire fighting equipment.

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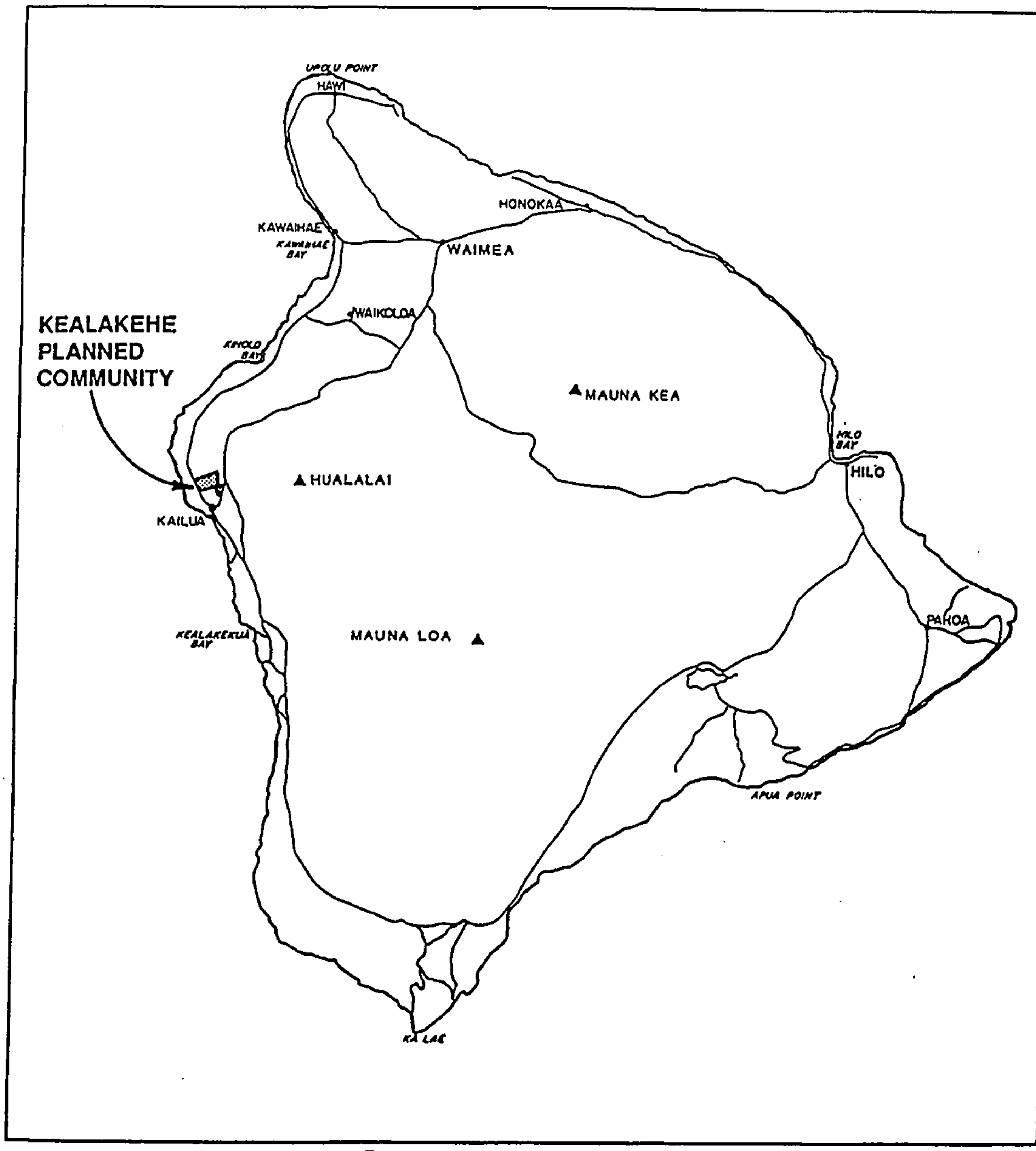

10 5 0 10
MILES

NORTH

Prepared by: Belt Collins and Associates

Figure 1
ISLAND OF HAWAII

Table 1

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Averaging Time	Maximum Allowable Concentration National Primary	National Secondary	State of Hawaii
Suspended Particulate Matter	$\mu g/m^3$	Annual	-	-	60[a]
		24 Hours	-	-	150[b]
Particulate Matter[c]	$\mu g/m^3$	Annual	50	50	-
		24 Hours	150[b]	150[b]	-
Sulfur Dioxide	$\mu g/m^3$	Annual	80	-	80
		24 Hours	365[b]	-	365[b]
		3 Hours	-	1300[b]	1300[b]
Nitrogen Dioxide	$\mu g/m^3$	Annual	100	100	70
Carbon Monoxide	mg/m^3	8 Hours	10[b]	-	5[b]
		1 Hour	40[b]	-	10[b]
Ozone	$\mu g/m^3$	1 Hour	235[b]	235[b]	100[b]
Lead	$\mu g/m^3$	Calendar Quarter	1.5	1.5	1.5

[a]Geometric mean

[b]Not to be exceeded more than once per year

[c]Particles less than or equal to 10 microns aerodynamic diameter

Table 2

ANNUAL SUMMARY OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST KEALAKEHE

Parameter / Location	1985	1986
Sulfur Dioxide / Kealakekua, Kona		
Period of Sampling (months)	7	8
No. of 24-Hr Samples	31	40
Range of 24-Hr Values (ug/m3)	<5-8	<5-12
Average Daily Value (ug/m3)	<5	<5
No. of State AAQS Exceedances	0	0
Particulate / Kealakekua, Kona		
Period of Sampling (months)	7	8
No. of 24-Hr Samples	34	40
Range of 24-Hr Values (ug/m3)	6-22	4-28
Average Daily Value (ug/m3)	12	16
No. of State AAQS Exceedances	0	0

Source: State of Hawaii Department of Health, "Hawaii Air Quality Data for the Period of January 1985 to December 1987"

Table 3

ESTIMATED WORST-CASE 1-HOUR CARBON MONOXIDE CONCENTRATIONS ALONG ROADWAYS NEAR KEALAKEHE PLANNED COMMUNITY PROJECT (milligrams per cubic meter)

Roadway Intersection	Year/Scenario: 1990/ Present AM	PM	2010/ Without Project AM	PM	2010/ With Project AM	PM
Queen Kaahumanu Hwy at:						
Kealakehe Parkway	3.2	4.3	2.6	1.8	11.4	10.8
Palani Road	21.0	16.7	11.6	9.2	13.0	8.9
Mamalahoa Hwy at:						
Kealakehe Parkway	1.5[a]	0.8[a]	2.3[a]	1.6[a]	7.7	4.6
Palani Road	3.4	1.8	5.4	4.6	4.8	3.6

Hawaii State AAQS: 10
National AAQS: 40

[a]Assumes through traffic only.

Table 4

ESTIMATED WORST-CASE 8-HOUR CARBON MONOXIDE CONCENTRATIONS
ALONG ROADWAYS NEAR KEALAKEHE PLANNED COMMUNITY PROJECT
(milligrams per cubic meter)

Roadway Intersection	Year/Scenario 1990/ Present	2010/ Without Project	2010/ With Project
Queen Kaahumanu Hwy at:			
Kealakehe Parkway	2.2	1.3	5.7
Palani Road	10.5	5.8	6.5
Mamalahoa Hwy at:			
Kealakehe Parkway	0.8[a]	1.2[a]	3.8
Palani Road	1.7	2.7	2.4

Hawaii State AAQS: 5
National AAQS: 10

[a]Assumes through traffic only.

Table 5

AIR POLLUTANT CONCENTRATIONS FOR SHORT-TERM EXPOSURES THAT PRODUCE ABOUT 5% INJURY TO VEGETATION GROWN UNDER SENSITIVE CONDITIONS

Pollutant	Time (hours)	Concentration (ppm) Producing 5% Injury		
		Sensitive	Intermediate	Resistant
Ozone	0.5	0.20-0.35	0.30-0.55	>0.50
	1.0	0.10-0.25	0.20-0.35	>0.30
	2.0	0.07-0.20	0.15-0.30	>0.25
	4.0	0.05-0.15	0.12-0.26	>0.23
	8.0	0.03-0.12	0.10-0.22	>0.20
Sulfur dioxide	0.5	1.0-4.0	3.5-10	>9.0
	1.0	0.50-2.5	2.0-7.5	>7.0
	2.0	0.30-2.0	1.5-5.0	>4.5
	4.0	0.15-1.25	1.0-3.5	>3.0
	8.0	0.10-0.75	0.50-2.0	>1.5
Nitrogen dioxide	0.5	6.0-12	10-25	>20
	1.0	3.0-10	9.0-20	>18
	2.0	2.5-7.5	7.0-15	>13
	4.0	2.0-6.0	5.0-12	>10
	8.0	1.5-5.0	4.0-9.0	>8

Source: Arthur C. Stern, ed., *Air Pollution*, Third Edition, Volume II (New York: Academic Press, 1977)

Table 6

ESTIMATED INDIRECT AIR POLLUTION EMISSIONS FROM KEALAKEHE PLANNED COMMUNITY PROJECT ELECTRICAL DEMAND[a]

Air Pollutant	Emission Rate (tons/year)
Particulate	9
Sulfur Dioxide	125
Carbon Monoxide	28
Volatile Organics	10
Nitrogen Oxides	121

[a]Based on U.S. EPA emission factors for utility gas turbines [3]. Assumes electrical demand of 50 million kw-hrs per year and low sulfur oil used to generate power.

Table 7

UNCONTROLLED AIR POLLUTION EMISSION FACTORS FOR MUNICIPAL REFUSE INCINERATORS (lb/ton)[a]

Air Pollutant	Emission Factor
Particulate	14[b]
Sulfur Oxides	2.5
Carbon Monoxide	35
Organics	1.5
Nitrogen Oxides	3

[a]Emission factors are given in terms of weight of material emitted per unit weight of refuse material charged.
[b]Assumes incinerator equipped with settling chamber and water spray.

Source: U.S. Environmental Protection Agency [3]

Table 8

THRESHOLD LIMIT VALUES AND COMMUNITY GUIDELINES FOR TOXIC SUBSTANCES KNOWN TO BE PRESENT IN KAILUA LANDFILL GASES (milligrams per cubic meter)

			Community Guideline[a]	
Substance	TLV-STEL	TLV-TWA	Acute	Chronic
Benzene	-	30	-	0.03
Butyl mercapton	-	1.5	-	0.0015
Ethyl benzene	545	435	5.4	0.44
Hexane	-	180	-	0.18
Toluene	560	375	5.6	0.38

[a]Based on Texas Air Control Board Regulations. Acute refers to 30-minute exposure; chronic refers to annual average exposure.

MARKET ANALYSIS

KPMG Peat Marwick

Certified Public Accountants

Market Assessment for Kealakehe Planned Community

Kealakehe, North Kona, Hawaii

Prepared for

BELT COLLINS & ASSOCIATES

July 1990

KPMG Peat Marwick

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July 12, 1990

Mr. Tom Papandrew
Belt Collins & Associates
680 Ala Moana Boulevard, Suite 200
Honolulu, Hawaii 96813

Dear Mr. Papandrew:

KPMG Peat Marwick is pleased to present the attached report entitled "Market Assessment for Kealakehe Planned Community".

The report presents the market assessment for residential and golf course development at the Kealakehe site in North Kona, island of Hawaii, and is organized into six chapters as follows:

I. Introduction and Executive Summary
II. Economic and Demographic Trends
III. Housing Market Review
IV. Housing Supply, Demand and Need
V. Housing Market Assessment
VI. Golf Course Market Assessment

* * * * * * *

Thank you for the opportunity to work with you in the planning of this important public project.

Very truly yours,

KPMG Peat Marwick

BELT COLLINS & ASSOCIATES

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BELT COLLINS & ASSOCIATES

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Table of Contents, Continued

BELT COLLINS & ASSOCIATES

Table of Contents, Continued

I - INTRODUCTION AND EXECUTIVE SUMMARY

This chapter introduces the market assessment for development of the Kealakehe planned community. The project is described, as are the objectives and scope of assistance of KPMG Peat Marwick. Study conclusions are summarized at the end of the chapter.

PROJECT DESCRIPTION

The State of Hawaii owns a parcel of approximately 840 acres in the district of North Kona, on the island of Hawaii. The area is called Kealakehe, derived from its history as part of the ahupua'a of the same name. The borders of the property include the Queen Kaahumanu Highway, the Kealakehe landfill, Kealakehe Village and the Kailua quarry. The general location of the property is shown in Exhibit I-A.

The State has embarked on a new communities strategy to address affordable housing and urban development needs. Government agencies, led by the State Housing Finance Development Corporation (HFDC), are to take the lead role in site acquisition, land planning and infrastructure development, while private developers will build housing and other facilities. A new community is under-way at Kapolei in Oahu's Ewa district, and a Maui project is to be developed at Lahaina. The Kealakehe property is being planned for a new community on the island of Hawaii.

The HFDC is considering development of the Kealakehe property as a residential community, primarily in order to meet existing and projected demand for afford-able housing in the west Hawaii region. The development is conceived of as a mixed-use planned community which could include:

- Affordably-priced housing for rent and ownership
- Market-priced housing
- Public golf course
- Neighborhood shopping center
- Community, civic, recreation and public facilities uses

The HFDC retained Belt Collins & Associates (Belt Collins) to coordinate Kealakehe planning, including preparation of necessary environmental impact disclosure and development permit documents. Belt Collins in turn retained KPMG Peat Marwick to prepare a market assessment for housing and golf course uses at Kealakehe.

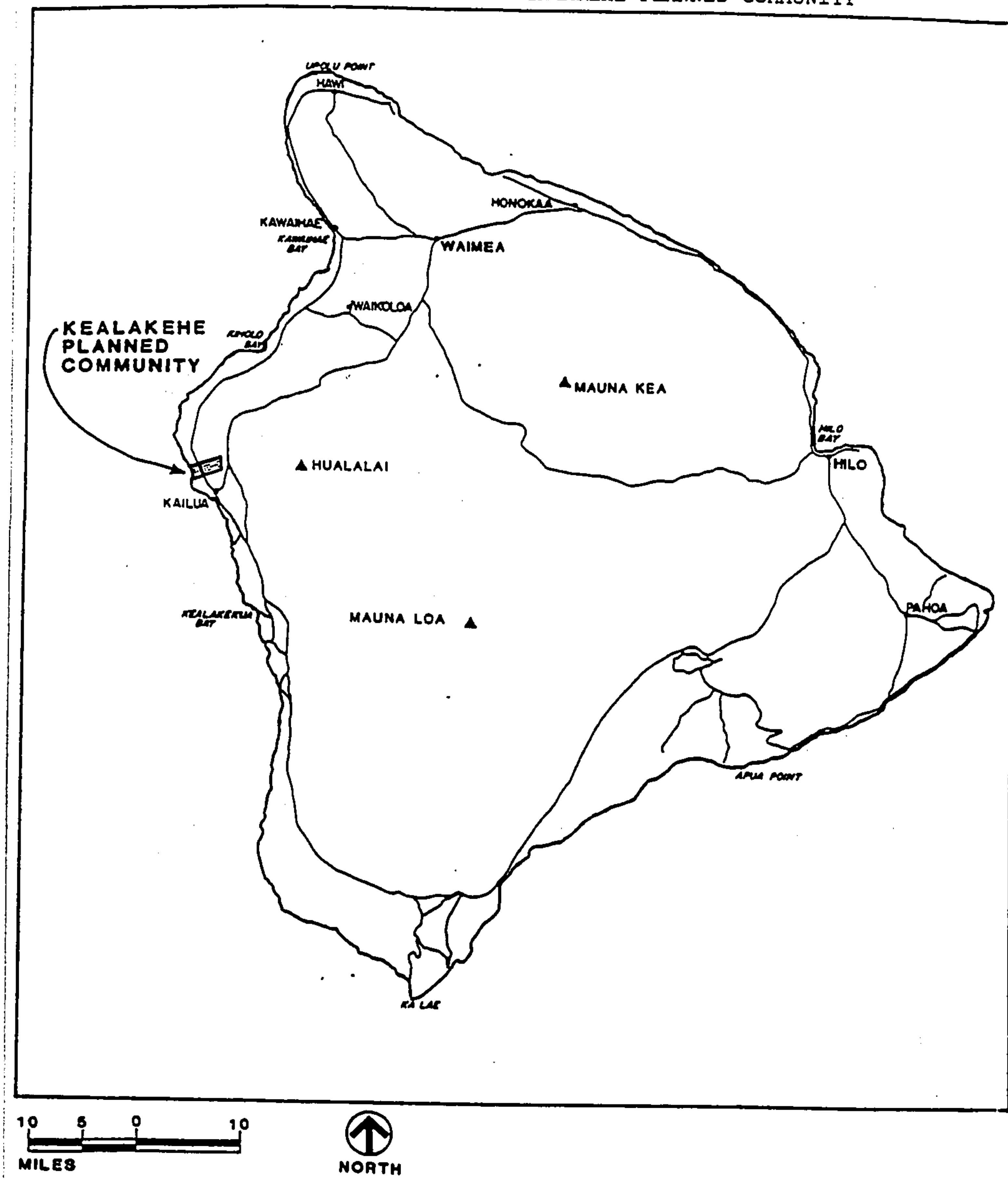
OBJECTIVES AND SCOPE OF ASSISTANCE

The objectives of KPMG Peat Marwick's assistance were to assist Belt Collins in preparing detailed land use development plans for the Kealakehe site by:

- Assessing the need for low and moderate income and market-priced hous-ing in the west Hawaii region over a 20-year period, and estimating the amount of the needs associated with the respective markets that could be expected to be accommodated at Kealakehe.

EXHIBIT I-A

GENERAL LOCATION OF KEALAKEHE PLANNED COMMUNITY



Prepared by: Belt Collins and Associates

Exhibit I-B

BELT COLLINS & ASSOCIATES

Summary of Market Support for
Kealakehe Planned Community Housing Development

1990 to 2010

Type of unit	Range of market support Low	High
Affordable:		
Ownership	1,800	2,100
Rental	690	1,160
Subtotal	2,490	3,260
Market units:	1,130	2,270
Total projected supportable units	3,620	5,530

- Evaluating the market potential for development of a municipal golf course at the project site.

To meet the objectives, the following scope of work was performed in two phases:

Phase I - Residential Market Assessment

- Project Orientation - Met with Belt Collins and representatives of the HFDC to:
  - Review the background, objectives, approach, work products and time table of the study.
  - Review the status of development planning for the site.
  - Obtain copies of prior reports and other sources of information.
- Site Visit - Visited and toured the Kealakehe site and its environs to evaluate its characteristics with respect to weather patterns, access, proximity to regional demand generators, highway frontage and other qualities.
- Island of Hawaii Economic and Demographic Trends - Using generally accepted public agency data as appropriate, described and projected trends on the island and in the west Hawaii region likely to affect housing demand during a 20-year anticipated project development period, including:
  - Population and employment growth
  - Household formations, characteristics and income patterns
- Island of Hawaii Housing Market Overview - Described recent and foreseeable trends in the residential market of the island and west Hawaii region, including:
  - Sales price levels and absorption rates
  - Rent levels and vacancies
  - Demolitions
  - Share of housing units reserved for visitor use
  - Planned new residential units and resident-oriented apartment units
- Project Housing Market Assessment - Assessed the anticipated market support for housing at Kealakehe in terms of:
  - Development concepts
  - Anticipated buyer markets
  - Anticipated renter target groups
  - Number of units supportable over a 20-year absorption period
  - Distribution between ownership and rental units
  - Supportable units by general price range, including:
    - Units affordable by low- and moderate-income households
    - Market-priced units

- Planning Assistance - Worked with Belt Collins in reviewing alternative development concepts.

- Informational Meetings - Participated in informational meetings and presentations.

Phase II - Non-Residential Land Use Market Assessment and Housing - Market Concept Refinement

- Identification of Complementary Non-Residential Uses - Assisted Belt Collins in identifying appropriate complementary non-residential uses for the Kealakehe site.

- Market Assessment for Golf Course Use - Analyzed market support for a municipal golf course, including:

  - Potential target markets
  - Development concepts
  - Amount of land or development product supportable
  - Development phasing

- Housing Market Concept Refinement - Reviewed the housing market assessment findings in terms of planned non-residential uses, including:

  - Housing development concepts
  - Adjustments relative to supportable units
  - Phasing and implementation

- Reporting - Summarized findings and conclusions in draft and final reports.

REPORT ORGANIZATION

This report is organized into six chapters, as follows:

I - Introduction
II - Economic and Demographic Trends
III - Housing Market Review
IV - Housing Supply, Demand and Need
V - Housing Market Assessment
VI - Golf Market Assessment

SUMMARY OF CONCLUSIONS

The major analysis and conclusions, presented in detail in the following chapters, are summarized in this section.

Economic and Demographic Trends

The Kealakehe planned community is expected to meet the critical housing need that now exists in the west Hawaii region, and to accommodate housing demand associated with expected rapid future population growth. Hawaii County's population is projected to increase at an annual rate of 2.6% to 2010, compared with a statewide growth rate of 1.1%. Within the Kealakehe market area, population is anticipated to grow to more than 100,000 in 2010. The market area's growth is expected to be primarily driven by expansion in visitor facilities and related service employment.

Housing Market Review

New housing construction on the island of Hawaii has reached high levels in 1988 and 1989, but construction for the decade did not keep pace with the growth of population and households. The inventory of visitor units increased more rapidly than did units for resident households. Thus, signs of a tightening housing market appeared in the late 1980s, including a decline in homeownership, increasing resale prices, and higher rents.

Housing Supply, Demand and Need

More than 21,000 new housing units are planned within the Kealakehe market area. In addition, developers are mandated to provide a proportion of units affordable to low- and moderate-income households. Federal, state and county housing efforts are also aimed at serving affordable housing demand.

Almost 40,000 new homes are projected to be needed in the county between 1987 and 2010, in order to meet future housing demand; about 25,000 of these homes could be needed within the Kealakehe market area. In order to meet State Housing Functional Plan goals, about 6,000 additional ownership units and 4,600 rental units could be needed at prices affordable to low and moderate-income households within the Kealakehe market area.

Housing Market Assessment

The number of affordable housing units supportable at Kealakehe is estimated at from about 2,490 to 3,260 units through 2010. Along with market-priced units, support is expected for a total of from 3,620 to 5,530 units in the same period. Market support is summarized in Exhibit I-B.

Golf Course Market Assessment

An 18-hole municipal golf course is proposed as one element of the Kealakehe planning community. While substantial expansion of golf courses is planned on the island of Hawaii, most new courses are expected to cater to visitors, resort residents and private club members.

Demand for lower-priced daily fee play among island residents could increase strongly in the 1990 to 2010 period, providing market support for an additional municipal course. Projected golf play at Kealakehe is anticipated to reach similar levels to the comparable Hilo municipal course by 1995, and could reach sustainable capacity by 2000.

II - ECONOMIC AND DEMOGRAPHIC TRENDS

This chapter describes the economic and demographic trends likely to influence housing supply and demand on the island of Hawaii from 1990 to 2010, the expected development period for the Kealakehe planned community. Projected population growth is detailed for the state of Hawaii, county of Hawaii and districts constituting the Kealakehe market area. Regional economic conditions, notably projected growth of the visitor industry, are also described.

POPULATION TRENDS

This section indicates projected population trends for the state, county and the Kealakehe market area.

State and County Population

Population growth projected for the state of Hawaii and county of Hawaii by the State Department of Business and Economic Development (DBED) are shown in Exhibit II-A, which indicates:

- State population growth from about 1.1 million in 1988 to more than 1.4 million by 2010.
- Growth in county population from an estimated 117,500 in 1988 to more than 206,000 by 2010.
- County population projected to increase at more than twice the rate (2.6% annual compound growth) of the state as a whole (1.2% annual rate).

Kealakehe Market Area

The Kealakehe planned community is being designed to accommodate housing needs associated with growth in the west Hawaii region. For this reason, the project's market area consists of those locations now experiencing or likely to experience pressure for housing development if Kealakehe is not built. Based on general location, land availability, and current residences of west Hawaii resort workers, the Kealakehe market area has been defined to include the districts of:

- North Kohala
- South Kohala
- North Kona
- South Kona
- Hamakua

The Kealakehe market area is depicted in Exhibit II-B.

Exhibit II-A

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Historical and Projected Population
State of Hawaii and County of Hawaii

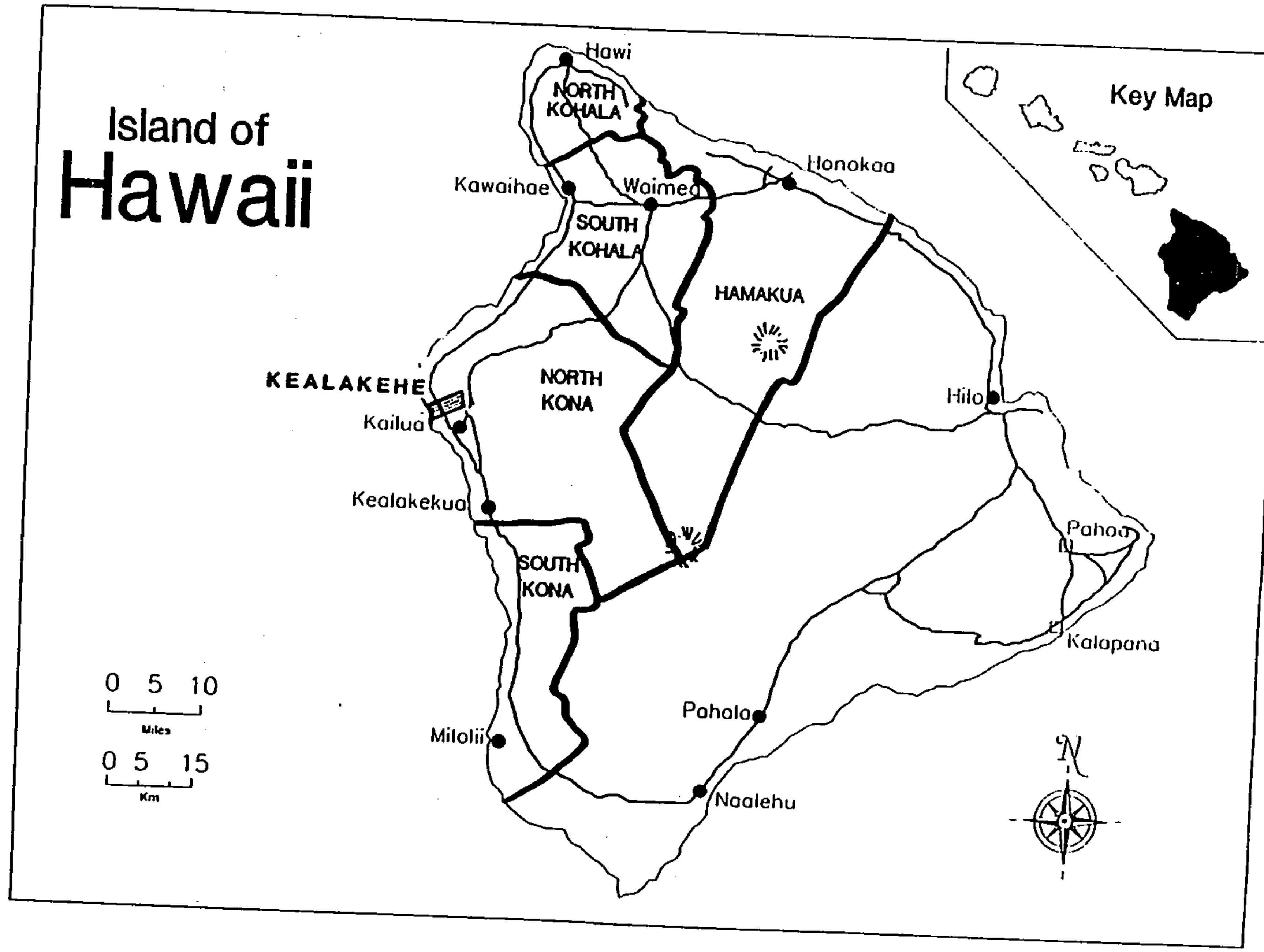
1988 to 2010

	1988	1990	1995	2000	2005	2010	Compound annual growth rate 1988 to 2010
State of Hawaii	1,098,200	1,137,200	1,225,200	1,285,100	1,350,800	1,435,500	1.2%
County of Hawaii	117,500	124,600	142,500	160,400	180,800	206,100	2.6

Source: State of Hawaii Department of Business and Economic Development, "Population and Economic Projections to 2010 (Series M-K)", November 1988.

EXHIBIT II-B

KEALAKEHE MARKET AREA



Projected Population Growth in Kealakehe Market Area

The county Hawaii General Plan presents a population distribution for districts within the county based on past growth patterns and assumptions about future employment growth. Application of these district shares to the county population projected by DBED are shown in Exhibit II-C. As indicated in the exhibit:

- Total population within the market area is projected to increase from about 46,000 in 1988 to about 108,000 in 2010.
- Projected growth for the Kealakehe market area, at a 3.9% annual rate, is significantly higher than for the county as a whole and almost three times the statewide rate.
- Within the market area, the districts of South Kohala and North Kona (where almost all new resort jobs are to be located) are projected to grow by even higher annual rates of 5% and 4% respectively.

ECONOMIC TRENDS

The economy of the island of Hawaii is based on agriculture, including sugar and diversified crops such as coffee and macadamia nuts, and tourism. High-technology research and development in agriculture, astronomy and energy are also emerging as new industries.

The visitor industry is expected tc be the primary source of economic growth during the development period for the Kealakehe project. This section describes plans for visitor industry development in west Hawaii and projects the resultant impacts on regional employment.

Projected Resort Hotel Development

Many new and expanded resort hotels are planned for development from 1989 to 2010. The potential schedule of new hotel units is presented in Exhibit II-D, arranged in terms of government development permissions received. As shown in the exhibit:

- The 540-unit Ritz Carlton Mauna Lani hotel is under construction.
- Nine resorts have all principal development approvals, including six with existing hotels. Additional hotel rooms at existing resorts could amount to almost 5,000 units.
- Three new resorts have received all principal development approvals, and could build out to about 2,600 rooms.
- Other resorts have been proposed in west Hawaii and in the Ka'u district, representing an additional 3,000 rooms.

Exhibit II-C

BELT COLLINS & ASSOCIATES

Historical and Projected Population
County of Hawaii and Kealakehe Market Area Districts

1988 to 2010

	Share of future population(1)	1988	1990	1995	2000	2005	2010	Growth rate 1988 to 2010
County of Hawaii (2)	100.0%	117,500	124,600	142,500	160,400	180,800	206,100	2.6%
District:								
North Kohala	3.1	3,700	3,900	4,400	5,000	5,600	6,300	2.5
South Kohala	11.1	7,900	8,800	11,600	15,300	20,100	26,500	5.6
North Kona	25.0	21,600	23,600	29,300	36,400	45,200	56,200	4.4
South Kona	6.3	7,500	7,900	8,900	10,100	11,400	12,900	2.5
Hamakaua (3)	3.1	5,300	5,300	5,400	5,500	5,600	5,700	0.3
Total Kealakehe market area		46,000	49,500	59,600	72,300	87,900	107,600	3.9%

(1) Expected share of county population in 2005, estimated by County Planning Department; in "Hawaii General Plan", August 1987; historical growth rates applied from 2005 to 2010.

(2) From Exhibit II-A.

(3) Growth rate adjusted to 1980-1988 historical rate to 2010.

Exhibit II-D

BELT COLLINS & ASSOCIATES

Proposed Hotel Development
On The Island of Hawaii

1989 to 2010

	Location	1989 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	Total 1989 to 2010
Under construction:							
Ritz Carlton Mauna Lani	South Kohala	540	-	-	-	-	540
Subtotal		540	-	-	-	-	540
With all land approvals(1), within existing resort:							
Waikoloa Beach Resort	South Kohala	-	400	400	400	-	1,200
Mauna Lani Resort	South Kohala	-	-	600	-	-	600
Keauhou Resort	North Kona	-	-	500	500	700	1,700
Kona Village addition	North Kona	-	50	-	-	-	50
Hapuna Beach Hotel	South Kohala	-	350	-	-	-	350
Punalu'u	Ka'u	-	425	210	400	-	1,035
Subtotal		-	1,225	1,710	1,300	700	4,935
With all land approvals(1), within new resort:							
Kaupulehu	North Kona	-	950	-	-	-	950
Regent Beach Resort	North Kona	-	400	-	-	-	400
Kohanaiki	North Kona	-	400	350	500	-	1,250
Subtotal		-	1,750	350	500	-	2,600
Other proposed:							
O'oma II	North Kona	-	600	-	-	-	600
Mahukona Resort	North Kohala	-	500	500	500	-	1,500
Hawaiian Riviera	Ka'u	-	950	-	-	-	950
Subtotal		-	2,050	500	500	-	3,050
Total (2)		540	5,025	2,560	2,300	700	11,125

(1) County General Plan, County zoning and State Land Use Commission approvals in place.
(2) Numbers represent maximum units proposed, where more specific plans have not been announced.

- The sum of planned resorts could represent more than 11,000 new hotel rooms, compared with the current inventory of less than 6,000 rooms.
- More than 80% of the hotel rooms proposed would be developed in the west Hawaii region.

Projected Resort Condominium Development

Development of condominium units in resort areas is expected to generate additional employment opportunities. Planned resort condominium units are depicted in Exhibit II-E, and indicate that:

- A total of 465 units are under construction or expected to start building in 1989.
- More than 7,350 additional units could be developed in existing resorts.
- About 1,300 condominium units are planned for new resorts with government approvals.
- Almost 1,800 additional condominium units are proposed.
- A total of more than 11,000 condominium units could be developed between 1989 and 2010. Most of the units -- more than 9,000 -- could be constructed in the west Hawaii region.

Relation of Proposed Visitor Unit Development to Economic Projections

The current inventory of visitor units, including resort condominium units used for visitor accommodations, is 8,171 units on the island of Hawaii. Economic projections of the DBED indicate that a similar number of visitor units could be absorbed as is now proposed; the figures below compare DBED projected visitor units to the total of existing and proposed visitor units:

Proposed and Projected Visitor Units
On The Island of Hawaii

1985 to 2010

Time period	Proposed(1)	Projected(2)
1990	8,900	10,100
1995	15,600	13,200
2000	19,900	16,400
2005	23,800	21,300
2010	24,900	27,100

(1) Exhibits II-D and II-E; resort condominiums estimated at 50% visitor use; includes existing visitor units.

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Proposed Resort Condominium Development
On The Island of Hawaii

1989 to 2010

	Location	1989 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	Total 1989 to 2010(2)
Under construction:							
Villas at Keauhou	North Kona	58	-	-	-	-	58
The Bluffs at Hapuna Beach	South Kohala	67	-	-	-	-	67
Shores at Waikoloa II	South Kohala	172	-	-	-	-	172
Holua at Keauhou		-	400	-	-	-	400
Subtotal		297	400	-	-	-	697
With all land approvals (1), within existing resort:							
Waikoloa Beach Resort	South Kohala	168	540	800	800	165	2,473
South Kohala Resort	South Kohala	-	-	450	-	-	450
Mauna Lani Resort	South Kohala	-	500	500	600	-	1,600
The Bluffs at Hapuna Beach	South Kohala	-	150	-	-	-	150
Keauhou Resort	North Kona	-	250	350	213	-	813
Punalu'u	Ka'u	-	430	450	490	500	1,870
Subtotal		168	1,870	2,550	2,103	665	7,356
With all land approvals (1), within new resort:							
Kaupulehu	North Kona	-	200	200	200	-	600
Regent Beach Resort	North Kona	-	200	-	-	-	200
Kohanaiki	North Kona	-	150	275	75	-	500
Subtotal		-	550	475	275	-	1,300

Exhibit II-E

BELT COLLINS & ASSOCIATES

Proposed Resort Condominium Development, Continued
On The Island of Hawaii

1989 to 2010

	Location	1989 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	Total 1989 to 2010(2)
Other proposed:							
Kohala Makai	North Kohala	-	-	220	230	-	450
Kahua Makai	North Kohala	-	278	300	300	-	878
Kahua Shores	North Kohala	-	-	-	242	-	242
O'oma II	North Kona	-	200	-	-	-	200
Hawaiian Riviera	Ka'u	-	-	-	-	-	-
Subtotal		-	478	520	772	-	1,770
Total(2)		465	3,298	3,545	3,150	665	11,123

(1) County General Plan, County zoning and State Land Use Commission aprovals in place.
(2) Numbers represent maximum units proposed, where more specific plans have not been announced.

(2) DBED, "Population and Economic Projections for the State of Hawaii to 2010 (Series M-K), November 1988; includes existing visitor units.

Employment Impacts of Planned Visitor Unit Development

The projected employment impacts of planned resort development are shown in Exhibit II-F. The exhibit indicates that:

- More than 30,000 new jobs could be created from direct, indirect and induced visitor spending.

- More than 20,000 new positions could be located on the island of Hawaii.

The location within the county of the new employment will depend on many factors, such as transportation links and the availability of land for industrial use. However, since more than 75% of the new visitor units are planned for west Hawaii, that region is expected to be most heavily impacted by employment growth.

Exhibit II-G projects employment by major industry for Hawaii County in the 1985-2010 period. From 1990 to 2010, about 39,000 new jobs would be created, with the most rapid growth in those areas most closely related to tourism, such as services, construction and eating and drinking.

Projected resort development, as established in Exhibits II-D, II-E and II-F, would produce more visitor industry jobs than now projected by DBED in Exhibit II-G. If more rapid job growth does in fact occur, it is likely that population will rise above levels projected by DBED. Projections performed for the Hawaii General Plan indicate more rapid growth than estimated by DBED. According to county projections, island population in 2005 could range from 173,000 to 258,000, compared with the DBED projection of 180,800. The official state DBED projections are used in this analysis.

Exhibit II-F

BELT COLLINS & ASSOCIATES

Projected Additional Employment Resulting
From Proposed Visitor Unit Development

1989 to 2010

	1989 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	Total
Proposed additional visitor units(1):						
Hotel rooms	540	5,025	2,560	2,300	700	11,125
Resort condominium units(2)	230	1,650	1,770	1,580	330	5,560
Total	770	6,675	4,330	3,880	1,030	16,685
Statewide employment:						
Direct(3):						
Hotel	590	5,530	2,820	2,530	770	12,240
Condominium	50	330	350	320	70	1,120
Resort commercial	150	1,380	710	630	190	3,060
Resort administration	-	30	20	20	-	70
Total	790	7,270	3,900	3,500	1,030	16,490
Indirect/induced(4):						
Hotel/resort	580	5,300	2,870	2,580	760	12,090
Commercial	90	830	430	380	110	1,840
Total	670	6,130	3,300	2,960	870	13,930

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Projected Additional Employment Resulting
From Proposed Visitor Unit Development, Continued

1989 to 2010

	1989 to 1990	1991 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	Total
Island of Hawaii employment:						
Direct(5)	710	6,540	3,510	3,150	930	14,840
Indirect/induced(6)	270	2,450	1,320	1,180	350	5,570
Total	980	8,990	4,830	4,330	1,280	20,400

(1) From Exhibits II-D and II-E.

(2) 50% of condominium units allocated to visitor pool, based on experience of rural resorts in Hawaii.

(3) Direct employees equivalent to 1.1 per hotel unit, 0.2 per condominium unit, 0.25 resort commercial employees per direct hotel employee, 0.06 resort administration employees per direct hotel employee.

(4) Indirect/induced employees equivalent to 0.9 per direct hotel, condominium and resort administration employee, 0.6 per resort commercial employee; based on DBED input-ouput multipliers.

(5) Approximately 90% of all direct jobs estimated to be located on the island of Hawaii.

(6) Approximately 40% of indirect/induced jobs estimated to be located on the Island of Hawaii.

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Projected Population and Employment by Industry
Hawaii County

1985 to 2010

	1985	1990	1995	2000	2005	2010	Growth rate 1985 to 2010
Resident population	109,500	124,600	142,500	160,400	180,800	206,100	2.7%
De facto population(1)	116,100	134,400	158,600	183,000	211,000	243,000	3.0
Civilian jobs:	42,400	50,800	59,300	68,200	78,300	89,800	3.0
Wage and salary jobs	37,700	43,100	50,800	59,000	68,600	79,500	3.0
Agriculture	3,500	3,700	3,800	3,900	4,000	4,100	0.6
Manufacturing	2,800	2,700	2,800	2,800	2,900	2,900	0.1
Construction	1,300	1,600	1,900	2,200	2,500	2,900	3.3
Tranportation, comm., utilities	2,100	2,600	3,000	3,400	3,900	4,500	3.1
Trade	6,400	7,300	8,500	9,900	11,500	13,300	3.0
Eating and drinking	2,700	3,800	5,000	6,300	8,000	9,900	5.3
Banking, financing	1,500	1,700	1,900	2,200	2,600	3,000	2.8
Services	8,800	11,600	14,600	17,700	21,200	25,300	4.3
Hotels	4,000	5,200	6,300	7,400	8,700	10,200	3.8
Other services	4,900	6,500	8,300	10,200	12,400	15,100	4.6
Government	6,800	8,100	9,300	10,600	12,000	13,600	2.8
State/Local	6,300	7,500	8,700	9,900	11,400	13,000	2.9
Federal	700	600	700	700	700	700	0.0
Self-employed	6,700	7,700	8,500	9,700	9,700	10,200	1.7

(1) Includes visitors.

Source: DBED, "Population and Economic Projections for the State of Hawaii to 2010 (Series M-K)", November 1988.

Exhibit II-G

III - HOUSING MARKET REVIEW

This chapter summarizes housing market trends on the island of Hawaii and in the Kealakehe market area. Changes in the housing inventory are discussed relating to housing units authorized by building permit and completed. Growth in the inventory of resident and non-resident housing units is described, as well as change in the extent of owner-occupancy among resident households. Housing pricing and affordability as measured by resale prices and observed rents are also discussed.

HOUSING INVENTORY TRENDS

This section describes changes in the housing unit inventory.

Units Authorized by Permit

Home construction has risen steadily in the past three years after relatively low production from 1981 to 1986. Exhibit III-A details housing units authorized by building permit in Hawaii County from 1980 through 1989. As shown in the exhibit:

- The 1989 calendar year marked a new high in unit authorizations, with more than 3,000 units permitted.
- The 1980-1989 average of 1,570 units also reflects the 1982-1986 period when from about 1,000 to 1,200 homes were permitted each year.
- About 80% of all units permitted, on average, have been single-family units.

Housing Unit Completions

From 1980 to 1987, a total of about 10,450 housing units were authorized by building permit. However, many of the permitted homes were not actually completed. Exhibit III-B indicates changes in housing supply by district on the island of Hawaii, and shows that about 8,100 units were completed in the 1980-1987 period. As also shown in the exhibit:

- The Puna district has had the most rapid growth in housing inventory, averaging 6.6% annual increase in the period.
- The housing inventory in Hamakua shows almost no increase from 1980 to 1987, reflecting removal from service of surplus plantation housing units.
- The housing stock in South Kohala and North Kona grew at a more rapid rate than for Hawaii County as a whole, but housing unit growth in the entire market area (3.1% per year) was only slightly higher than the countywide rate of 3% per year.

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Units Authorized by Building Permit
County of Hawaii

1980 to 1989

Year	Single-family units	Multifamily units(1)	Total units
1980	1,192	739	1,931
1981	1,033	285	1,318
1982	809	245	1,054
1983	880	96	976
1984	910	181	1,091
1985	988	190	1,178
1986	1,129	39	1,168
1987	1,367	361	1,728
1988	1,715	474	2,189
1989	2,562	455	3,017
Average	1,260	310	1,570

(1) Duplexes counted as multifamily units.

Source: Bank of Hawaii, "Construction in Hawaii 1989", and First Hawaiian Bank, "Economic Indicators", September 1989; 1989 data from County of Hawaii.

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Housing Inventory by District
Hawaii County

1980 to 1987

District	Total housing units 1980	1987	Change 1980 to 1987	Annual growth rate 1980 to 1987
Kealakehe market area:				
North Kohala	1,122	1,263	141	1.7%
South Kohala	2,218	2,938	720	4.1
North Kona	7,540	9,717	2,177	3.7
South Kona	1,722	2,097	375	2.9
Hamakua	1,741	1,804	63	0.5
Market area subtotal	14,343	17,819	3,476	3.1
Other:				
North Hilo	581	639	58	1.4
South Hilo	14,301	16,220	1,919	1.8
Puna	4,126	6,463	2,337	6.6
Ka'u	1,441	1,733	292	2.7
Other island subtotal	20,449	25,055	4,606	2.9
Total	34,792	42,874	8,082	3.0%

Sources: Hawaii County Planning Department, Hawaii General Plan; 1987 counts estimated by Planning Department from unpublished sources as of December 5, 1989.

Change in Resident Housing Unit Inventory

The island's housing inventory also includes units not occupied by residents, such as vacation homes and resort condominium units intended for part-time residents or visitor rentals. Historic and projected nonresident housing units are shown in Exhibit III-C, and indicate that:

- Units identified in the visitor unit inventory increased from about 600 in 1980 to more than 2,100 in 1987 -- an annual increase of 19%.

- Based on comparison with Exhibit III-B, more than 18% of the increase in overall housing inventory from 1980 to 1987 consisted of visitor units.

- Market support for visitor condominium units is projected to grow with accelerated resort development and expansion in the number of both first-time and repeat visitors. Visitor condominium units could increase by 10% annually to 2000, and by 7% annually to 2010, adding as many as 8,000 new units to the visitor condominium inventory.

Owner Occupancy Trends

The extent of owner occupancy -- the percentage of resident households living in homes they own -- is considered to be an important indicator of housing affordability. Increasing owner occupancy is an explicit goal of state housing programs, in that the State Housing Functional Plan targets attainment of a 60% statewide owner occupancy rate.

Hawaii County has historically had a high rate of homeownership; in 1980, owner-occupied units represented 59% of island households. However, homeownership on the island has declined in the 1980s, as shown in Exhibit III-D:

- As shown previously in Exhibit III-B, total housing stock grew at an annual rate of 3.0% from 1980 to 1987.

- Resident units (total inventory, less visitor units) increased from 33,594 to 40,772 in 1987, a rate of 2.8% per year.

- While owner-occupied units increased at 1.0% per year, the proportion of owner households declined from about 60% to 49%.

Relation of Population and Housing Inventory Growth

In the 1980-1987 period, population in the county of Hawaii has increased more rapidly than the housing inventory. The stock of resident units grew at annual rate of 2.8% during the period, compared to estimated annual population growth of 3.1%.

HOUSING AFFORDABILITY TRENDS

The affordability of rental and for-sale housing within the Kealakehe market area is described in this section.

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Historical and Projected
Nonresident Housing Units
County of Hawaii

1980 to 2010

Year	Nonresident housing units	Annual growth from prior period
1980(1)	621	-%
1985	2,279	29.7
1987	2,102	(4.0)
1990(2)	2,400	4.5
1995(3)	5,440	17.8
2000	7,600	6.9
2005	8,900	3.2
2010	10,320	3.0

(1) Condominium units in rental pools or intended for transient occupancy based on February survey data from Hawaii Visitors bureau.

(2) Estimated from 1988 inventory and 50% of units projected to be completed by 1990 from Exhibit II-E.

(3) Estimated based on projected visitor market support.

Exhibit III-D

BELT COLLINS & ASSOCIATES

Owner Occupancy in Hawaii County

1980 to 1988

	1980	1985	1987	1988	Compound annual growth 1980 to 1988
Population:					
Resident population	92,000	101,100	114,400	117,500	3.1%
Persons per household(1)	3.09	3.08	3.02	3.00	(0.4)
Households	29,806	32,825	37,881	39,167	3.5
Owner-occupied units:					
Total units	17,731	18,773	18,704	19,187	1.0
Percentage owner households	59.5	57.2	49.4	49.0	(2.4%)

(1) Estimated for 1988.

Prices of Existing Homes

Single-family residence average prices have risen steadily in the Kealakehe market area between 1986 and 1989, increasing at an average annual rate of 25% for the period. Resale trends are shown in Exhibit III-E, with key trends as follows:

- The average single-family resale price was almost $214,000 in 1989, significantly higher than 1988's average of about $160,000.
- About 90% of sales in 1988 and 1989 occurred in South Kohala or North Kona. The other three, more rural districts had few resales.
- Resale prices in the Kealakehe market area remained higher than for Hawaii County as a whole, with 1989 market area prices averaging 27% higher than countywide.

Condominium resale prices also rose steadily in the market area, increasing by an average annual rate of 29% from 1986 to 1989. Resale trends are shown in Exhibit III-F, and highlighted as follows:

- Almost 90% of the condominium resales on the island occurred within the South Kohala, North Kona and South Kona districts of the Kealakehe market area. Thus, market area and countywide average prices had a relatively constant relationship.
- Resale prices levelled off in the first nine months of 1989, with the average price of about $202,000 declining slightly from the 1988 average of $215,000.

Residential Lot Prices

Many island residents prefer to acquire vacant residential lots and build custom homes. Thus, lot prices are an important indicator of housing affordability. Current sales prices for North Kona lots of less than one acre are shown in Exhibit III-G. As shown in the exhibit:

- The average lot sold for more than $187,000 in the first three months of 1990, a figure well out of reach of most moderate-income households.
- While prices were highest in the visitor-oriented Keauhou area, average per-square foot prices elsewhere ranged from about $9.50 to about $16.50.

Affordability of Resale Housing

Housing prices are most meaningful in relation to household incomes among Hawaii County residents. Exhibit III-H portrays housing affordability based on the 1990 distribution of household incomes as estimated by the U.S. Department of Housing and Urban Development.

The HUD distribution divides households into "deciles", ten income brackets each representing 10% of all households. Thus, the D-1 decile includes the lowest 10% of households by income level, the D-2 decile those between the tenth and twentieth percentile, as so forth.

Exhibit III-E

BELT COLLINS & ASSOCIATES

Resale Trends for Single-Family Residences
County of Hawaii and Kealakehe Market Area

1986 to 1989

Sales price range	Number of sales					Market area		County	
	North Kohala	South Kohala	North Kona	South Kona	Hamakua	Sales	Percent of sales	Sales	Percent of sales
1988 sales:									
Less than $ 60,000	1	4	24	-	-	29	5%	63	7%
$ 60,000 to 79,999	3	3	21	1	7	35	6	131	14
80,000 to 99,999	3	5	28	1	5	42	7	167	18
100,000 to 119,999	1	5	51	2	1	60	10	96	10
120,000 to 149,999	3	35	113	6	2	159	28	190	21
150,000 to 174,999	2	26	71	2	-	101	17	108	12
75,000 to 199,999	-	22	31	-	-	54	9	62	7
200,000 or more	1	34	63	-	-	98	17	109	12
Total sales	14	134	402	13	15	578	100%	926	100%
1989 year to date sales(1):									
Less than $ 60,000	-	-	1	1	-	2	1	24	4
$ 60,000 to 79,999	1	-	4	-	1	6	2	60	9
80,000 to 99,999	1	2	11	-	2	16	4	89	14
100,000 to 119,999	3	4	17	-	1	25	6	71	11
120,000 to 149,999	4	13	56	1	2	76	20	109	17
150,000 to 174,999	1	16	59	2	1	79	21	87	14
175,000 to 199,999	-	13	44	2	-	59	15	64	10
200,000 or more	-	45	74	2	1	122	32	129	20
Total sales	10	93	266	8	8	385	100%	633	100%

(Continued)

BELT COLLINS & ASSOCIATES

Resale Trends for Single-Family Residences
County of Hawaii and Kealakehe Market Area, Continued

1986 to 1989

	Market area	County	Market area of % county
Average sales price:			
1986	$ 114,302	$ 93,561	122%
1987	145,765	110,641	132
1988	159,980	135,300	118
1989	213,875	168,972	127

Source: Multiple Listing Service, Hawaii, Inc.

Exhibit III-E, Cont.

Exhibit III-F

BELT COLLINS & ASSOCIATES

Resale Trends for Condominiums
County of Hawaii and Kealakehe Market Area

1986 to 1989

Sales price range	Number of sales: North Kohala	South Kohala	North Kona	South Kona	Hamakua	Market area: Sales	Percent of sales	County: Sales	Percent of sales
1988 sales:									
Less than $ 60,000	-	6	85	7	-	98	16%	127	19%
$ 60,000 to 79,999	-	4	45	1	-	50	8	70	10
80,000 to 99,999	-	19	60	-	-	79	13	95	14
100,000 to 119,999	-	26	52	-	-	78	13	82	12
120,000 to 149,999	-	13	46	-	-	59	10	66	10
150,000 to 174,999	-	1	26	-	-	27	5	27	4
175,000 to 199,999	-	-	19	-	-	19	3	19	3
200,000 or more	-	134	52	1	-	187	31	190	28
Total sales		203	385	9		597	100%	676	100%
1989 year to date sales(1):									
Less than $ 60,000	-	3	32	10	-	45	9	59	10
$ 60,000 to 79,999	-	8	56	-	-	64	13	89	16
80,000 to 99,999	-	7	46	-	-	53	10	61	11
100,000 to 119,999	-	16	53	-	-	69	14	75	13
120,000 to 149,999	-	13	79	-	-	92	18	94	17
150,000 to 174,999	-	4	43	-	-	47	9	49	9
175,000 to 199,999	-	-	20	-	-	20	4	20	4
200,000 or more	-	70	47	-	-	117	23	118	21
Total sales	-	121	376	10	-	507	100%	565	100%

(Continued)

BELT COLLINS & ASSOCIATES

Resale Trends for Condominiums
County of Hawaii and Kealakehe Market Area, Continued

1986 to 1989

	Market area	County	Market area of % county
Average sales price:			
1986	$ 99,542	$ 90,918	109%
1987	126,069	121,227	104
1988	214,895	204,033	105
1989	202,481	189,874	107

(1) No condominium sales in North Kohala and Hamakua districts.

Source: Multiple Listing Service Hawaii, Inc.

BELT COLLINS & ASSOCIATES

Vacant Residential Lot Sales
in North Kona District

January 1990 to March 1990

			Weighted average	
			Sales price	
Tax map section	Principal residential areas	Lot size (square foot)	Total	Per square foot
7 - 2	Kaloko, Kona Ocean View	9,550	$ 155,000	$ 16.23
7 - 3	Kona Highlands, Kalaoa, Kona Palisades	12,770	113,500	10.08
7 - 4	Queen Liliuokalani Village, Paniolo Country	9,070	84,700	9.56
7 - 5	Kailua-Kona, Kona Heights, Kona Hillcrest	16,250	170,000	12.85
7 - 6	Holualoa, Alii Kai	10,630	153,000	15.80
7 - 7	Komohana, Kona Sea View	13,210	202,600	16.34
7 - 8	Keauhou	16,720	370,100	22.82
	Average	12,600	$ 178,414	$ 14.69

Source: Multiple Listing Service Hawaii, Inc.

Exhibit III-H

BELT COLLINS & ASSOCIATES

Housing Affordability for Hawaii County Residents
by Income Decile

	1990 resident income decile									
	Very Low/Low				Low/moderate		Moderate		Market	
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-9.5
1988 maximum annual income(1)	$ 9,000	14,000	19,000	23,700	28,800	33,500	40,200	49,100	64,400	83,300
1990 estimated income(2)	10,000	15,600	21,100	25,600	32,000	38,400	44,800	54,600	71,600	92,600
Monthly maximum income	833	1,300	1,758	2,133	2,667	3,200	3,733	4,550	5,967	7,717
Maximum monthly mortgage principal and interest(3)	150	304	455	579	755	931	1,107	1,377	1,844	2,422
At 10% interest:										
Maximum mortgage amount	17,100	34,600	51,900	66,000	86,000	106,100	126,100	156,900	210,100	275,900
Maximum home purchase price at (4):										
5% down	18,000	36,000	55,000	69,000	91,000	112,000	133,000	165,000	221,000	290,000
10% down	19,000	38,000	58,000	73,000	96,000	118,000	140,000	174,000	233,000	307,000
20% down	21,000	43,000	65,000	83,000	108,000	133,000	158,000	196,000	263,000	345,000
At 9% interest:										
Maximum mortgage amount	18,600	37,800	56,600	72,000	93,800	115,700	137,600	171,100	229,200	300,900
Maximum home purchase price at(4):										
5% down	20,000	40,000	60,000	76,000	99,000	122,000	145,000	180,000	241,000	317,000
10% down	21,000	42,000	63,000	80,000	104,000	129,000	153,000	190,000	255,000	334,000
20% down	23,000	47,000	71,000	90,000	117,000	145,000	172,000	214,000	287,000	376,000

(1) U.S. Department of Housing and Urban Development.

(2) Certain deciles estimated based on 1988 distribution and 1990 median income of $32,000.

(3) 33% of monthly income, less $125 for real property taxes and insurance.

(4) Maximum home purchase price: mortgage principal and interest at specified interest rate, plus down payment; rounded to nearest $1,000.

The exhibit further displays the maximum home price affordable by the highest income in the decile under conventional mortgage financing loan interest rates and downpayment terms. Mortgage interest rates of 9% and 10% are shown.

The decile distribution has housing program, as well as statistical, significance. For housing planning purposes, the deciles are commonly consolidated into four groups:

- The very low/low income group consists of households in the first four deciles, the lowest 40% of the population based on household income.
  - This group includes households earning less than 80% of median income.
  - With a 10% downpayment, maximum home prices for this group are $73,000 to $80,000 depending on the mortgage interest rate.
- The low/moderate income group consists of households in the fifth and sixth decile.
  - This group includes households earning from 80% to 120% of median income.
  - Maximum home prices for the moderate income gap group are $118,000 to $129,000 with a 10% downpayment, varying with the mortgage interest rate.
- The moderate income group consists of households in the seventh decile, earning between 120% and 140% of median income.
- The market group consists of households earning more than 140% of median income.

Review of housing resale trends in the west Hawaii region relative to the purchasing power of resident households indicates some erosion in affordability in 1988 and 1989, especially in regard to single-family homes. Resale prices by affordability group are summarized in Exhibit III-I, with a more typical 20% downpayment assumption used:

- Very low and low income households could afford to purchase at most about one in ten (11%) of the single-family homes sold during 1988. The number of affordable units fell to 3% in 1989.
- Low/moderate income households could afford about one in four (28%) of the single-family homes sold in 1988; by 1989, affordable resales declined to 13% of the total.
- Moderate income households, who could have afforded up to 56% of the single-family homes sold in 1988, could have afforded up to 33% of homes sold in 1989.

Loss of purchasing power in condominium units was not so pronounced in 1988 and 1989, as also shown in Exhibit III-I. However, many resold condominium units are smaller units, are located within resort areas, or are otherwise not desirable to resident households.

Exhibit III-I

BELT COLLINS & ASSOCIATES

Home Resale Prices by Affordability Group
Kealakehe Market Area

1988 to 1989

Income group(1)	Affordable home price(2)	Single-family home sales below maximum price 1988	Single-family home sales below maximum price 1989	Condominium unit sales below maximum price 1988	Condominium unit sales below maximum price 1989
Very low/low income: Up to 80% of median income	$ 80,000	11%	3%	24%	22%
Low/Moderate: 80% to 120% of median income	120,000	28	13	50	46
Moderate: 120% to 140% of median income	150,000	56	33	60	64

(1) From Exhibit III-G.
(2) From Exhibit III-G; rounded, using 20% downpayment.

BELT COLLINS & ASSOCIATES

Advertised Apartment Rents
in West Hawaii Region

August 1986 to April 1990

Survey period	Average rent	Compound annual increase
August 1986	$658	-%
August 1989	810	7.2
April 1990	909	18.3

Source: Hawaii County Office of Housing and Community Development, periodic rent surveys; 1989 and 1990 data from newspaper rental unit advertisements.

Rental Housing Trends

The market for rental housing has tightened significantly in the past several years, due to new jobs and population growth in the west Hawaii region. Among the indicators of diminished rental housing supply are the following:

- Vacancy rates for year-round housing units, which reached 20% in North Kona and South Kohala in the 1980 Census, have declined. A HUD survey in 1987 found an islandwide rental vacancy rate of 6%, with virtually no vacancies in west Hawaii. Additional rental housing has since been constructed in the region.

- Rents on advertised housing units have risen steadily from 1986 to 1990, as shown in Exhibit III-J. Rents were determined from units advertised in the West Hawaii Today regional newspaper. This sample covered about 50 units. Surveyed rents increased at an 18% annual rate in the period ending with April 1990.

- The limited supply of multifamily units consists mainly of rentals in the $700 to $900 monthly range, as shown in Exhibit III-K.

BELT COLLINS & ASSOCIATES

Monthly Rental Rates for
Market Area Multifamily Units

1990

Development	Location	Average unit size: One bedroom	Average unit size: Two bedroom	Average rental size: One bedroom	Average rental size: Two bedroom
Kona Bali Kai	Alii Drive	620	1,035	$ 600	$ 1,000
Kona Palms	Alii Drive	825	1,040	700	850
Royal Kahili	Alii Drive	N/A	900	750	900
White Sands	Alii Drive	N/A	1,000	N/A	1,000
Kona Mansions	Kuakini Highway	600	900	550	750
The Villages	Waikoloa Village	700	800	700	900
Waikoloa Hills	Waikoloa Village	700	860	800	950
Fairway Terrace	Waikoloa Village	525	925	890	975
Average		662	933	$ 713	$ 916

N/A Not applicable.

IV - HOUSING SUPPLY, DEMAND AND NEED

This chapter estimates future housing supply and demand in the Kealakehe market area. Planned housing development in the region is detailed, including market, private affordable and government-sponsored projects. Future housing demand is estimated based on current housing inventory, trends in household patterns and expected growth of regional population. Projected housing need in the county and the Kealakehe market area are also summarized.

PLANNED HOUSING DEVELOPMENT

This section details planned housing development in the Kealakehe market area.

Resident Market Housing Projects

Market housing in the region is generally planned to be developed in one of the following types of projects:

- Master-planned communities, large acreages under unified ownership in which a variety of housing products could be developed over an extended time period.
- Resort-oriented communities, consisting of multifamily and single-family properties oriented toward visitors, second-home buyers and full-time residents.
- Agricultural or estate lots, in which lots of 1 acre or more in size are sold for eventual home development.
- Residential lots, where smaller lots are sold for eventual home development or building house/lot packages.
- Subdivisions or multifamily projects, including other housing products marketed to residents.

In resort areas such as west Hawaii, visitor and second-home housing demand is a major force in the market. Resort-oriented communities in particular contain relatively few full-time residents. Thus, growth in the number of resort-oriented communities in the region is not further discussed in this section. Visitor and second-home buyers represent a major market for agricultural or estate lots as well. However, these projects are subsequently discussed because they also serve the resident market.

Exhibit IV-A identifies planned market housing projects in the region. As shown in the exhibit, more than 21,000 potential resident market units are being planned. As also shown in the exhibit:

- At least eight large tracts are proposed for residential communities that could include as many as 16,400 units. However:

Exhibit IV-A

BELT COLLINS & ASSOCIATES

Planned Resident Market Housing Projects
in West Hawaii Region

1989 to 2000

Project		Number units by location: North Kohala	South Kohala	North Kona	Total
Master-planned communities, development underway:					
Waikoloa Village	To 1990	-	150	-	
	1991 to 1995	-	1,800	-	
	1996 to 2000	-	1,500	-	
	Subtotal	-	3,450	-	3,450
Master-planned communities, with government approvals:					
Y-O Ltd.		-	-	1,433	1,433
Master-planned communities, requiring government approvals:					
Parker Ranch 2020		-	800	-	
Signal Puako		-	2,700	-	
Puako Mauka		-	2,000	-	
	Subtotal	-	5,500	-	5,500
Master-planned communities, in conceptual stage:					
Lanihau		-	-	3,000	
Kohala Ranch		3,050	-	-	
Queen Liliuokalani Trust		-	-	N/A	
	Subtotal	3,050	-	3,000	6,050
Agricultural lot or estate projects:					
Kohala-by-the-Sea		73	-	-	
Maliu Ridge		170	-	-	
Waiwailani		85	-	-	
Kapaanui		170	-	-	
Kahua Makai		N/A	-	-	
Puu Lani Ranch		-	-	45	
Waiki'i Ranch		-	-	207	
Mokuloa		-	68	-	
Estates at Waimea		-	44	-	
	Subtotal	498	112	252	862

(Continued)

BELT COLLINS & ASSOCIATES

Planned Resident Market Housing Projects
in West Hawaii Region, Continued

1989 to 2000

Project	Number units by location: North Kohala	South Kohala	North Kona	Total
Residential lot projects, with governmental approvals:				
Ainakea	165	-	-	
South Kohala View Estates	-	46	-	
Subtotal	165	46	-	211
Other housing projects, with government approvals:				
Taiyo Fudasan				
Kona Coast Associates	-	-	300	
Gamlon	-	-	950	
Alii Village	-	-	500	
Kaulana at Kona	-	-	368	
	-	-	276	
Subtotal	-	-	2,394	2,394
Other housing projects, requiring government approvals:				
Pualani				
Kona Woods	-	-	546	
Pu'uhonua	-	-	110	
	-	-	479	
Subtotal	-	-	1,135	1,135
Total units planned	3,713	9,108	8,214	21,035

- Only one project, Waikoloa Village, has advanced in its development program to offer product today.
- One other project has necessary government approvals.
- More than 11,500 of the planned units are still in conceptual design or government approvals processing. Years of infrastructure development will be required before housing is developed.

● More than 800 agricultural and estate lots are planned for the region, in addition to large lots to be developed at Waikoloa Village and Kohala Ranch.

● More than 3,700 units are planned within smaller projects. About one-third, or 1,100 units, require additional government approvals.

Private Affordable Housing Projects

State and county agencies have anticipated future needs by establishing affordable housing development requirements as a condition of development approval. Conditions normally take one of several forms:

● In the case of resorts and other employment-generating projects, a requirement that a certain number of affordable housing units be provided for employees.

● In the case of projects with a residential component, a requirement that a percentage of units developed be priced to be affordable by households in specific income brackets.

● As alternatives, developers are mandated to meet affordable housing needs through donation of land or money to allow government or non-profit development of affordable housing.

Establishment of affordable housing requirements encourages developers to utilize available government programs to reduce costs. However, meeting requirements is not predicated on government assistance.

Exhibit IV-B indicates the affordable housing commitments mandated in the region. As shown in the exhibit:

● The amount of affordable units required will be related to the ultimate project build-out. Since most commitments are expressed as a percentage of total residential units built, scaling back the resort or residential development program would reduce the number of affordable units as well.

● About 7,000 affordable units could be required, if all projects are built out to the maximum numbers planned.

Exhibit IV-B

BELT COLLINS & ASSOCIATES

Hawaii County Affordable Housing
Commitments by Target Group

Project/developer	Planned market housing units	Target groups for affordable units: Below 80% of median	80% to 120%	120% to 140%	Total(3)	Comments
Resort projects:						
South Kohala Resort	550	-	-	-	-	$2,043,000 cash payment accepted.
Waikoloa Beach	3,400	-	-	-	-	Providing land; 32 units built.
Keauhou	1,300	-	-	-	170	Not yet established.
Mauna Lani	3,000	-	-	-	-	
Kona Village	-	-	-	-	-	$100,000 cash payment accepted.
Punalu'u	1,870	-	-	-	-	Subject to future study.
Kaupulehu	600	122	237	359	718	
Regent Beach	200	254	494	749	1,497	
Kohanaiki	500	161	312	473	945	
Subtotal(1)	11,420	537	1,043	1,581	3,330	
Residential projects:						
Gamlon(2)	500	-	-	-	50	
Y-O Ltd.(2)	1,433	-	-	-	143	
Ainakea(2)	165	-	-	-	10	5.7 acres donated in additon.
Colony Associates	70	-	-	-	-	$175,000 cash payment accepted.
Kohala Ranch	3,050	305	610	915	1,830	
Keauhou Investment	310	-	-	-	31	
Signal Puako	2,700	-	810	810	1,620	
Subtotal(1)	8,228	305	1,420	1,725	3,684	
Total affordable units(1)		842	2,463	3,306	7,014	

(1) Requirements by target group do not add to total, as some are not specified by target group.

(2) Pricing of affordable units not specified.

(3) Total with maximum project buildout; affordable units could be located on- or off-site; subject to further negotiation under specific agreements.

Sources: County of Hawaii, Office of Housing and Community Development, and State of Hawaii, Housing Finance and development Corporation.

As also indicated by the exhibit, a relatively small number of affordable units have been built to date. Affordable units have been constructed at Waikoloa Village and at Ainakea, and the La'ilani project was developed by Mauna Lani Resort. A total of 257 affordable units have been built as a result of land use requirements.

Exhibit IV-B also summarizes the affordable housing commitments, in terms of the market group mandated to be served. As the exhibit indicates:

- Most of the almost 7,000 affordable units mandated are targeted to specific income groups.
- Relatively few of the units, about 800, are mandated to be affordable by households earning less than 80% of the area median income.
- Less than half of the mandated units are reserved for those earning less than 120% of median income.

Unlike the more than 21,000 planned units identified in Exhibit IV-A, private affordable units do not necessarily represent an increase in housing supply. Instead, the land use requirements could contribute to a redistribution of housing product toward a greater percentage of lower-priced units.

The extent to which the existing affordable housing commitments actually deliver affordable units depends on a number of factors, including:

- Availability of government housing assistance
- Availability of infrastructure to service new residential communities
- Success in marketing lower-priced homeownership units and leasing affordable rentals
- Degree to which developers seek to maximize unit counts in project build-out
- Flexibility in negotiating satisfaction of commitments

Government agencies could perform a supportive and expediting role through such means as:

- Providing serviced land or developing public facilities
- Efficiently staging land so that it is available for development at appropriate times
- Assisting builders in realizing cost savings
- Providing home buyer and renter assistance
- Reducing affordable housing investment risk

In each of these areas, ongoing development of a government-sponsored, master-planned community at Kealakehe could provide a crucial bridge between housing need and existing affordable housing commitments.

Planned Government-Sponsored Housing Projects

Exhibit IV-C shows the affordable housing projects in planning or development by government housing agencies on the island of Hawaii. About 3,500 units are in the planning stages; as also shown by the exhibit:

- The county's Office of Housing and Community Development (OHCD) is planning almost 2,000 units.
  - However, all but about 100 of the units are planned for after 1992.
  - The county's major project in the region is planned for a 300-acre site at Waikoloa Village, where more than 1,700 units could be developed.
- The Department of Hawaiian Home Lands has an ambitious program to lease homestead lands to eligible native Hawaiians. Two homestead areas in the west Hawaii region, at Waimea and Kawaihae, could accommodate additional housing, although industrial, commercial and agricultural leases are also anticipated.
- Smaller projects are planned by the OHCD, Hawaii Housing Authority and Department of Health to accommodate special needs, as for the handicapped and those requiring group living facilities.
- In addition to the Kealakehe project, the HFDC has plans for about 500 affordable units on the island. Three projects are planned in west Hawaii, although most units would not be built until after 1992.

PROJECTED HOUSING DEMAND

This section projects future demand for housing in the Kealakehe market area, based on anticipated population, household patterns and market trends.

Factors Affecting Projected Housing Demand

The amount of units required to meet future housing demand is affected by a number of factors, including:

- Projected population growth
- Trends in household size
- Current resident housing inventory
- Loss of existing units
- Targeted numbers of vacant available units

Projections of persons per housing unit and targeted vacancy rates introduce the greatest variability in housing demand projections.

Exhibit IV-C

BELT COLLINS & ASSOCIATES

Planned Affordable Housing Projects in the County of Hawaii

1990 to 1992

Project	Location	Unit completion date 1990	1991	1992	Future	Total
Housing Finance Development Corporation:(1)						
Homeownership:						
Miloli'i	South Kona	44	-	-	-	44
Piihonua Meadows	Hilo	37	-	-	-	37
Hale Nama Olama	Hilo	-	-	41	-	41
Lalamilo	South Kona	31	-	-	-	31
Kealakehe	North Kona	28	10	-	-	38
Upper Lalamilo	South Kohala	-	-	50	250	300
Other:						
HCC model homes	Hilo	1	1	1	2	5
Total		141	11	92	252	496
Department of Hawaiian Home Lands:						
Homeownership:						
Lot development(2)	Homestead areas	-	454	-	523	977
Hawaii Housing Authority:						
Special needs housing:						
Emergency shelter	Hilo	-	4	-	-	4
Teacher housing	South Kohala	2	-	-	-	2
Total		2	4	-	-	6
Department of Health:						
Special needs housing:						
SDMI units(3)	Various	-	2	-	-	2
County of Hawaii:						
Homeownership:						
Waikoloa	North Kona	-	-	-	1,200	1,200
Kona	North Kona	-	-	12	-	12
Ainakea	North Kohala	10	-	-	-	10
Hilo	Hilo	-	-	8	-	8
Total		10	-	20	1,200	1,230

BELT COLLINS & ASSOCIATES

Planned Affordable Housing Projects
in the County of Hawaii, Continued

1990 to 1992

Project	Location	Unit completion date 1990	1991	1992	Future	Total
Affordable rentals:						
Waikoloa	North Kona	-	-	-	525	525
Elderly rentals:						
Waimea	South Kohala	25	-	-	-	25
Kona	Undetermined	25	-	-	-	25
Ainakea	North Kohala	21	-	-	-	21
Hilo	Hilo	-	-	25	-	25
Honokaa	Hamakua	-	-	-	50	50
Papaaloa	North Hilo	-	-	-	25	25
Pahala	Ka'u	-	-	-	10	10
Puna	Puna	-	-	-	25	25
Total		71	-	25	110	206
Handicapped rentals:						
Hale Ulu Hoi	Hilo	18	-	-	-	18
Total planned units		242	471	137	2,610	3,460

(1) Many projects could be developed with a combination of County, HFDC and Federal Assistance.

(2) Lots may be leased without subdivision improvements.

(3) New or renovated housing for severely disabled-mentally impaired.

The number of persons per housing unit has been declining for both the state and for Hawaii County during the 1970s and 1980s. Even smaller households are expected in the future, with more single-person households, split families, and elderly-headed households. Estimates of household size trends since 1980 are presented below:

Household Size Estimates
State of Hawaii and Hawaii County

1980 to 1987

	State	County
1980(1)	3.15	3.09
1985(2)	3.06	3.08
1987(3)	3.02	2.98

(1) U.S. Bureau of Census, "1980 Census of Population and Housing".

(2) U.S. Bureau of Census, "Estimates of Households, for Counties, July 1, 1985".

(3) State estimates, from U.S. Bureau of Census, "current Population Reports, Population Estimates and Projections"; County estimates from U.S. Department of Housing and Urban Development, "Comprehensive Housing Market Analysis Hawaii County Housing Market Area".

As noted in Chapter III, housing vacancy rates have varied greatly in Hawaii County in the 1980s. A 5% vacancy rate is considered optimal by HUD in order to provide some market choice to consumers.

Projected Housing Demand for the County of Hawaii

Exhibit IV-D projects the number of additional housing units required to shelter the population of Hawaii County through 2010. These projections use the following assumptions:

- Population is as estimated under the State of Hawaii's Series M-K projections for the county.
- Persons per housing unit are estimated at 2.8 in 1990, trending down to 2.7 persons per unit by 2010.
- Future loss of housing units is estimated at demolition rates observed from 1980 to 1988.

Exhibit IV-D

BELT COLLINS & ASSOCIATES

Projected Housing Demand
County of Hawaii

1987 to 2010

	1990	1995	2000	2005	2010
Housing demand:					
Population(1)	124,600	142,500	160,400	180,800	206,100
Persons per housing unit(2)	2.8	2.8	2.75	2.75	2.7
Total units required, rounded	44,500	50,900	58,300	65,700	76,300
Housing supply:					
1988 housing stock(3)	42,900	40,320	40,100	39,880	39,660
Projected demolitions for period(4)	225	225	225	225	225
Nonresident unit inventory(5)	2,354	-	-	-	-
Remaining resident units, rounded	40,320	40,100	39,880	39,660	39,440
Excess of demand over supply	4,180	10,800	18,420	26,040	36,860
Additional vacancy factor	4%	4%	4%	4%	4%
Additional units to meet vacancy factor, rounded(6)	1,780	2,040	2,330	2,630	3,050
Cumulative total resident units needed, rounded	6,000	12,800	20,800	28,700	39,900
Total resident units needed per year for period	3,000	1,360	1,600	1,580	2,240
Average annual resident units needed					1,730

(1) From Exhibit II-A.
(2) Projected by Hawaii County Planning Department.
(3) Bank of Hawaii, Construction in Hawaii 1989.
(4) Based on 1980-1988 data.
(5) DBED, "Housing Unit Estimates for Hawaii, 1970-1988".
(6) 1988 vacancy rate estimated at 1%.

- Demand is estimated assuming a 5% vacancy rate to provide consumer choice.

- No allowance is made for existing pent-up demand for affordable rental or homeownership units.

The year 1988 is used as a baseline to estimate the existing housing inventory. As shown in the exhibit, additional housing unit demand is projected to amount to:

- A total of 4,200 housing units for the island as a whole by 1990, less resident units constructed in the 1988-1990 period. Resident housing unit completions would have to amount to more than 2,100 units annually.

- An additional 6,800 units from 1991 to 1995, representing unit completions at a rate of almost 1,400 units per year.

- An additional 8,000 units from 1996 to 2000, and 7,900 units from 2001 to 2005, representing annual completion of more than 1,600 resident units.

- An additional 11,200 units from 2006 to 2010, representing annual completion of more than 2,200 resident units.

An overall total of 39,900 units would be required over the period, less resident homes completed from 1988 to 1990. This would represent an average of more than 1,700 additional resident units completed each year.

<u>Projected Housing Demand in Kealakehe Market Area</u>

More than half of the future housing demand on the island of Hawaii will be associated with population growth in the Kealakehe market area. As shown in Exhibit IV-E, 25,540 additional housing units could be needed in the region by 2010 based on population growth indicated above in Exhibit II-C. Market demand, as shown in Exhibit IV-E, would be as follows:

- North Kohala demand of about 50 units per year.
- South Kohala demand of about 310 units annually.
- North Kona demand of about 570 units per year.
- South Kona demand of about 120 units annually.
- Hamakua demand of about 20 units per year.

Total market area demand could require addition of 1,070 units per year from 1987 to 2010.

<u>AFFORDABLE HOUSING NEED</u>

This section summarizes housing need for the county of Hawaii and the Kealakehe market area through 2010. Goals are established for affordable homeownership and rental units for the island and market area.

Exhibit IV-E

BELT COLLINS & ASSOCIATES

Projected Cumulative Housing Demand by District
Kealakehe Market Area

1988 to 2010

	Estimated 1987 resident housing units(1)	Additional housing units					Units per year
		1990	1995	2000	2005	2010	
North Kohala	1,263	190	370	630	850	1,160	50
South Kohala	2,769	500	1,540	3,020	4,830	7,440	310
North Kona	7,965	800	2,920	5,800	9,130	13,680	570
South Kona	2,097	840	1,210	1,720	2,210	2,870	120
Hamakua	1,804	160	200	280	310	390	20
Existing units	15,898						
Total market area demand		2,490	6,240	11,450	17,330	25,540	1,070

(1) Total housing inventory from Hawaii County Planning Department land use inventory, excluding visitor units.

Affordable Homeownership Unit Targets

Historically, the extent of homeownership has been related to household income level. This is shown for the state as a whole for 1980 in Exhibit IV-F, which indicates:

- There is a direct relationship between income and ownership. While less than 25% of households earning under $10,000 in 1979 were homeowners, more than 80% of those earning more than $35,000 owned their homes.

- Although homeownership is less widespread in lower income brackets, many lower-income households are owners. This reflects many elderly-headed households, where lower present incomes do not reflect long-term ownership of homes purchased at far lower price levels than currently prevail.

- A sizeable minority of households with incomes seemingly sufficient to qualify for homeownership still rent. In 1979, almost half -- 45% -- of households earning from $20,000 to $25,000 annually were renting. This reflects a shortage of moderately-priced housing, and also a possible lack of units suitable for families at moderate prices.

Exhibit IV-G presents similar information on the income distribution of owners and renters in Hawaii County in 1980. Overall homeownership in the county was higher than for the entire state, due primarily to greater numbers of lower-income and moderate-income owners.

The current ability of Hawaii County resident households to afford homeownership units, relative to their income, was described previously in Exhibit III-H. A similar distribution of the population into deciles is used to estimate affordable homeownership unit goals in Exhibit IV-H, as follows:

- The State Housing Functional Plan goal of 60% homeownership among resident households is used as the target.

- A distribution of owners by income decile is shown to indicate the probable distribution by 2010 if ownership follows the declining trend shown for Hawaii County in the 1980-1987 period. With this distribution, owner occupancy declines to 38% of resident households in 2010.

- The 60% overall homeownership rate is applied to the income distribution of households, in order to establish what proportion of each 10% of households -- each decile -- would have to attain homeownership in order to reach the 60% overall homeownership goal.

- The difference of homeowners in each decile represents additional homeownership units needed. These are distributed to the Kealakehe market area and other areas of the county on the basis of projected location of households shown in Exhibits IV-D and IV-E.

Exhibit IV-F

BELT COLLINS & ASSOCIATES

Household Tenure by Income for
State of Hawaii, 1980

Income in 1979	Owners	Renters	Percent owners	Total	Percent of total median income: Minimum	Percent of total median income: Maximum	Percent paying 35% or more of income for rent
Less than $ 5,000	$ 5,713	18,689	23.4%	24,402	-%	24.4%	96.7%
5,001 to 9,999	10,035	29,664	25.3	39,699	24.4	48.8	70.3
10,000 to 12,499	6,746	15,904	29.8	22,650	48.8	61.1	50.5
12,500 to 14,999	6,443	12,588	33.9	19,031	61.1	73.3	37.1
15,000 to 19,999	15,352	22,359	40.7	37,711	73.3	97.7	31.4
20,000 to 24,999	19,078	15,863	54.6	34,941	97.7	122.1	19.3
25,000 to 34,999	35,653	16,729	68.1	52,382	122.1	171.0	9.4
35,000 to 49,999	32,226	7,366	81.4	39,592	171.0	244.2	3.4
50,000 +	20,670	2,974	87.4	23,644	244.2%	-%	1.1%
Totals	151,916	142,136	51.7%	294,052			
Median income	$ 28,263	13,853		20,473			

Source: 1980 Census of Population and Housing.

BELT COLLINS & ASSOCIATES

Household Tenure by Income for
Hawaii County, 1980

Income in 1979	Owners	Renters	Percent owners	Total	Percent of total median income: Minimum	Percent of total median income: Maximum	Percent paying 35% or more of income for rent
Less than $ 5,000	1,162	2,222	34.3%	3,384	-%	26.1%	44.6%
5,001 to 9,999	1,843	2,591	41.6	4,434	26.1	52.3	24.0
10,000 to 14,000	2,357	1,995	54.2	4,352	52.3	78.4	14.8
15,000 to 19,000	2,156	2,263	48.8	4,419	78.4	104.5	9.7
20,000 +	8,326	2,759	75.1	11,085	104.5%	-%	3.5%
Total	15,844	11,830	57.3%	27,674			
Median income				$ 19,131			

Source: Census of Population and Housing, STF 3-A file for Hawaii County.

U.S. Department of Housing & Urban Development, "Estimated median family income for fiscal year 1988."

Exhibit IV-G

Exhibit IV-H

BELT COLLINS & ASSOCIATES

Affordable Homeownership Unit Targets
with Projected Trend
Hawaii County

1990 to 2010

	2010 resident income deciles (in 1990 dollars)										
	Very low/low				Low/moderate		Moder-ate	Market			Total average
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-9.5	
Maximum annual income(1)	$10,000	15,600	21,100	25,600	32,000	38,400	44,800	54,600	71,600	92,600	32,000
Number of households(2)	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	3,800	76,000
Projected renters by decile, 2010(3)	90%	85%	85%	85%	80%	75%	55%	30%	20%	10%	61.0%
Number of households in decile:											
Renter	6,800	6,500	6,500	6,500	6,100	5,700	4,200	2,300	1,500	400	46,900
Owner	800	1,100	1,100	1,100	1,500	1,900	3,400	5,300	6,100	3,400	29,100
Percentage owners to meet 60% goal	10.0%	15.0%	30.0%	45.0%	60.0%	70.0%	75.0%	80.0%	80.0%	90.0%	
Additional owners	-	-	1,200	2,300	3,100	3,400	2,300	800	-	-	13,100
Kealakehe market area	-	-	720	1,380	1,860	2,040	1,380	480	-	-	7,860
Rest of island	-	-	480	920	1,240	1,360	920	320	-	-	5,240

(1) From Exhibit III-H.

(2) Based on projected households in 2010, from Exhibit IV-D.

(3) Estimated from 1980 Census data; adjusted for change in homeownership patterns in county from 1980 to 1988 and projected to 2010.

- Additional homeownership units projected to be required are:
  - A total of 13,100 units for Hawaii County as a whole.
  - Approximately 7,860 units within the Kealakehe market area.
  - About 800 of those units would be required for households earning more than 140% of median income, leaving a total of 12,300 ownership units required for households earning less than 140% of median income.

The needed pricing of affordable units to accommodate additional homeowners, based on their ability to pay, is shown in Exhibit IV-I. Maximum unit pricing based on the general housing need groups, is shown below:

Required Affordable Homeownership Units
by General Income Category

Category	Percent median income	Units required County	Units required Market area	Maximum unit price(1)
Very low/low income	80%	3,500	2,100	$ 80,000
Low/moderate	120%	6,500	3,900	127,000
Moderate and market	120%-140%	2,300	1,380	150,000
Total		12,300	7,380	

(1) Based on 9% mortgage interest rate and 10% down payment.

Affordable Rental Unit Targets

The need for affordable rental units is estimated from historical patterns of ability to pay for rental housing, applied to a population of households assumed to be composed of 60% homeowners. Affordable rental unit targets are shown in Exhibit IV-J, and calculated as follows:

- A similar distribution of households by income and tenure is used as with the homeownership unit targets, although it is calculated from percentage of renters in each income decile.
- Based on percentage of households paying more than 35% of income for rent in 1980, as shown in Exhibit IV-G for Hawaii County, the projected number of renters in need is estimated for 2010 for the county as a whole and for the Kealakehe market area. Projections by income group are shown below.

Exhibit IV-I

BELT COLLINS & ASSOCIATES

Affordable Homeownership Unit Targets
by Unit Price Range with Projected Trend
Hawaii County

1989 to 2010

	2010 resident income deciles (in 1990 dollars)										
	Very low/low			Low/Moderate			Moderate	Market			Total average
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-9.5	
To meet 60% homeownership goal:											
Additional owners	-	-	1,200	2,300	3,100	3,400	2,300	800	-	-	13,100
Kealakehe market area	-	-	720	1,380	1,860	2,040	1,380	480	-	-	7,860
Rest of island	-	-	480	920	1,240	1,360	920	320	-	-	5,240
Maximum home purchase price at 9% interest and:											
5% down			60,000	76,000	99,000	122,000	145,000	180,000			
10% down			63,000	80,000	104,000	129,000	153,000	190,000			
20% down			71,000	90,000	117,000	145,000	172,000	214,000			
Maximum home purchase price at 10% interest and:											
5% down			55,000	69,000	91,000	112,000	133,000	165,000			
10% down			58,000	73,000	96,000	118,000	140,000	174,000			
20% down			65,000	83,000	100,000	133,000	158,000	196,000			

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Affordable Rental Unit Targets
Hawaii County

1989 to 2010

	2010 resident income deciles (in 1990 dollars)										
	Very low/low				Low/moderate		Moderate	Market			Total average
	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-9.5	
Maximum annual income(1)	$ 10,000	15,600	21,100	25,600	32,000	38,400	44,800	54,600	71,600	92,600	32,000
Number of households(2)	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	3,800	76,000
Projected renters by decile 2010, with 60% ownership(3)	90.0%	85.0%	70.0%	55.0%	40.0%	30.0%	25.0%	20.0%	20.0%	10.0%	40.0%
Renter households	6,800	6,500	5,300	4,200	3,000	2,300	1,900	1,500	1,500	400	33,800
Percentage renters in need(4)	45.0%	45.0%	25.0%	10.0%	10.0%	7.5%	7.5%	5.0%	5.0%	3.5%	
Number of renters	3,100	2,900	1,300	400	300	200	100	100	100	-	8,500
Kealakehe market area	1,860	1,740	780	240	180	120	60	60	60	-	5,100
Rest of island	1,240	1,160	520	160	120	80	40	40	40	-	3,400

(1) Maximum income in 1988 from U.S. Department of Housing and Urban Development, adjusted with 1989 median.

(2) Based on projected households in 2010, from Exhibit IV-F.

(3) Estimated from 1980 Census data; adjusted for change in homeownership patters in county from 1980 to 1987 and projected to 2010.

(4) Based on percentage of renters paying more than 35% of income for housing from Exhibit IV-1.

Exhibit IV-J

Projected Renters in Need
by Income Group

Category	Percent median income	County total	Market area	Maximum monthly rent(1)
Very low/low income	80%	7,700	4,080	$ 535- 618
Low/moderate	120%	500	270	855- 938
Moderate and market	120%-140%	100	50	1,025-1,108
Total		8,300	4,400	

(1) Based on maximum rent equivalent to 30% of monthly gross income less utility expense allowance as established by HUD.

V - KEALAKEHE HOUSING MARKET ASSESSMENT

This chapter assesses support for affordable and market-priced housing at the Kealakehe planned community. The number of homes of each type supportable at the site is estimated on the basis of projected demand in the market area and anticipated market conditions. Market support is also presented by five-year time interval for the project development period from 1990 to 2010 and for affordable homeownership and rental units, and market units.

Home sales and rental projects under development in the region comparable to the Kealakehe projects are also reviewed. Based on the comparable projects, recommendations are made for development phasing and unit characteristics.

SUPPORTABLE HOUSING UNITS

This section identifies the number of affordable and market-priced housing units potentially supported at Kealakehe. Market support is further segmented into homeownership and rental units, and is estimated by five-year interval through the project development period.

Supportable Affordable Units at Kealakehe

Islandwide and market area projected housing demand was estimated in Chapter IV. Estimates of required affordable ownership and rental units from Chapter IV are used to identify supportable units at Kealakehe, with one adjustment:

- Required additional homeownership units include those needed for households in the 120% to 160% of median income category. More widespread homeownership in this group would be required to reach the 60% ownership goal of the State Housing Functional Plan..

- The HFDC development program targets new community development toward households earning less than 120% of median income. Therefore affordable unit demand is limited to units available for those earning less than 120% of median income.

Supportable affordable units are shown in Exhibit V-A, and estimated as follows:

- Affordable ownership and rental unit demand groups were projected for the market area in Exhibits IV-H and IV-J, respectively. Because affordable rental and ownership demand were independently projected based on affordability criteria, some households could be both potential renters or homeowners.

- Capture rates, expressing the percentage of total demand that could be accommodated at Kealakehe, are estimated for each income and tenure group:

  - The Kealakehe project is estimated to capture from about 30% to 35% of affordable homeownership demand in the market area. Capture rates rise with income, reflecting the increasing ability of households to purchase homes with higher incomes.

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Affordable Housing Market Support
for Kealakehe Planned Community

1990 to 2010

	County total	Market area total	Projected Kealakehe site capture rates Low	Projected Kealakehe site capture rates High	Planned units Low	Planned units High
Affordable unit demand:						
Ownership units(1):						
Low/moderate income	10,000	6,000	30%	35%	1,800	2,100
Subtotal	10,000	6,000	30	35	1,800	2,100
Rental units(2):						
Very low/low income	7,700	4,620	15	25	690	1,160
Subtotal	7,700	4,620	15	25	690	1,160
Total demand(3)	17,700	10,620	23%	31%	2,490	3,260

(1) Projected renter households earning less than 120% of area median income as shown in Exhibit IV-H.

(2) Projected renter households earnings less than 80% of median income and paying excessive rent as shown in Exhibit IV-J.

(3) Total is greater than need group due to some renters being part of both potential owner and renter demand groups.

- The Kealakehe project is estimated to capture from about 15% to 25% of affordable rental unit demand in the market area. Capture rates also rise with renter income. Renter capture rates are expected to be lower than homeowner rates due to:
  - The preponderance of low income renters
  - The difficulty of producing heavily subsidized low-rent housing in quantity
  - The fact that many of the already planned affordable projects on the island, as shown previously in Exhibit IV-B, are targeted at households earning less than 80% of median income.

As shown in Exhibit V-A, affordable housing unit support at Kealakehe is estimated at from about 2,490 to about 3,260 units through the year 2010.

<u>Supportable Market Units at Kealakehe</u>

The Kealakehe planned community is intended to address a broad range of housing needs, including those which can be met with market-priced units. Market housing demand is estimated based on:

- Overall market area demand of 25,540 units, as shown previously in Exhibit IV-E.
- From overall market area demand, affordable unit demand to be accommodated at Kealakehe is subtracted. A mid-range number of 2,875 affordable units is applied from Exhibit V-A.
- Remaining market area demand is projected to be 22,665 units through the year 2010.

It is estimated that the Kealakehe community could capture from 5% to 10% of market housing unit demand from 1990 to 2010. The Kealakehe share of new market units could represent from 1,130 to 2,270 units.

<u>Total Market Support for Housing Development at Kealakehe</u>

Total market support consists of supportable affordable and market-priced units at Kealakehe. Based on the findings of this chapter, supportable units range from 3,620 to 5,530 units, as shown below:

Summary of Market Support for
Kealakehe Planned Community Housing Development
1990 to 2010

Type of unit	Range of market support: Low	High
Affordable:		
Ownership	1,800	2,100
Rental	690	1,160
Subtotal	2,490	3,260
Market units:	1,130	2,270
Total projected supportable units	3,620	5,530

Exhibit V-B

BELT COLLINS & ASSOCIATES

Cumulative Market Support for
Kealakehe Planned Community by Time Period

1990 to 2010

Type of unit	1990	1995	2000	2005	2010	Total
Affordable ownership units:						
Cumulative demand(1)	600	1,720	3,300	4,500	6,000	6,000
Market support:						
Low	180	520	990	1,350	1,800	1,800
High	210	600	1,160	1,580	2,100	2,100
Affordable rental units:						
Cumulative demand(2)	460	1,320	2,540	3,470	4,620	4,620
Market support:						
Low	70	200	380	520	690	690
High	120	330	640	870	1,160	1,160
Subtotal affordable units:						
Low	250	720	1,370	1,870	2,490	2,490
High	330	930	1,800	2,450	3,260	3,260
Market units:						
Cumulative demand(3)	2,200	5,415	9,865	15,170	22,665	22,665
Market support:						
Low	110	270	490	760	1,130	1,130
High	220	540	990	1,520	2,270	2,270
Total supportable units:						
Low	360	990	1,860	2,630	3,620	3,620
High	550	1,470	2,790	3,970	5,530	5,530

(1) From Exhibit IV-H.

(2) From Exhibit IV-J.

(3) Cumulative market area demand, from Exhibit IV-E, less mid-range of affordable development at Kealakehe.

Supportable Units by Time Period

Cumulative market support for Kealakehe housing units over the development period is shown in Exhibit V-B. As noted in the exhibit:

- The market is projected to support from 250 to 330 affordable units and from 110 to 220 market units in 1990.
- Cumulative support could increase to from about 1,860 to about 2,790 units by 2000.
- Market support could further grow to the 3,620-unit to 5,530-unit range by 2010.

Market support segmented by five-year time period is shown in Exhibit V-C. This exhibit indicates that:

- In general, market support will increase over the twenty-year development period, in line with regional growth.
- Annual absorption in the 1990 to 1995 period could reach 200 to 290 units at average capture rates.
- The highest degree of potential market absorption, after initial development, could occur in the 2005 to 2010 period, when from 200 to 310 units could be absorbed annually.
- Annual absorption over the entire development period could range from 170 to 260 units, depending upon the size of the development program.

RESIDENTIAL DEVELOPMENT CHARACTERISTICS

This section identifies significant site factors affecting development characteristics of the Kealakehe site. Comparable ownership and rental projects in the Kealakehe market area are reviewed, and recommendations are presented for housing characteristics and development phasing.

Site Factors

The characteristics of the Kealakehe property and development plan could influence the types, mix and pricing of planned housing units. The following could be particularly significant:

- Project areas planned for housing may need buffering or separation from nearby uses with negative impacts such as Queen Kaahumanu Highway and the Kealakehe landfill. Planned major roads through the project may also require buffering. Provision of open space might necessitate somewhat higher densities or smaller residential lots.
- The planned golf course could represent a major buffer, open space and visual amenity.

Exhibit V-C

BELT COLLINS & ASSOCIATES

Incremental Market Support for
Kealakehe Planned Community by Time Period

1990 to 2010

Type of unit	1990	1995	2000	2005	2010	Total
Affordable ownership units:						
Low	180	340	470	360	450	1,800
High	210	390	560	420	520	2,100
Affordable rental units:						
Low	70	130	180	140	170	690
High	120	210	310	230	290	1,160
Market units:						
Low	110	160	220	270	370	1,130
High	220	320	450	530	750	2,270
Total supportable units:						
Low	360	630	870	770	990	3,620
High	550	920	1,320	1,180	1,560	5,530
Units per year(1):						
Low	-	200	170	150	200	170
High	-	290	260	240	310	260

(1) Based on initial development in 1990.

- The property generally slopes upward from about 50 feet above sea level at the Queen Kaahumanu Highway property line to about 1000 feet at the eastern property line. Higher portions of the property feature excellent ocean and coastal views and a cooler climate with greater rainfall.

- Kealakehe would be a master-planned development, with parks, schools and other community facilities conveniently located in relation to residential neighborhoods.

- Regional development trends and county policies embodied in the draft "K to K Plan", indicate that Kealakehe will be located within the future Kailua-Kona regional center, with nearby employment, shopping and government service facilities.

Comparable Housing Projects Review

This section reviews recently opened rental and sales projects that could be comparable to homes to be developed at Kealakehe. Project characteristics, unit types and amenities are described, as well as pricing and unit sizes. Characteristics of project buyers and renters are summarized.

Comparable Home Sales Projects

Three home sales projects in the Kealakehe market area were selected for review, based on:

- Location
- Sales price affordability to moderate income buyers
- Potential similarity to Kealakehe development concept
- Current or recent sales program

The comparable projects, each located in Kailua-Kona, are:

- The Kamani Trees condominium subdivision
- The Pines at Kailua-Kona planned unit development
- Kuakini Makai subdivision

Project characteristics are summarized in Exhibit V-D. As shown in the exhibit:

- Lot size - Kuakini Makai provides individual lots at a minimum of 10,000 square feet area, which represents typical county residential zoning and a preferred size for home buyers. The Kamani Trees and Pines developments feature much smaller lot sizes, ranging from 3,100 to 6,400 square feet. Strong sales indicate that smaller lot sizes have become more acceptable acceptable to buyers of lower-priced homes. Lot sizes indicate the greatest differentiation among the comparable projects.

- Density - With smaller lot sizes, the Kamani Trees and Pines projects achieve single-family unit densities greater than 6 units per acre. The more conventional subdivision pattern at Kuakini Makai yields less than 4 units per acre.

Exhibit V-D

BELT COLLINS & ASSOCIATES

Comparable Kealakehe Market Area
Home Sales Project Characteristics

	Kamani Trees	Pines	Kuakini Makai
Developer	James P. Schuler & Associates	Taiyo Hawaii, Ltd.	Maryl Development
Location	Kealoha Street, Kailua-Kona	Nani Kailua Drive, Kialua-Kona	Kailua-Kona
Status	Phase I sold and under construction	Two of four planned increments built and sold	First of two planned increments built and sold
Land ownership	Fee simple	Fee simple	Fee simple
Unit type	Detached single-family	Zero lot line single-family	Detached single-family
Units	137	189	34 - increment I 99 - total units
Density (units/acre)	6	6.3	3.5
Lot size (square feet)	5,000 (average)	3,200 (average)	10,000 (minimum)
Common amenities	None	Landscaped, maintained common areas, private park	Ocean views, lots graded and landscaped
Pricing	$121,900 - 131,900 (2/2 units) $138,900 - 146,900 (3/2 units) $160,000 (3/2.5 units)	$117,500 - 142,000 (Phase I) $125,500 - 155,000 (Phase II)	$144,900 (Phase I) $179,000 - 215,000 (Phase II)
Unit distribution			
1 bedroom	30%	-%	-%
2 bedroom	60	80	50
3 bedroom	10	20	50
Unit size:			
1 bedroom	800 - 860	-	-
2 bedroom	1,000	1,070 - 1,180(1)	1,272
3 bedroom	1,225	1,350(1)	1,376
Common area maintenance	$15 - $18/month	$97 - $117/month	None

(1) Including lanai, excluding garage area.

Source: Interviews with developers, real estate brokers and property managers.

- Common amenities - The projects provide few, if any, common facilities. Most amenities take the form of upgrading within the units.

- Maintenance fees - Common area maintenance fees are assessed at both the Kamani Trees and Pines projects. While Kamani Trees monthly fees are relatively low at $15 to $18, Pines buyers would pay from $97 to $117, which covers landscaping and maintenance of sidewalks, streets and other improvements in front yards.

- Number of bedrooms - Two-bedroom units represent half or more of the homes in each of the projects, with three-bedroom units accounting for the remainder.

- Unit size - There is substantial variation in unit size, ranging from 800 to almost 1,300 square feet for two-bedroom units, and from 1,000 to almost 1,400 square feet for three-bedroom units.

- Pricing - Units currently in sales at the Kamani Trees project are the least expensive, with two-bedroom prices ranging from $121,900 to $131,900. Pricing for new increments at the Pines and Kuakini Makai have risen substantially from earlier sales, and were projected to start at $125,500 and $179,000, respectively.

Exhibit V-E summarizes home buyer market segments at the three Kealakehe market area projects. As shown in the exhibit:

- Buyer origins - Households already living in the region represent about half or more of buyers in the three developments. Buyers from the U.S. Mainland, including investors familiar with the region or those looking for a part-time seasonal home, have proven to be an important source of demand.

- Family type - Couples and families with young children have accounted for about half of all sales at the three projects. Retirees, including many second-home buyers, have been numerous as well.

- Owner occupancy - Owner-occupants are 70% to 80% of original sales at the Kamani Trees and Pines projects. Investor participation was greater at the more expensive Kuakini Makai development.

Homeownership Unit Recommendations

The comparable projects review may indicate a number of areas in which Kealakehe homeownership units could find important market niches and provide competitive sales inventory. While each of the comparable projects is priced beyond the reach of most if not all moderate-income buyers, successful elements could be incorporated in the HFDC development program. The following should be considered:

- All three comparable projects have sold well, and have surplus buyers for available inventory. While this is related to west Hawaii's economic growth and affordable mortgage rates, it also suggests strong market support for homes on the lower stratum of market prices, in these cases between $117,000 and $144,900 for units sold in early phases of the comparable projects.

Exhibit V-E

BELT COLLINS & ASSOCIATES

Comparable Kealakehe Market Area
Home Sales Project Buyer Profiles

	Kamani Trees	Pines	Kuakini Makai
Units sold	75	91	34
Buyer origin:			
West Hawaii	65%	50% - 60%	40%
Other Hawaii	30	10 - 20	-
Mainland	5	20 - 30	60
Foreign	-	- - -	-
Total	100%	100%	100%
Family type:			
Singles	10	10	-
Couples	50	30	30
Young families	10	20	35
Retirees	30	40	35
Total	100%	100%	100%
Investment type:			
Owner-occupant	80	70	25
Second home	10	15	25
Investor	10	15	50
Total	100%	100%	100%

Source: Interviews with developers and real estate brokers.

- Strong sales at The Pines and The Kamani Trees indicates that smaller-lot, higher density single-family projects can be attractive to moderate-income buyers. These projects, featuring lots smaller than 5,000 square feet and overall project densities of about 6 units per gross acre, could allow for reductions in land and facilities costs.

- Common amenities have proven less important to the single-family unit buyer than opportunities to upgrade within the home. However, common amenities could prove significant to the developer, in establishing a tone for the community and enhancing sales in the later years of the development program. Thus, inclusion of common amenities should be considered more in terms of overall community marketing and in rental housing development.

- Projects in sales have attracted a clientele among couples and retirees or part-time residents. They have been less successful, however, in accommodating families with children. In order to better address family needs, larger units or a greater number of three-bedroom units would be required.

- Appropriate site design could accommodate slightly larger units within the same general density range, if individual lots smaller than 4,000 square feet were employed. If this option is pursued, standardized design of unit frontages and common maintenance through an association could be used to maintain an overall positive image and high-quality appearance.

- While market units within an HFDC-planned community are usually thought of as being those priced above affordable levels, other types of units could be considered for the market-price consumers as well. For example, lower-priced, smaller condominium units could be marketed without HFDC's "buy back" restriction. Potential price appreciation in these units could assist a mobile population of younger people to accumulate equity for a purchase of a future market unit.

<u>Comparable Rental Projects</u>

Three rental projects in the Kealakehe market area were selected for review, based on:

- Location
- Potential similarity to Kealakehe development concept
- Current or recent leasing program

The comparable projects are:

- The Villages at Waikoloa apartments
- The Fairway Terrace at Waikoloa condominium project
- The La'ilani garden apartments at Kealakehe Village

These projects cover a broad range of the regional rental market and can be strongly distinguished from one another:

- The Villages was constructed to accommodate Waikoloa area resort workers. It is a moderately-priced market rental project with few amenities.

- Fairway Terrace is designed to attract upscale professionals seeking rental units. The project is constructed for eventual sale as condominium units, and contains numerous amenities and common facilities.

- The La'ilani development was built by Mauna Lani Resort for sale to, and management under, the State HFDC. Rents are subsidized under a state rent supplement program for qualifying tenants, and other tenants pay market rents which are somewhat below rents at the other projects.

The comparable rental projects' characteristics are summarized in Exhibit V-F, as follows:

- Unit type - Each project is of low-rise configuration with one to two stories.

- Density - The projects attain net densities of 11 to 16 units per acre.

- Common amenities - Both Waikoloa Village rental developments offer golf course frontage and golf course views which are reflected in higher rents for these units. In addition:

  - The Villages has two swimming pools and a recreation area.

  - Fairway Terrace has extensive amenities, including a pool, community recreation center and upgraded appliances in each unit including microwave ovens.

  - La'ilani provides outdoor features such as a boat parking area, tot lots, athletic courts and a pavilion.

- Number of bedrooms - Two-bedroom units represent more than two-thirds of units at all three projects. The Villages was designed as 100% two-bedroom units, although reconfiguration with internal lock outs has allowed less than 10% of the units to be converted to one-bedroom units. The La'ilani project is the sole development to include three-bedroom units, amounting to 12% of the total inventory.

- Unit size - Two-bedroom unit sizes range from 682 to 960 square feet. Units at the Villages are the largest of the three projects. One-bedroom units range from an average of 509 to 800 square feet. Three-bedroom units at La'ilani contain 930 square feet.

- Pricing - Rents are lowest at La'ilani, ranging from $460 to $785 per month; in addition, qualifying tenants receive state rental assistance payments averaging $168 per month. Fairway Terrace rents are about 10% higher than at the Villages. Rents at the Waikoloa projects range from $600 to $935, depending upon number of bedrooms, furnishings, floor and frontage.

Exhibit V-F

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Comparable Kealakehe Market Area
Home Sales Project Characteristics

	The Villages	Fairway Terrace	La'ilani
Developer	Villages at Waikoloa, Inc.	TFK Development and Allison Investment Corporation	Mauna Lani Resort
Location	Lua Kula Street Waikoloa Village	Lua Kula Street Waikoloa Village	Kealakehe Village
Status	Constructed in leaseup	Constructed in leaseup	Fully leased
Unit type	Garden apartment four-plex	Eight-plex	Garden apartment
Units	216	200	200
Density (units/acre)	13.8	11.7	12.9
Common amenities	Two pools Recreation area Golf frontage	Pool, recreation center; appliance upgrades; microwave	Laundry area, pavilion, tot lots, athletic courts
Rents(1):			
1 bedroom	\$600 - 700	\$675 - 775	\$460
2 bedroom	795 - 925	890 - 935	660
3 bedroom	-	-	785
Unit distribution			
1 bedroom	10%	32%	16%
2 bedroom	90	68	72
3 bedroom	-	-	12
Total	100%	100%	100%

Exhibit V-F, Cont.

BELT COLLINS & ASSOCIATES

Comparable Kealakehe Market Area
Home Sales Project Characteristics, Continued

	The Villages	Fairway Terrace	La'ilani
Average unit size (Square feet):			
1 bedroom	800	524	509
2 bedroom	960	924	682
3 bedroom	-	-	930
Units rented/sold:	140	32	199
Renter/owner origin:			
West Hawaii	50%	30%	80%
Other Hawaii	20	20	20
Mainland	20	25	-
International	10	25	-
Total	100%	100%	100%
Family type:			
Singles	30%	40%	20% - 25%
Couples	30	25	5 - 10
Young families	30	25	50 - 60
Retirees	10	10	5 - 10
Total	100%	100%	100%

(1) Rents not counting $175 monthly rent supplement to qualifying La'ilani tenants.

Source: Interviews with developers, real estate brokers and property managers.

- Renter origins - A majority of the renters at the three projects previously lived in the west Hawaii area. From 30% to 50% of Waikoloa renters came from outside of the state.

- Renter family type - Each of the projects has achieved a different renter profile. La'ilani caters heavily to families, with more than 70% of renter households having children. The Villages population includes many couples and singles and some families, while Fairway Terrace has attracted more singles and couples.

Rental Unit Recommendations

The comparable projects review indicates a number of areas in which Kealakehe rental units could fill important market niches. The following should be considered:

- Garden apartments, townhouse and four-plex structures in one to two story configuration appear to offer the best fit with development trends in the west Hawaii region. Density of 12 to 15 units per gross acre could be attained.

- Availability of common facilities appear more important in rental than in homeownership projects. Provision should be made for recreation and community needs on rental project sites.

- The use of internal "lock out" configurations within three- and four-bedroom units should be considered, so that the larger units can be used either for larger families, or for smaller families with additional rental units for singles or couples. This configuration would require units with at least two bathrooms.

- Strong demand appears to exist for rental projects priced between La'ilani (at $460 to $785) and The Villages at Waikoloa (at $600 to $925).

- Larger, three-bedroom two-bath units suitable for families could fill an important niche. If configured for reduction to smaller units through lockouts, these larger units could also be adaptable for singles and couples.

- Smaller units appear acceptable to renters in recent lease up trends. One-bedroom units could be developed in the 450-550 square foot range, with two-bedroom units sized from 650 to 800 square feet. Three-bedroom units could range from 750 to 900 square feet.

- As regional population increases, demand could emerge for some specialized rental housing products, as for the independent elderly, older people requiring some form of medical or assisted living services, or group homes. Provision should be made for these higher-density facilities in project areas near commercial and community facilities.

Development Phasing

The Kealakehe planned community would be built over a period of about 20 years, with all housing units completed by about 2010. The mix of housing developed -- affordable ownership units, affordable rental units and market units -- should be relatively flexible in order to respond to market needs and opportunities. A general phasing scheme is presented to assist in project planning.

Key phasing considerations are as follows:

- Housing development could proceed at higher levels to 1995, in order to accommodate growth in a period of strong employment expansion and to service pent up demand.
- Market units could be phased in early in the Kealakehe development program, so as to establish the community as an attractive location and to provide future move up opportunities.

A potential phasing schedule is presented in Exhibit V-G, for a 4,000-unit project including about 1,400 affordable ownership and about 1,000 affordable rental units and about 1,600 market units. As shown in the exhibit:

- Recommended phasing differs somewhat from projected absorption as shown previously in Exhibit V-C. Absorption estimates were based on average capture rates. Recommended phasing produces absorption at the same average capture rate over the 20-year period, but with varying (rather than constant) capture rates in each of the four five-year intervals constituting the 20-year development program.
- Overall development would be highest in the first five years at 250 units per year, stabilize at about 175 units each year for the next ten years, and be completed with about 200 units in each of the last five years.
- Affordable ownership housing production would decline as a proportion of total development after the first five years, and would range from 40 to 90 units annually.
- Affordable rental units would represent about 60 units per year through 1995, but would decline for the 1996-2005 period, when other rental projects are expected to be developed.
- Market units would range from 60 to 100 units per year, with the highest production levels in the first and final five-year periods.

Ownership Unit Pricing

Prices of ownership units at the Kealakehe planned community could be influenced by a number of factors, including:

- Potential home buyer affordability
- Ability to recapture development costs
- Provision of first-time and move-up buyer opportunities
- Competitive supply

Exhibit V-G

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Recommended Annual Production of
Kealakehe Housing Units
by Time Period

1990 to 2010

Type of unit	1990 to 1995	1996 to 2000	2001 to 2005	2006 to 2010	Average	Total
Affordable housing:						
Ownership units	90	90	70	40	70	1,400
Rental units	60	30	40	70	50	1,000
Market housing:						
Market units	100	60	60	90	80	1,600
	250	175	175	200	200	4,000

Since Kealakehe is planned as part of the State of Hawaii's new communities initiative, pricing is established to meet criteria of affordability for low- and moderate-income buyers. Based on the affordable homeownership unit targets shown previously in Exhibits IV-H and IV-I, the recommended project build-out shown in Exhibit V-G, and affordability criteria presented in Exhibit III-H, the following pricing considerations are presented:

- A total of 1,400 affordable homeownership units could be supported, with:
  - About 50% of units priced below $100,000 in 1990 dollars.
  - About 50% of units priced between $100,000 and $130,000 in 1990 dollars.
- A total of 1,600 market units, with the proportion of ownership and rental units determined by market needs and opportunities over the course of the development program. Market ownership unit pricing should take into account the following considerations:
  - Meeting State Housing Functional Plan homeownership goals would require production of additional units priced between $120,000 and $150,000 for households earning between 120% and 140% of median income.
  - Additional homeownership opportunities will also be needed for families earning from 140% to 160% of median income, with unit prices targeted for from $150,000 to $200,000.
  - The Kealakehe development program might provide a number of premium development sites with golf course frontage. Based on typical golf frontage premiums in other communities, a limited number of units in the $250,000 to $350,000 range could be provided.

VI - GOLF COURSE MARKET ASSESSMENT

An 18-hole municipal golf course is proposed as one element of the Kealakehe planned community. This chapter assesses potential market support for the course. Existing golf courses in the market area and on the island of Hawaii are reviewed in terms of size, facilities, fees and play levels. Planned golf courses are also discussed. Finally, future play levels at the Kealakehe municipal course are projected.

EXISTING GOLF COURSES ON THE ISLAND OF HAWAII

This section describes golf courses in operation on the island.

Location of Golf Courses

There are twelve golf courses currently operated on the island of Hawaii. Existing courses are summarized in Exhibit VI-A, which indicates:

- Seven of the courses are located in resort areas.

- The remaining five courses are located away from resort areas and cater primarily to island residents and club members.

Resort Golf Courses

Visitors are the predominant users of resort courses on the island of Hawaii, although "off-property" golfers are accommodated on a daily fee basis. In general, the resort courses charge differently for play by non-guests, as shown for resort courses on all islands in Exhibit VI-B:

- Total green and cart fees at resort courses average $60 per 18-hole round for "on-property" guests, $85 for visitors staying off-property and $56 for Hawaii residents. Resident "kamaaina" rates are extended to resident-visitors from other islands, as well as residents of the island of Hawaii.

- On the island of Hawaii, total fees average $74 for Hawaii residents, well above the average on-property guest fee of $53. Off-property visitors pay an average of $85.

Resort courses in Hawaii are widely used, with highest use levels at more established, larger resorts. Utilization is shown in Exhibit VI-C, which indicates play levels at an average of 144 rounds per day.

Non-resort Golf Courses

The island of Hawaii has five golf courses situated outside of resort areas, as shown previously in Exhibit VI-A. The Hilo Municipal course is operated by the County of Hawaii, while the other courses are privately owned but permit daily fee play. Non-resort golf course use patterns differ markedly from those of resort courses, and are summarized in Exhibit VI-D:

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Golf Courses on the Island of Hawaii

1989

Course	Location	Number of holes
Resort courses:		
Waikoloa Beach Golf Club	Waikoloa Beach	18
Waikoloa Kings Course	Waikoloa Beach	18
Waikoloa Village Golf Club	Waikoloa Village	18
Kona Country Club	Keauhou	27
Mauna Kea Beach Hotel Golf Course	Mauna Kea	18
Francis I'i Brown	Manua Lani	18
Sea Mountain Golf Course	Punalu'u	18
Subtotal		135
Off-resort courses:		
Naniloa Country Club	Hilo	9
Hilo Municipal Golf Course	Hilo	18
Volcano Golf and Country Club	Volcano	18
Discovery Harbour Golf Course	Naalehu	18
Hamakua Country Club	Honokaa	9
Subtotal		72
Total golf holes in operation		207

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Total Green and Cart Fees
at Selected Resort Golf Courses in Hawaii

1989

	Resort guests	Non-resort guests	Hawaii residents
Oahu:			
Sheraton Makaha Resort and Country Club(1)	$ 45	95	55
Turtle Bay Golf Course(2)	65	80/ 90	40/ 45
Oahu average	55	91	49
Maui:			
Wailea Blue and Orange Courses			
Peak season (December-April)	45	90	45(3)
Low season (May-November)	30	60	30(3)
Royal Kaanapali - North and South Courses	74	74	74
Kapalua Golf Club - Bay Course and Village Course	55	85	40
Maui average	56	78	51
Kauai:			
Princeville Golf Club:			
Peak season (December-March)	53	68	48(4)
Low season (April-November)	48	63	43(4)
Kiahuna Golf Club	52(5)	58	34
Kiele Golf Course	105	125	55
Kauai Lagoons Golf Course	85	105	45
Kauai average	74	89	45
Hawaii:			
Mauna Kea Beach Golf Course	55	90	90
Mauna Lani:			
Peak season (December-March)	50	100	100
Low season (April-November)	50	70	70
Waikoloa Beach Resort and Golf Club			
Peak season (January-March)	55	90	45
Low season (April-December)	55	90	45

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Total Green and Cart Fees
at Selected Resort Golf Courses in Hawaii, Continued

1989

	Resort guests	Non-resort guests	Hawaii residents
Kona Country Club			
Peak season (January-March)	53	75	75
Peak season (April-December)	47	70	70
Hawaii average	53	85	74
All islands:			
Range	30-105	60-125	30-100
Average	$ 60	85	56

(1) Guests from other Sheraton hotels pay $85.

(2) Higher rates are charged for weekend by non-resort guests and Hawaii residents.

(3) Rate offered only to Maui residents.

(4) Hawaii residents who do not live on Kauai pay $58 in peak season and $53 in low season.

(5) Rates paid by guests of Poipu area hotels.

Source: Compiled from discussions with course representatives and published information.

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Average Daily Rounds of Golf
at Selected Resort Courses

1988

	Daily rounds of golf		
	Average	Desired	Maximum
Oahu:			
Makaha	152	200	200(1)
Turtle Bay	178	250	320
Maui:			
Wailea:			
Blue Course	135	216	216(1)
Orange Course	135	216	216(1)
Royal Kaanapali:			
North Course	173	N/A	250
South Course	123	N/A	250
Kapalua Golf Club:			
Bay Course	190	230	280
Village Course	137	210	240
Kauai:			
Princeville Golf Club(2)	178	200 - 235(3)	235
Kiahuna Golf Club	123	250	300
Hawaii:			
Mauna Lani - Francis I'i Brown Golf Course	129	200	250
Mauna Kea Beach Golf Course	148	230	265
Waikoloa Beach Resort Golf Course	118	180 - 200	230
Keauhou Golf Course(2)	187	250	350
Average (rounded)(4)	144	250	350

N/A Not available.

(1) Maximum level of play is the same as desired level.

(2) Utilizing all 27 holes available in 1987.

(3) Desired level of play is 200 rounds per holes in the winter and 235 per 18 holes in summer months due to greater number of daylight hours.

(4) Excluding Princeville Golf Club and Keauhou Golf Course.

Source: Based on interviews with golf professionals or representatives of the respective courses.

Exhibit VI-D

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Utilization and Fees at Non-Resort Golf Courses
on the Island of Hawaii

	Naniloa Country Club	Hilo Municipal Golf Course(1)	Volcano Golf and Country Club	Discovery Harbor Golf Course	Hamakua Country Club
Average daily rounds of play	60	275	N/A	10	20
Daily fees for residents per round:					
Green fees	$ N/A	6.00	21.00-24.00	10.00	10.00
Cart rental	7.00-14.00	14.50	9.00-10.00	14.00	-
Daily fees for visitors per round:					
Green fees	N/A	6.00	35.00	10.00	10.00
Cart rental	7.00-14.00	14.50	9.00-10.00	14.00	-
Market mix:					
Local and members	80%	95%	95%	100%	100%
Visitors	20	5	5	-	-

(1) Also offers senior citizen discount rate.

Source: Interviews of golf professionals, directors of golf and club managers.

- The Hilo Municipal course is the most heavily used on the island, with 275 average rounds per day. However, the other non-resort courses have relatively low use levels, below 60 rounds per day.

- Fees are far lower than for resort courses. As shown in Exhibit VI-B, average resident fees on island resort courses are $74, compared with Hilo Municipal's charge of $20.50. Several non-resort courses offer further discounts, as for senior citizens and members of golfing clubs.

- Non-resort courses cater primarily to residents, who make up from 80% to 100% of total rounds played.

While non-resort courses charge far less for play than resort courses, few offer comparable facilities. Exhibit VI-E summarizes facilities at non-resort courses:

- Two of the five courses -- Naniloa and the Hamakua Country Club in Honokaa -- do not have a clubhouse.

- Only Hilo Municipal has a teaching professional.

- Two of the courses have limited 9-hole layouts.

Planned Golf Courses

Expansion in the number and capacity of island golf courses is anticipated with the growth of west Hawaii resorts. Planned and proposed golf courses on the island are shown in Exhibit VI-F, which indicates:

- While Waikoloa Beach Resort has just opened a second course, the other two existing South Kohala area resorts have announced plans for second 18-hole courses to be built in the next few years.

- The Kona Country Club at Keauhou Resort plans to add nine holes to bring its capacity to 36 holes.

- Ten other courses are proposed in conjunction with planned resort development.

- Six other courses are proposed, most in the context of a master-planned resident community. Development plans for these courses are now somewhat indefinite, but are unlikely to offer play at low municipal rates.

MUNICIPAL GOLF COURSE MARKET ASSESSMENT

This section estimates potential market support for a municipal golf course at the Kealakehe planned community.

Market Position

The preceding section points to the existence of parallel golf markets on the island of Hawaii, including:

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Facilities at Non-Resort Golf Courses
on the Island of Hawaii

	Naniloa Country Club	Hilo Municipal Golf Course(1)	Volcano Golf and Country Club	Discovery Harbor Golf Course	Hamakua Country Club
Number of holes	9	18	18	18	9
Property size (acres)	65	130	N/A	N/A	19
Facilities:					
Clubhouse	-	X	X	X	-
Restaurant	-	X	X	-	-
Lounge/bar	-	X	X	-	X
Pro shop	X	X	X	-	-
Locker room	-	X	X	-	-
Driving range	X	-	X	X	
Practice green	X	X	X	X	-
Resident golf pro	-	X	-	-	-

Source: Interviews of golf professionals, directors of golf and club managers.

Exhibit VI-E

Exhibit VI-F

BELT COLLINS & ASSOCIATES

Planned and Proposed Golf Courses
on the Island of Hawaii

1989

Course	Location	Number of holes
Planned:		
Mauna Kea Resort - second course (1991-1992)	Mauna Kea	18
Mauna Lani - second course (1991-1992)	Mauna Lani	18
Waikoloa Highlands course	Waikoloa Village	18
TSA residential community course	Kaloko	18
Oneloa	Puna	36
Subtotal		108
Proposed:		
Additional resort course	Waikoloa Beach	36
Hapuna Beach Resort - mauka course	Mauna Kea	18
Planned resort courses	Kaupulehu	36
Regent Beach Resort Course	Regent Beach	18
Planned resort course	Awake'e	18
Planned resort course	Kohanaiki	18
Kona Country Club expansion	Keauhou	9
Hawaiian Palace resort course	Hawaiian Riviera	18
Ka'u Aina resort courses	Hawaiian Riviera	36
Royal Vista Golf and Country Club	North Kona	27
Kohala Ranch	North Kohala	18
Signal Puako	South Kohala	36
Subtotal		288
Total Planned and proposed golf holes		396

- A resort golf market oriented toward visitors, offering a variety of high-quality facilities at relatively high use fees ranging from about $50 to $75 per round.

- A local golf market oriented toward residents, providing fewer facilities and substantially lower fees ranging from $6 to $24 per round.

The planned course at Kealakehe is intended to primarily cater to residents, although regional visitors could represent a secondary source of demand. As a municipally-operated course, fees could be expected to be similar to the daily average of $20.50 at the Hilo Municipal Course. For this reason, Hilo Municipal is selected as the most comparable facility for demand projections.

<u>Proposed Development Concept</u>

Demand for golf at Kealakehe is estimated based on the following development concept:

- The course would be designed to cater primarily to Hawaii residents, although nonresidents could play the course at the same daily fees.

- The fee structure could yield somewhat lower average fees by residents through special discounts for senior citizens, golfing clubs, monthly or seasonal passes or other adjustments.

- The course would offer an 18-hole layout, designed to maximize adjacent residential lot frontage.

- The course would offer facilities comparable or superior to Hilo Municipal, with a clubhouse, pro shop, practice facilities, locker space and a resident teaching professional.

<u>Projected Demand for Golf at Kealakehe</u>

Play levels projected for the Kealakehe municipal course are based on the following assumptions:

- Resident demand within the Kealakehe market area would be similar to that now experienced in the Hilo Municipal course's primary market area of North Hilo, South Hilo and Puna.

- Golf participation is expected to increase from 1988 to 2010, in line with national trends. A 1% annual compound rate of increase in resident play is projected.

- Play by visitors could be expected to represent about 15% of total demand, since many visitors would stay in accommodations lacking golf, and Kealakehe would be well located to capture visitor play.

Projected demand is shown in Exhibit VI-G, based on the above assumptions and resident population projections for the Kealakehe market area. As shown in the exhibit:

BELT COLLINS & ASSOCIATES

Projected Demand for Golf at
Kealakehe Municipal Course

(average rounds per day)

	1990	1995	2000	2005	2010
Resident demand:					
Daily rounds per 1000 residents(1)	3.1	3.3	3.5	3.7	3.9
Market area resident population, projected(2)	49,500	59,600	72,300	87,900	107,600
Projected daily rounds by residents	150	200	250	330	420
Visitor demand:					
Projected daily rounds by visitors(3)	30	40	50	60	80
Projected total demand	180	240	300	390	500

(1) Based on average daily play at Hilo Municipal and average annual growth of 1% in participation rate.

(2) As shown in Exhibit II-C.

(3) At 15% of total play.

- By 1995, total demand could reach 240 rounds per day, representing potential play levels equivalent to 90% of those at the Hilo Municipal course.
- Demand could exceed 300 rounds by 2000. Unless additional courses were developed in other market area locations, the Kealakehe course could reach capacity by 2000.

PUBLIC REVENUES AND COSTS

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	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Church/Child Care Development GET												
Site Improvement/Acre						200,000						20
Acres						3						
Church/Child Care Development						600,000						60
GET Rate						4%						
Church/Child Care Site Devevelopment GET						24,000						2
Construction Cost/Sq.Ft.						100						
Sq.Ft.						17,820						1
Construction Cost						1,782,000						1,78
GET Rate						4%						
Construction GET						71,280						7
Church/Child Care Development GET						95,280						9
Schedule A-2: Operations General Excise Tax Revenue												
Golf Course Operations GET					43,200	45,120	47,040	48,960	50,880	52,800	54,720	5
Commercial Center Operations GET					0	0	462,000	646,800	831,600	1,016,400	1,201,200	1,38
Total Operations GET					43,200	45,120	509,040	695,760	882,480	1,069,200	1,255,920	1,44
Golf Course Operations GET												
Average Revenue/Round					20	20	20	20	20	20	20	
Rounds Per Year					54,000	56,400	58,800	61,200	63,600	66,000	68,400	7
Operating Revenue					1,080,000	1,128,000	1,176,000	1,224,000	1,272,000	1,320,000	1,368,000	1,41
GET Rate					4%	4%	4%	4%	4%	4%	4%	
Golf Course Operations GET					43,200	45,120	47,040	48,960	50,880	52,800	54,720	5
Commercial Center Operations GET												
Sales/Sq.Ft.							231	231	231	231	231	
Sq.Ft.							50,000	70,000	90,000	110,000	130,000	15
Operating Revenue							11,550,000	16,170,000	20,790,000	25,410,000	30,030,000	34,65
GET Rate							4%	4%	4%	4%	4%	
Commercial Center Operations GET							462,000	646,800	831,600	1,016,400	1,201,200	1,38

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
			200,000										
			3										
			600,000										1,200,000
			4%										
			24,000										48,000
			100										
			17,820										
			1,782,000										3,564,000
			4%										
			71,280										142,560
			95,280										190,560
50,880	52,800	54,720	56,640	58,560	60,480	62,400	64,320	66,240	68,160	70,080	72,000	0	921,600
331,600	1,016,400	1,201,200	1,386,000	1,570,800	1,755,600	1,940,400	2,125,200	2,310,000	2,402,400	2,402,400	2,402,400	2,402,400	24,855,600
382,480	1,069,200	1,255,920	1,442,640	1,629,360	1,816,080	2,002,800	2,189,520	2,376,240	2,470,560	2,472,480	2,474,400	2,402,400	25,777,200
20	20	20	20	20	20	20	20	20	20	20	20		
63,600	66,000	68,400	70,800	73,200	75,600	78,000	80,400	82,800	85,200	87,600	90,000		1,152,000
272,000	1,320,000	1,368,000	1,416,000	1,464,000	1,512,000	1,560,000	1,608,000	1,656,000	1,704,000	1,752,000	1,800,000		23,040,000
4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%		
50,880	52,800	54,720	56,640	58,560	60,480	62,400	64,320	66,240	68,160	70,080	72,000		921,600
231	231	231	231	231	231	231	231	231	231	231	231	231	
90,000	110,000	130,000	150,000	170,000	190,000	210,000	230,000	250,000	260,000	260,000	260,000	260,000	2,690,000
790,000	25,410,000	30,030,000	34,650,000	39,270,000	43,890,000	48,510,000	53,130,000	57,750,000	60,060,000	60,060,000	60,060,000	60,060,000	621,390,000
4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
331,600	1,016,400	1,201,200	1,386,000	1,570,800	1,755,600	1,940,400	2,125,200	2,310,000	2,402,400	2,402,400	2,402,400	2,402,400	24,855,600

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Schedule A-3: Personal Consumption General Excise Tax Revenue

Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Construction Personal Consumption GET	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516
Golf Course Personal Consumption GET	0	0	0	12,062	12,062	12,062	12,062	12,062	12,062	12,062
Restaurant Personal Consumption GET	0	0	0	1,150	1,150	1,150	1,150	1,150	1,150	1,150
Commercial Center Personal Consumption GET	0	0	0	0	0	6,722	10,332	13,942	17,552	21,162
Schools Personal Consumption GET	0	0	0	0	23,328	25,272	26,730	28,674	31,590	33,534
Services Personal Consumption GET	0	0	0	0	0	1,590	3,180	4,770	6,360	7,950
Total Personal Consumption GET	348,516	348,516	348,516	361,728	385,056	395,312	401,970	409,114	417,230	424,374

Construction Personal Consumption GET	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Average Income	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Payroll Deduction Rate	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Payroll Deduction	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800
Net Payroll	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200
Personal Consumption Rate	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
Personal Consumption Expenditure	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520
GET Rate	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Average GET	461	461	461	461	461	461	461	461	461	461
Direct, Indirect & Induced Jobs	756	756	756	756	756	756	756	756	756	756
Construction Personal Consumption GET	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516

Golf Course Personal Consumption GET	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Average Income				17,000	17,000	17,000	17,000	17,000	17,000	17,000
Payroll Deduction Rate				20%	20%	20%	20%	20%	20%	20%
Payroll Deduction				3,400	3,400	3,400	3,400	3,400	3,400	3,400
Net Payroll				13,600	13,600	13,600	13,600	13,600	13,600	13,600
Personal Consumption Rate				60%	60%	60%	60%	60%	60%	60%
Personal Consumption Expenditure				8,160	8,160	8,160	8,160	8,160	8,160	8,160
GET Rate				4%	4%	4%	4%	4%	4%	4%
Average GET				326	326	326	326	326	326	326
Direct, Indirect & Induced Jobs				37	37	37	37	37	37	37
Golf Course Personal Consumption GET				12,062	12,062	12,062	12,062	12,062	12,062	12,062

Golf Course Restaurant Personal Consumption GET	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Average Income				12,000	12,000	12,000	12,000	12,000	12,000	12,000
Payroll Deduction Rate				20%	20%	20%	20%	20%	20%	20%
Payroll Deduction				2,400	2,400	2,400	2,400	2,400	2,400	2,400
Net Payroll				9,600	9,600	9,600	9,600	9,600	9,600	9,600
Personal Consumption Rate				60%	60%	60%	60%	60%	60%	60%
Personal Consumption Expenditure				5,760	5,760	5,760	5,760	5,760	5,760	5,760
GET Rate				4%	4%	4%	4%	4%	4%	4%
Average GET				230	230	230	230	230	230	230
Direct, Indirect & Induced Jobs				5	5	5	5	5	5	5
Golf Course Restaurant Personal Consumption GET				1,150	1,150	1,150	1,150	1,150	1,150	1,150
Golf Course & Restaurant Personal Consumption GET				13,212	13,212	13,212	13,212	13,212	13,212	13,212

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
	48,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	6,970,320
	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	205,054
	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	19,550
	13,942	17,552	21,162	24,772	28,382	31,992	44,479	45,399	48,319	50,229	50,229	50,229	50,229	491,969
	28,674	31,590	33,534	34,020	34,020	34,020	34,020	34,020	34,020	34,020	34,020	34,020	34,020	509,328
	4,770	6,360	7,950	9,540	11,130	12,720	14,310	15,900	17,490	19,080	20,670	23,055	23,055	190,800
	09,114	417,230	424,374	430,060	435,260	440,460	454,637	457,047	459,557	465,057	466,647	469,032	469,032	8,387,021
	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	
	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	19,200	
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	11,520	
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	461	461	461	461	461	461	461	461	461	461	461	461	461	
	756	756	756	756	756	756	756	756	756	756	756	756	756	
	48,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	348,516	6,970,320
	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	289,000
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	57,800
	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	13,600	231,200
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	8,160	8,160	8,160	8,160	8,160	8,160	8,160	8,160	8,160	8,160	8,160	8,160	8,160	138,720
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	326	326	326	326	326	326	326	326	326	326	326	326	326	
	37	37	37	37	37	37	37	37	37	37	37	37	37	
	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	12,062	205,054
	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	204,000
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	40,800
	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	163,200
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	97,920
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	230	230	230	230	230	230	230	230	230	230	230	230	230	
	5	5	5	5	5	5	5	5	5	5	5	5	5	
	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	1,150	19,550
	13,212	13,212	13,212	13,212	13,212	13,212	13,212	13,212	13,212	13,212	13,212	13,212	13,212	224,604

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	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Commercial Center Personal Consumption GET											
Average Income (Retail)											
Payroll Deduction Rate							14,000	14,000	14,000	14,000	14,000
Payroll Deduction							20%	20%	20%	20%	20%
Net Payroll							2,800	2,800	2,800	2,800	2,800
Personal Consumption Rate							11,200	11,200	11,200	11,200	11,200
Personal Consumption Expenditure							60%	60%	60%	60%	60%
GET Rate							6,720	6,720	6,720	6,720	6,720
Average GET							4%	4%	4%	4%	4%
Direct, Indirect & Induced Jobs							269	269	269	269	269
Retail Consumption GET							10	20	30	40	50
							2,690	5,380	8,070	10,760	13,450
Average Income (Restaurant)											
Payroll Deduction Rate							12,000	12,000	12,000	12,000	12,000
Payroll Deduction							20%	20%	20%	20%	20%
Net Payroll							2,400	2,400	2,400	2,400	2,400
Personal Consumption Rate							9,600	9,600	9,600	9,600	9,600
Personal Consumption Expenditure							60%	60%	60%	60%	60%
GET Rate							5,760	5,760	5,760	5,760	5,760
Average GET							4%	4%	4%	4%	4%
Direct, Indirect & Induced Jobs							230	230	230	230	230
Restaurant Consumption GET							4	8	12	16	20
							920	1,840	2,760	3,680	4,600
Average Income (Auto Repair)											
Payroll Deduction Rate							15,000	15,000	15,000	15,000	15,000
Payroll Deduction							20%	20%	20%	20%	20%
Net Payroll							3,000	3,000	3,000	3,000	3,000
Personal Consumption Rate							12,000	12,000	12,000	12,000	12,000
Personal Consumption Expenditure							60%	60%	60%	60%	60%
GET Rate							7,200	7,200	7,200	7,200	7,200
Average GET							4%	4%	4%	4%	4%
Direct, Indirect & Induced Jobs							288	288	288	288	288
Auto Repair Consumption GET							6	6	6	6	6
							1,728	1,728	1,728	1,728	1,728
Average Income (Health, Professional)											
Payroll Deduction Rate							18,000	18,000	18,000	18,000	18,000
Payroll Deduction							20%	20%	20%	20%	20%
Net Payroll							3,600	3,600	3,600	3,600	3,600
Personal Consumption Rate							14,400	14,400	14,400	14,400	14,400
Personal Consumption Expenditure							60%	60%	60%	60%	60%
GET Rate							8,640	8,640	8,640	8,640	8,640
Average GET							4%	4%	4%	4%	4%
Direct, Indirect & Induced Jobs							346	346	346	346	346
Health, Professional Consumption GET							4	4	4	4	4
							1,384	1,384	1,384	1,384	1,384
Commercial Center Consumption GET							6,722	10,332	13,942	17,552	21,162

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	
	11,200	11,200	11,200	11,200	11,200	11,200	11,200	11,200	11,200	11,200	11,200	11,200	11,200	
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	6,720	6,720	6,720	6,720	6,720	6,720	6,720	6,720	6,720	6,720	6,720	6,720	6,720	
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	269	269	269	269	269	269	269	269	269	269	269	269	269	
	30	40	50	60	70	80	123	123	123	123	123	123	123	
	8,070	10,760	13,450	16,140	18,830	21,520	33,087	33,087	33,087	33,087	33,087	33,087	33,087	328,449
	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	
	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	230	230	230	230	230	230	230	230	230	230	230	230	230	
	12	16	20	24	28	32	36	40	44	61	61	61	61	
	2,760	3,680	4,600	5,520	6,440	7,360	8,280	9,200	10,120	14,030	14,030	14,030	14,030	116,840
	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	
	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	288	288	288	288	288	288	288	288	288	288	288	288	288	
	6	6	6	6	6	6	6	6	6	6	6	6	6	
	1,728	1,728	1,728	1,728	1,728	1,728	1,728	1,728	1,728	1,728	1,728	1,728	1,728	25,920
	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	
	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	
	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	14,400	
	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
	8,640	8,640	8,640	8,640	8,640	8,640	8,640	8,640	8,640	8,640	8,640	8,640	8,640	
	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
	346	346	346	346	346	346	346	346	346	346	346	346	346	
	4	4	4	4	4	4	4	4	4	4	4	4	4	
	1,384	1,384	1,384	1,384	1,384	1,384	1,384	1,384	1,384	1,384	1,384	1,384	1,384	20,760
	13,942	17,552	21,162	24,772	28,382	31,992	44,479	45,399	46,319	50,229	50,229	50,229	50,229	491,969

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	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2
Schools Personal Consumption GET												
Average Income						25,300	25,300	25,300	25,300	25,300	25,300	25
Payroll Deduction Rate						20%	20%	20%	20%	20%	20%	
Payroll Deduction						5,060	5,060	5,060	5,060	5,060	5,060	5,
Net Payroll						20,240	20,240	20,240	20,240	20,240	20,240	20,
Personal Consumption Rate						60%	60%	60%	60%	60%	60%	
Personal Consumption Expenditure						12,144	12,144	12,144	12,144	12,144	12,144	12,
GET Rate						4%	4%	4%	4%	4%	4%	
Average GET						486	486	486	486	486	486	
Total Direct, Indirect & Induced Jobs						48	52	55	59	65	69	
Schools Consumption GET						23,328	25,272	26,730	28,674	31,590	33,534	34,
Services Personal Consumption GET												
Average Income (Personal Services)							13,800	13,800	13,800	13,800	13,800	13,
Payroll Deduction Rate							20%	20%	20%	20%	20%	
Payroll Deduction							2,760	2,760	2,760	2,760	2,760	2,
Net Payroll							11,040	11,040	11,040	11,040	11,040	11,
Personal Consumption Rate							60%	60%	60%	60%	60%	
Personal Consumption Expenditure							6,624	6,624	6,624	6,624	6,624	6,
GET Rate							4%	4%	4%	4%	4%	
Average GET							265	265	265	265	265	2
Direct, Indirect & Induced Jobs							6	12	18	24	30	
Services Personal Consumption GET							1,590	3,180	4,770	6,360	7,950	9,

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	
20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
5,060	5,060	5,060	5,060	5,060	5,060	5,060	5,060	5,060	5,060	5,060	5,060	5,060	
20,240	20,240	20,240	20,240	20,240	20,240	20,240	20,240	20,240	20,240	20,240	20,240	20,240	
60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	12,144	
4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
486	486	486	486	486	486	486	486	486	486	486	486	486	
59	65	69	70	70	70	70	70	70	70	70	70	70	
28,674	31,590	33,534	34,020	34,020	34,020	34,020	34,020	34,020	34,020	34,020	34,020	34,020	509,328

13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	
20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	2,760	
11,040	11,040	11,040	11,040	11,040	11,040	11,040	11,040	11,040	11,040	11,040	11,040	11,040	
60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	
6,624	6,624	6,624	6,624	6,624	6,624	6,624	6,624	6,624	6,624	6,624	6,624	6,624	
4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	
265	265	265	265	265	265	265	265	265	265	265	265	265	
18	24	30	36	42	48	54	60	66	72	78	87	87	
4,770	6,360	7,950	9,540	11,130	12,720	14,310	15,900	17,490	19,080	20,670	23,055	23,055	190,800

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	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Schedule B: State Corporate Income Tax Revenue											
Residential		86,080	57,920	45,760	47,488	48,448	67,072	67,072	45,440	33,792	31,808
Golf Course		0	0	57,600	2,916	3,038	3,159	3,281	3,402	3,524	3,645
Commercial		0	0	0	0	36,640	56,960	71,744	86,528	105,312	96,096
School		0	0	0	208,000	0	0	0	0	0	0
Total Corporate Income Tax Revenue		86,080	57,920	103,360	258,404	88,126	127,191	142,097	135,370	142,628	131,549
Schedule B-1: Residential Corporate Income Tax Revenue											
Single Family Development Corporate Income Tax		86,080	57,920	44,480	44,160	45,120	62,720	64,000	45,440	28,160	29,760
Multi-Family Development Corporate Income Tax		0	0	1,280	3,328	3,328	4,352	3,072	0	5,632	2,048
Total Residential Corporate Income Tax Revenue		86,080	57,920	45,760	47,488	48,448	67,072	67,072	45,440	33,792	31,808
Single Family Profit/Unit		5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Single Family Units		269	181	139	138	141	196	200	142	88	93
Single Family Profit		1,345,000	905,000	695,000	690,000	705,000	980,000	1,000,000	710,000	440,000	465,000
Tax Rate		6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%
Single Family Development Corporate Income Tax		86,050	57,920	44,480	44,160	45,120	62,720	64,000	45,440	28,160	29,760
Multi-Family Profit/Unit				4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Multi-Family Units				5	13	13	17	12	0	22	8
Multi-Family Profit				20,000	52,000	52,000	68,000	48,000	0	88,000	32,000
Tax Rate				6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%
Multi-Family Development Corporate Income Tax				1,280	3,328	3,328	4,352	3,072	0	5,632	2,048
Schedule B-2: Golf Course Corporate Income Tax Revenue											
Construction				57,600							
Operations				0	2,916	3,038	3,159	3,281	3,402	3,524	3,645
Golf Course Corporate Income Tax Revenue				57,600	2,916	3,038	3,159	3,281	3,402	3,524	3,645
Construction											
Construction Cost				22,500,000							
Profit Margin				4%							
Construction Taxable Income				900,000							
Corporate Income Tax Rate				6.4%							
Construction Corporate Income Tax				57,600							
Operations											
Average Revenue/Round					20	20	20	20	20	20	20
Rounds Per Year					54,000	56,250	58,500	60,750	63,000	65,250	67,500
Operating Revenue					1,080,000	1,125,000	1,170,000	1,215,000	1,260,000	1,305,000	1,350,000
Profit Margin					5%	5%	5%	5%	5%	5%	5%
Taxable Income					54,000	56,250	58,500	60,750	63,000	65,250	67,500
Corporate Income Tax Rate					5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Operations Corporate Income Tax Rate					2,916	3,038	3,159	3,281	3,402	3,524	3,645

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
5,440	33,792	31,808	35,456	47,808	57,024	52,672	46,784	37,568	58,240	58,240	56,000	51,520	1,032,192
3,402	3,524	3,645	3,767	3,888	4,010	4,131	4,253	4,374	4,496	4,617	4,739	4,860	123,696
6,528	105,312	96,096	110,880	125,664	140,448	155,232	170,016	184,800	192,192	192,192	192,192	192,192	2,109,088
0	0	0	0	0	0	0	0	0	0	0	0	0	208,000
5,370	142,628	131,549	150,103	177,360	201,482	212,035	221,053	226,742	254,928	255,049	252,931	248,572	3,472,976
15,440	28,160	29,760	33,920	43,200	31,680	34,240	31,680	22,720	58,240	58,240	56,000	51,520	929,280
0	5,632	2,048	1,536	4,608	25,344	18,432	15,104	14,848	0	0	0	0	102,912
15,440	33,792	31,808	35,456	47,808	57,024	52,672	46,784	37,568	58,240	58,240	56,000	51,520	1,032,192
5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	
142	88	93	106	135	99	107	99	71	182	182	175	161	
0,000	440,000	465,000	530,000	675,000	495,000	535,000	495,000	355,000	910,000	910,000	875,000	805,000	
6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	
5,440	28,160	29,760	33,920	43,200	31,680	34,240	31,680	22,720	58,240	58,240	56,000	51,520	929,280
4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	
0	22	8	6	18	99	72	59	58	0	0	0	0	
0	88,000	32,000	24,000	72,000	396,000	288,000	236,000	232,000	0	0	0	0	
6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	
0	5,632	2,048	1,536	4,608	25,344	18,432	15,104	14,848	0	0	0	0	102,912
													57,600
3,402	3,524	3,645	3,767	3,888	4,010	4,131	4,253	4,374	4,496	4,617	4,739	4,860	66,096
3,402	3,524	3,645	3,767	3,888	4,010	4,131	4,253	4,374	4,496	4,617	4,739	4,860	123,696
													57,600
20	20	20	20	20	20	20	20	20	20	20	20	20	
3,000	65,250	67,500	69,750	72,000	74,250	76,500	78,750	81,000	83,250	85,500	87,750	90,000	
0,000	1,305,000	1,350,000	1,395,000	1,440,000	1,485,000	1,530,000	1,575,000	1,620,000	1,665,000	1,710,000	1,755,000	1,800,000	
5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
3,000	65,250	67,500	69,750	72,000	74,250	76,500	78,750	81,000	83,250	85,500	87,750	90,000	
5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	
3,402	3,524	3,645	3,767	3,888	4,010	4,131	4,253	4,374	4,496	4,617	4,739	4,860	66,096

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Schedule B-3: Commercial Corporate Income Tax Revenue	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Construction of Commercial Center						38,640	20,000	20,000	20,000	24,000	0	
Operations						0	36,960	51,744	66,528	81,312	96,096	11(
Commercial Corporate Income Tax Revenue						38,640	56,960	71,744	86,528	105,312	96,096	11(
Construction of Commercial Center												
Site Improvement/Acre						200,000						
Acres						26						
Commercial Development						5,200,000						
Construction Cost/Sq.Ft.						125	125	125	125	125		
Sq.Ft.						50,000	50,000	50,000	50,000	60,000		
Construction Development						6,250,000	6,250,000	6,250,000	6,250,000	7,500,000		
Construction						11,450,000	6,250,000	6,250,000	6,250,000	7,500,000		
Profit Margin						5%	5%	5%	5%	5%		
Construction Taxable Income						572,500	312,500	312,500	312,500	375,000		
Corporate Income Tax Rate						6.4%	6.4%	6.4%	6.4%	6.4%		
Construction Corporate Income Tax						36,640	20,000	20,000	20,000	24,000		
Operations												
Sales/Sq.Ft.							231	231	231	231	231	
Sq.Ft.							50,000	70,000	90,000	110,000	130,000	150,(
Operating Revenue							11,550,000	16,170,000	20,790,000	25,410,000	30,030,000	34,650,(
Profit Margin							5%	5%	5%	5%	5%	
Taxable Income							577,500	808,500	1,039,500	1,270,500	1,501,500	1,732,5
Corporate Income Tax Rate							6.4%	6.4%	6.4%	6.4%	6.4%	6
Operations Corporate Income Tax Rate							36,960	51,744	66,528	81,312	96,096	110,8

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
20,000	24,000	0	0	0	0	0	0	0	0	0	0	0	120,640
36,528	81,312	96,096	110,880	125,664	140,448	155,232	170,016	184,800	192,192	192,192	192,192	192,192	1,988,448
36,528	105,312	96,096	110,880	125,664	140,448	155,232	170,016	184,800	192,192	192,192	192,192	192,192	2,109,088
													200,000
													26
													5,200,000
125	125												
60,000	60,000												625
60,000	7,500,000												260,000
													32,500,000
0,000	7,500,000												
5%	5%												
2,500	375,000												
6.4%	6.4%												
0,000	24,000												120,640
231	231	231	231	231	231	231	231	231	231	231	231	231	
0,000	110,000	130,000	150,000	170,000	190,000	210,000	230,000	250,000	260,000	260,000	260,000	260,000	2,690,000
0,000	25,410,000	30,030,000	34,650,000	39,270,000	43,890,000	48,510,000	53,130,000	57,750,000	60,060,000	60,060,000	60,060,000	60,060,000	621,390,000
5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
9,500	1,270,500	1,501,500	1,732,500	1,963,500	2,194,500	2,425,500	2,656,500	2,887,500	3,003,000	3,003,000	3,003,000	3,003,000	
6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	
6,528	81,312	96,096	110,880	125,664	140,448	155,232	170,016	184,800	192,192	192,192	192,192	192,192	1,988,448

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Schedule B-4: School Corporate Income Tax Revenue	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
School Construction		0	0	0	65,000,000	0	0	0	0	0	0
Profit Margin		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Taxable Income		0	0	0	3,250,000	0	0	0	0	0	0
Corporate Income Tax Rate		6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%
School Construction Corporate Income Tax		0	0	0	208,000	0	0	0	0	0	0

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
0	0	0	0	0	0	0	0	0	0	0	0	0	
5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
0	0	0	0	0	0	0	0	0	0	0	0	0	
6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	
0	0	0	0	0	0	0	0	0	0	0	0	0	208,000

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Schedule C: State Individual Income Tax Revenue

	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Construction		1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716
Golf Course		0	0	0	41,831	41,831	41,831	41,831	41,831	41,831	41,831
Commercial		0	0	0	0	0	20,086	30,390	40,694	50,998	61,302
School		0	0	0	0	85,200	92,300	97,625	104,725	115,375	122,475
Services Personal		0	0	0	0	0	4,608	9,216	13,824	18,432	23,040
Individual Income Tax		1,255,716	1,255,716	1,255,716	1,297,547	1,382,747	1,414,541	1,434,778	1,456,790	1,482,352	1,504,364

Schedule C-1: Construction Individual Income Tax Revenue

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Average Income	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000
Deductions	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020
Taxable Income	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980
Income Tax Rate	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Construction Individual Income Tax	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661
Direct, Indirect & Induced Jobs	756	756	756	756	756	756	756	756	756	756
Construction Individual Income Tax Rev.	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716

Schedule C-2: Golf Course Individual Income Tax Revenue

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Golf Course Individual Income Tax Rev.				38,776	38,776	38,776	38,776	38,776	38,776	38,776
Restaurant Individual Income Tax Rev.				3,055	3,055	3,055	3,055	3,055	3,055	3,055
Total GC & Restaurant Individual Inc. Tax Rev.				41,831	41,831	41,831	41,831	41,831	41,831	41,831
Average Income (Golf Course)				17,000	17,000	17,000	17,000	17,000	17,000	17,000
Deductions				5,020	5,020	5,020	5,020	5,020	5,020	5,020
Taxable Income				11,980	11,980	11,980	11,980	11,980	11,980	11,980
Income Tax Rate				8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Golf Course Individual Income Tax				1,048	1,048	1,048	1,048	1,048	1,048	1,048
Direct, Indirect & Induced Jobs				37	37	37	37	37	37	37
Golf Course Individual Income Tax Rev.				38,776	38,776	38,776	38,776	38,776	38,776	38,776
Average Income (Restaurant)				12,000	12,000	12,000	12,000	12,000	12,000	12,000
Deductions				5,020	5,020	5,020	5,020	5,020	5,020	5,020
Taxable Income				6,980	6,980	6,980	6,980	6,980	6,980	6,980
Income Tax Rate				8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Restaurant Individual Income Tax				611	611	611	611	611	611	611
Direct, Indirect & Induced Jobs				5	5	5	5	5	5	5
Restaurant Individual Income Tax Rev.				3,055	3,055	3,055	3,055	3,055	3,055	3,055

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
55,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	25,114,320
41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	711,127
40,694	50,998	61,302	71,606	81,910	92,214	128,456	130,900	133,344	143,731	143,731	143,731	143,731	1,416,824
04,725	115,376	122,475	124,250	124,250	124,250	124,250	124,250	124,250	124,250	124,250	124,250	124,250	1,660,200
13,824	18,432	23,040	27,648	32,256	36,864	41,472	46,080	50,688	55,296	59,904	66,816	66,816	552,960
56,790	1,482,352	1,504,364	1,521,051	1,535,963	1,550,875	1,591,725	1,598,777	1,605,829	1,620,824	1,625,432	1,632,344	1,632,344	29,655,431
24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	480,000
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	100,400
18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	18,980	379,600
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	1,661	33,220
756	756	756	756	756	756	756	756	756	756	756	756	756	
55,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	1,255,716	25,114,320
38,776	38,776	38,776	38,776	38,776	38,776	38,770	38,776	38,776	38,776	38,776	38,776	38,776	659,192
3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	51,935
41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	41,831	711,127
17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	289,000
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	85,340
11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	203,660
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	1,048	17,816
37	37	37	37	37	37	37	37	37	37	37	37	37	
38,776	38,776	38,776	38,776	38,776	38,776	38,776	38,776	38,776	38,776	38,776	38,776	38,776	659,192
2,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
611	611	611	611	611	611	611	611	611	611	611	611	611	
5	5	5	5	5	5	5	5	5	5	5	5	5	
3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	3,055	51,935

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Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Schedule C-3: Commercial Individual Income Tax Revenue										
Retail Individual Income Tax						7,860	15,720	23,580	31,440	39,300
Restaurant Individual Income Tax						2,444	4,888	7,332	9,776	12,220
Banking Individual Income Tax						5,238	5,238	5,238	5,238	5,238
Health, Professionals Individual Income Tax						4,544	4,544	4,544	4,544	4,544
Total Commercial Individual Income Tax Revenue						20,086	30,390	40,694	50,998	61,302
Commercial Center Individual Income Tax										
Average Income (Retail)						14,000	14,000	14,000	14,000	14,000
Deductions						5,020	5,020	5,020	5,020	5,020
Taxable Income						8,980	8,980	8,980	8,980	8,980
Income Tax Rate						8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Retail Individual Income Tax						786	786	786	786	786
Direct, Indirect & Induced Jobs						10	20	30	40	50
Retail Individual Income Tax						7,860	15,720	23,580	31,440	39,300
Average Income (Restaurant)						12,000	12,000	12,000	12,000	12,000
Deductions						5,020	5,020	5,020	5,020	5,020
Taxable Income						6,980	6,980	6,980	6,980	6,980
Income Tax Rate						8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Restaurant Individual Income Tax						611	611	611	611	611
Direct, Indirect & Induced Jobs						4	8	12	16	20
Restaurant Individual Income Tax						2,444	4,888	7,332	9,776	12,220
Average Income (Auto Repair)						15,000	15,000	15,000	15,000	15,000
Deductions						5,020	5,020	5,020	5,020	5,020
Taxable Income						9,980	9,980	9,980	9,980	9,980
Income Tax Rate						8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Auto Repair Individual Income Tax						873	873	873	873	873
Direct, Indirect & Induced Jobs						6	6	6	6	6
Auto Repair Individual Income Tax						5,238	5,238	5,238	5,238	5,238
Average Income (Health, Professional)						18,000	18,000	18,000	18,000	18,000
Deductions						5,020	5,020	5,020	5,020	5,020
Taxable Income						12,980	12,980	12,980	12,980	12,980
Income Tax Rate						8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Health, Professional Individual Income Tax						1,136	1,136	1,136	1,136	1,136
Direct, Indirect & Induced Jobs						4	4	4	4	4
Health, Professional Individual Income Tax						4,544	4,544	4,544	4,544	4,544
Schedule C-4: Schools Individual Income Tax Revenue										
Schools Consumption										
Average Income (Schools)					25,300	25,300	25,300	25,300	25,300	25,300
Deductions					5,020	5,020	5,020	5,020	5,020	5,020
Taxable Income					20,280	20,280	20,280	20,280	20,280	20,280
Income Tax Rate					8.75%	8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Schools Individual Income Tax					1,775	1,775	1,775	1,775	1,775	1,775
Direct, Indirect & Induced Jobs					48	52	55	59	65	69
Schools Individual Income Tax					85,200	92,300	97,625	104,725	115,375	122,475

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
23,580	31,440	39,300	47,160	55,020	62,880	96,678	96,678	96,678	96,678	96,678	96,678	96,678	959,706
7,332	9,776	12,220	14,664	17,108	19,552	21,996	24,440	26,884	37,271	37,271	37,271	37,271	310,388
5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	78,570
4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	68,160
40,694	50,998	61,302	71,606	81,910	92,214	128,456	130,900	133,344	143,731	143,731	143,731	143,731	1,416,824
14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
8,980	8,980	8,980	8,980	8,980	8,980	8,980	8,980	8,980	8,980	8,980	8,980	8,980	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
786	786	786	786	786	786	786	786	786	786	786	786	786	
30	40	50	60	70	80	123	123	123	123	123	123	123	
23,580	31,440	39,300	47,160	55,020	62,880	96,678	96,678	96,678	96,678	96,678	96,678	96,678	959,706
12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	6,980	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
611	611	611	611	611	611	611	611	611	611	611	611	611	
12	16	20	24	28	32	36	40	44	61	61	61	61	
7,332	9,776	12,220	14,664	17,108	19,552	21,996	24,440	26,884	37,271	37,271	37,271	37,271	310,388
15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
9,980	9,980	9,980	9,980	9,980	9,980	9,980	9,980	9,980	9,980	9,980	9,980	9,980	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
873	873	873	873	873	873	873	873	873	873	873	873	873	
6	6	6	6	6	6	6	6	6	6	6	6	6	
5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	5,238	78,570
18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
12,980	12,980	12,980	12,980	12,980	12,980	12,980	12,980	12,980	12,980	12,980	12,980	12,980	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	
4	4	4	4	4	4	4	4	4	4	4	4	4	
4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	4,544	68,160
25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
20,280	20,280	20,280	20,280	20,280	20,280	20,280	20,280	20,280	20,280	20,280	20,280	20,280	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775	1,775	
59	65	69	70	70	70	70	70	70	70	70	70	70	
104,725	115,375	122,475	124,250	124,250	124,250	124,250	124,250	124,250	124,250	124,250	124,250	124,250	1,860,200

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Schedule C-5: Services Personal Individual Income Tax Revenue	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Services Personal Consumption											
Average Income (Services Personal)							13,800	13,800	13,800	13,800	13,800
Deductions							5,020	5,020	5,020	5,020	5,020
Taxable Income							8,780	8,780	8,780	8,780	8,780
Income Tax Rate							8.75%	8.75%	8.75%	8.75%	8.75%
Ave. Services Personal Individual Income Tax							768	768	768	768	768
Direct, Indirect & Induced Jobs							6	12	18	24	30
Services Personal Individual Income Tax							4,608	9,216	13,824	18,432	23,040

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
3,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	13,800	
5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	5,020	
8,780	8,780	8,780	8,780	8,780	8,780	8,780	8,780	8,780	8,780	8,780	8,780	8,780	
8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	8.75%	
768	768	768	768	768	768	768	768	768	768	768	768	768	
18	24	30	36	42	48	54	60	66	72	78	87	87	
3,824	18,432	23,040	27,648	32,256	36,864	41,472	46,080	50,688	55,296	59,904	66,816	66,816	552,960

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Schedule D: County Real Property Tax Revenue	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Affordable		152,320	255,136	332,248	405,552	480,760	580,720	683,536	765,408	799,680	830,144	8
Resident Market		78,753	173,689	255,621	351,858	449,395	589,849	725,101	797,929	894,166	983,901	1,0
Non-Resident Market		88,018	99,807	10,175	11,951	12,113	17,442	16,796	9,044	11,951	11,144	
Commercial		0	0	0	0	97,325	150,450	203,675	256,700	320,450	320,450	3
Total County Real Property Tax		319,090	528,632	598,043	769,361	1,039,593	1,338,461	1,629,008	1,829,081	2,026,247	2,145,638	2,2

Schedule D-1: Affordable Unit Real Property Tax Revenue	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Affordable Average Sales Price	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	10
Plus Ave. HFDC Price	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	3
Less Discount on Land (20% x 45,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	
Affordable Average Sales Price	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	13
Homeowner exemption	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	2
Taxable Value	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	11
Tax Rate	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
Average Real Property Tax	952	952	952	952	952	952	952	952	952	952	
Affordable Units	160	108	81	77	79	105	108	86	36	32	
Cumulative Affordable Units	160	268	349	426	505	610	718	804	840	872	
Affordable Unit Real Property Tax Revenue	152,320	255,136	332,248	405,552	480,760	580,720	683,536	765,408	799,680	830,144	87

Schedule D-2: Resident Market Unit Real Property Tax Revenue	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Resident Market Average Sales Price	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	19
Homeowner exemption	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	2
Taxable Value	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	17
Tax Rate	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
Average Real Property Tax	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	
Market Units	109	73	63	74	75	108	104	56	74	69	
% Resident	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Resident Units	55	66	57	67	68	97	94	50	67	62	
Cumulative Resident Units	55	120	177	244	311	408	502	552	619	681	
Resident Market Unit Real Property Tax Revenue	78,753	173,689	255,621	351,858	449,395	589,849	725,101	797,929	894,166	983,901	1,074

Schedule D-3: Non-resident Market Unit Real Property Tax Revenue	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Non-resident Market Average Sales Price	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190
Homeowner exemption	0	0	0	0	0	0	0	0	0	0	
Taxable Value	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190
Tax Rate	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0
Average Real Property Tax	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1
Market Units	109	73	63	74	75	108	104	56	74	69	
% Non-resident	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	
Non-resident Units	55	7	6	7	8	11	10	6	7	7	
Cumulative Non-resident Units	55	62	68	76	83	94	104	110	117	124	
Non-resident Market Unit Real Property Tax Revenue	88,018	99,807	10,175	11,951	12,113	17,442	16,796	9,044	11,951	11,144	11

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
765,408	799,680	830,144	870,128	944,384	1,043,392	1,130,976	1,210,944	1,283,296	1,351,840	1,420,384	1,488,928	1,557,472	17,587,248
797,929	894,166	983,901	1,074,936	1,172,473	1,294,720	1,407,864	1,504,101	1,573,027	1,716,082	1,859,137	1,993,089	2,108,833	21,004,520
9,044	11,951	11,144	11,305	12,113	15,181	14,051	11,951	8,560	17,765	17,765	16,635	14,374	428,137
256,700	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	4,553,450
829,081	2,026,247	2,145,638	2,276,819	2,449,420	2,673,743	2,873,340	3,047,446	3,185,333	3,406,137	3,617,736	3,819,101	4,001,129	43,573,355

105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	105,000	
36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	
(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	(9,000)	
132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	
20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	112,000	
0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
952	952	952	952	952	952	952	952	952	952	952	952	952	
88	36	32	42	78	104	92	84	76	72	72	72	72	1,636
804	840	872	914	992	1096	1188	1272	1348	1420	1492	1564	1636	18,474
765,408	799,680	830,144	870,128	944,384	1,043,392	1,130,976	1,210,944	1,283,296	1,351,840	1,420,384	1,488,928	1,557,472	17,587,248

190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	
20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	170,000	
0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	1,445	
56	74	69	70	75	94	87	74	53	110	110	103	89	1,670
50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	
50	67	62	63	68	85	78	67	48	99	99	93	80	1,459
552	619	681	744	811	896	974	1041	1089	1188	1287	1379	1459	
797,929	894,166	983,901	1,074,936	1,172,473	1,294,720	1,407,864	1,504,101	1,573,027	1,716,082	1,859,137	1,993,089	2,108,833	21,004,520

190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	
0	0	0	0	0	0	0	0	0	0	0	0	0	
190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	
0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,615	1,616	1,616	1,616	
56	74	69	70	75	94	87	74	53	110	110	103	89	1,670
50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%	
6	7	7	7	8	9	9	7	5	11	11	10	9	211
110	117	124	131	139	148	157	164	169	180	191	202	211	421
9,044	11,951	11,144	11,305	12,113	15,181	14,051	11,951	8,560	17,765	17,765	16,635	14,374	428,137

[illegible] MASTER PLAN
PUBLIC REVENUES AND COSTS
For the Years 1992 - 2011

File Name: RE/FINAL.WK1
Date: [illegible]
Time: [illegible] AM

	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Schedule D-4: Commercial Real Property Tax Revenue												
Site Improvements/Acre						208,000						
Acres						25						
Infrastructure Development						5,200,000						
Construction Cost/Sq.Ft.						125	125	125	125	125		
Sq.Ft.						50,000	50,000	50,000	50,000	60,000		
Construction Development						6,250,000	6,250,000	6,250,000	6,250,000	7,500,000		
Infrastructure & Construction						11,450,000	6,250,000	6,250,000	6,250,000	7,500,000		
Cumulative Taxable Value						11,450,000	17,700,000	23,950,000	30,200,000	37,700,000	37,700,000	37,700,000
Tax Rate						0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%
Commercial Real Property Tax Revenue						97,325	150,450	203,575	256,700	320,450	320,450	320,450

CORRECTION

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

KEALAKEHE MASTER PLAN
PUBLIC REVENUES AND COSTS
For the Years 1992 – 2011

File Name: REVFINAL.WK1
Date: 09/10/90
Time: 12:00 AM

Schedule D–4: Commercial Real Property Tax Revenue	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Site Improvements/Acre						200,000						
Acres						26						
Infrastructure Development						5,200,000						
Construction Cost/Sq.Ft.						125	125	125	125	125		
Sq.Ft.						50,000	50,000	50,000	50,000	60,000		
Construction Development						6,250,000	6,250,000	6,250,000	6,250,000	7,500,000		
Infrastructure & Construction						11,450,000	6,250,000	6,250,000	6,250,000	7,500,000		
Cumulative Taxable Value						11,450,000	17,700,000	23,950,000	30,200,000	37,700,000	37,700,000	37,70
Tax Rate						0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
Commercial Real Property Tax Revenue						97,325	150,450	203,575	256,700	320,450	320,450	32

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
													200,000
													26
													5,200,000
125	125												
50,000	60,000												625
250,000	7,500,000												260,000
250,000	7,500,000												32,500,000
200,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	37,700,000	
0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	0.85%	
256,700	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	320,450	4,553,450

KEALAKEHE MASTER PLAN
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Schedule E: Public Operating Revenues

Public Operating Revenues	Est. FY90 Budget	Schedule Est. FY90 Per Household	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Res., Apt. & Commercial													
Improved Residential	12,660,000	310											
Apartment	7,778,000	190											
Commercial	3,584,000	88											
Total Res., Apt. & Commercial	24,022,000	588											
Real Property Taxes – Other													
Industrial	1,999,000	49	13,181	22,050	29,694	38,857	48,167	61,544	74,284	81,242	90,160	98,588	106,967
Agricultural	14,041,000	344	92,536	154,800	208,464	272,792	338,152	432,064	521,504	570,352	632,960	692,128	750,952
Conservation	1,064,000	26	6,994	11,700	15,756	20,618	25,558	32,656	39,416	43,108	47,840	52,312	56,758
Hotel/Resort	6,595,000	161	43,309	72,450	97,566	127,673	158,263	202,216	244,076	266,938	296,240	323,932	351,463
Unimproved Residential	2,358,000	58	15,602	26,100	35,148	45,994	57,014	72,848	87,928	96,164	106,720	116,696	126,614
Reconcile Tax Found. & County	866,000												
Total Real Prop. – Other	26,923,000		171,622	287,100	386,628	505,934	627,154	801,328	967,208	1,(57,804	1,173,920	1,283,656	1,392,754
Total Real Prop. County	50,945,000												
Fuel & Utility													
Fuel Tax	2,560,879	63	16,947	28,350	38,178	49,959	61,929	79,128	95,508	104,454	115,920	126,756	137,529
Fuel Tax Increase	2,038,184	50	13,450	22,500	30,300	39,650	49,150	62,800	75,800	82,900	92,000	100,600	109,150
Public Utility Franchise Tax	1,820,500	45	12,105	20,250	27,270	35,685	44,235	56,520	68,220	74,610	82,800	90,540	98,235
Total Fuel & Utility	6,419,563		42,502	71,100	95,748	125,294	155,314	198,448	239,528	261,964	290,720	317,896	344,914
Licenses and Permits	4,290,770	105	28,245	47,250	63,630	83,265	103,215	131,880	159,180	174,090	193,200	211,260	229,215
Money & Prop. (not included)	2,714,800	66											
Intergovernmental Revenues	20,830,954	510	137,190	229,478	309,030	404,390	501,281	640,497	773,084	845,497	938,308	1,026,020	1,113,221
Charges for Services	2,368,160	58	15,602	26,088	35,132	45,973	56,988	72,815	87,888	96,120	106,671	116,643	126,556
Other Revenues	5,059,278	124	33,356	55,734	75,055	98,216	121,748	155,560	187,761	205,349	227,890	249,193	270,371
Fund Bal. (not included)	3,374,016												
Total Public Operating Rev.	96,002,541	2350	214,393	358,550	482,847	631,844	783,232	1,000,752	1,207,914	1,321,056	1,466,069	1,603,115	1,739,364
No. of Units			269	181	156	187	190	273	260	142	182	172	171
Cumulative No. of Units			269	450	606	793	983	1256	1516	1658	1840	2012	2183
County Population	40,849												

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
81,242	90,160	98,588	106,967	116,130	127,547	138,180	147,245	153,566	166,894	180,222	192,766	203,742	2,091,076
70,352	632,960	692,128	750,952	815,280	895,432	970,080	1,033,720	1,078,096	1,171,664	1,265,232	1,353,296	1,430,352	14,680,200
43,108	47,840	52,312	56,758	61,620	67,678	73,320	78,130	81,484	88,556	95,628	102,284	108,108	1,109,650
66,938	296,240	323,932	351,463	381,570	419,083	454,020	483,805	504,574	548,366	592,158	633,374	669,438	6,870,676
96,164	106,720	116,696	126,614	137,460	150,974	163,560	174,290	181,772	197,548	213,324	228,172	241,164	2,475,160
57,804	1,173,920	1,283,656	1,392,754	1,512,060	1,660,714	1,799,160	1,917,190	1,999,492	2,173,028	2,346,564	2,509,892	2,652,804	27,226,012
04,454	115,920	126,756	137,529	149,310	163,989	177,660	189,315	197,442	214,578	231,714	247,842	261,954	2,688,525
82,900	92,000	100,600	109,150	118,500	130,150	141,000	150,250	156,700	170,300	183,900	196,700	207,900	2,133,750
74,610	82,800	90,540	98,235	106,650	117,135	126,900	135,225	141,030	153,270	165,510	177,030	187,110	1,920,375
61,964	290,720	317,896	344,914	374,460	411,274	445,560	474,790	495,172	538,148	581,124	621,672	656,964	6,742,650
74,090	193,200	211,260	229,215	248,850	273,315	296,100	315,525	329,070	357,630	386,190	413,070	436,590	4,480,875
45,497	938,308	1,026,020	1,113,221	1,208,582	1,327,400	1,438,059	1,532,400	1,598,184	1,736,890	1,875,597	2,006,144	2,120,373	21,762,136
96,120	106,671	116,643	126,556	137,397	150,905	163,485	174,210	181,689	197,458	213,227	228,068	241,054	2,474,027
05,349	227,890	249,193	270,371	293,532	322,390	349,266	372,179	388,156	421,844	455,532	487,238	514,981	5,285,474
21,056	1,466,069	1,603,115	1,739,364	1,888,361	2,074,010	2,246,911	2,394,314	2,497,099	2,713,822	2,930,545	3,134,520	3,312,998	34,002,512
142	182	172	171	187	233	217	185	129	272	272	256	224	4,158
1658	1840	2012	2183	2370	2603	2820	3005	3134	3406	3678	3934	4158	42,674

KEALAKEHE MASTER PLAN
PUBLIC REVENUES AND COSTS
For the Years 1992 – 2011

File Name: REVFINAL.WK1
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	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Schedule F: Public Operating Costs												
State Public Operating Costs		0	0	0	0	1,578,720	1,710,280	1,808,950	1,940,510	2,137,850	2,269,410	2,302
County Public Operating Costs		577,274	965,700	1,300,476	1,701,778	2,109,518	2,695,376	3,253,336	3,558,068	3,948,640	4,317,752	4,684
Total State & County Public Operating Costs		577,274	965,700	1,300,476	1,701,778	3,688,238	4,405,656	5,062,286	5,498,578	6,086,490	6,587,162	6,987
Schedule F-1: State Public Operating Costs												
Average Salary (Schools)						25,300	25,300	25,300	25,300	25,300	25,300	25
Benefits (30%)						7590	7590	7590	7590	7590	7590	
Total Average Salary and Benefits						32890	32890	32890	32890	32890	32890	3
Direct, Indirect & Induced Jobs						48	52	55	59	65	69	
State Public Operating Costs – Salaries						1,578,720	1,710,280	1,808,950	1,940,510	2,137,850	2,269,410	2,302

Schedule F-2: County Public Operating Costs

	Est. FY90 Budget	Est. FY90 Per Household	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
General Government	14,332,164	351	94,419	157,950	212,706	278,343	345,033	440,856	532,116	581,958	645,840	706,212	768
Public Safety	34,075,014	834	224,346	375,300	505,404	661,362	819,822	1,047,504	1,264,344	1,382,772	1,534,560	1,678,008	1,820,
Highways	6,738,874	165	44,385	74,250	99,990	130,845	162,195	207,240	250,140	273,570	303,600	331,980	360,
Sanitation and Waste Removal	4,237,651	104	27,976	46,800	63,024	82,472	102,232	130,624	157,664	172,432	191,3[illegible]	[illegible]	227,
Health, Education and Welfare	3,907,164	96	25,824	43,200	58,176	76,128	94,368	120,576	145,536	159,168	[illegible]		209,
Culture and Recreation	7,299,374	179	48,151	80,550	108,474	141,947	175,957	224,824	271,364	296,782		[illegible]	390,
Debt Service (not included)	8,357,492	205											
Pension & Retirement	2,592,182	63	16,947	28,350	38,178	49,959	61,929	79,128	95,508	104,4[illegible]	115,920	126,756	137,
Health Fund	3,314,000	81	21,789	36,450	49,086	64,233	79,623	101,736	122,796	134,[illegible]	149,040	162,972	176,
Miscellaneous	11,148,626	273	73,437	122,850	165,438	216,489	268,359	342,888	413,868	45[illegible],634	502,320	549,276	595,
Total Public Operating Costs	96,002,541		577,274	965,700	1,300,476	1,701,778	2,109,518	2,695,376	3,253,336	3,558,068	3,948,640	4,317,752	4,684,
No. of Units			269	181	156	187	190	273	260	142	182	172	
Cumulative No. of Units			269	450	606	793	983	1256	[illegible]	1658	1840	2012	2
County Population	40,849												

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
940,510	2,137,850	2,269,410	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	
558,068	3,948,640	4,317,752	4,684,718	5,086,020	5,586,038	6,051,720	6,448,730	6,725,564	7,309,276	7,892,988	8,442,364	8,923,068	
498,578	6,086,490	6,587,162	6,987,018	7,388,320	7,888,338	8,354,020	8,751,030	9,027,864	9,611,576	10,195,288	10,744,664	11,225,368	126,047,124
25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	25,300	
7590	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590	7590	
32890	32890	32890	32890	32890	32890	32890	32890	32890	32890	32890	32890	32890	
59	65	69	70	70	70	70	70	70	70	70	70	70	
940,510	2,137,850	2,269,410	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	2,302,300	34,468,720
581,958	645,840	706,212	766,233	831,870	913,653	989,820	1,054,755	1,100,034	1,195,506	1,290,978	1,380,834	1,459,458	14,978,926
382,772	1,534,560	1,678,008	1,820,622	1,976,580	2,170,902	2,351,880	2,506,170	2,613,756	2,840,604	3,067,452	3,280,956	3,467,772	35,590,950
273,570	303,600	331,980	360,195	391,050	429,495	465,300	496,825	517,110	561,990	606,870	649,110	686,070	7,041,376
172,432	191,3[illegible]	[illegible]	227,032	246,480	270,712	293,280	312,520	325,936	354,224	382,512	409,136	432,432	4,438,200
159,168	[illegible]		209,568	227,520	249,888	270,720	288,480	300,864	326,976	353,088	377,664	399,168	4,096,800
296,782			390,757	424,230	465,937	504,780	537,895	560,966	609,674	658,362	704,186	744,282	7,638,825
104,45[illegible]	115,920	126,756	137,529	149,310	163,989	177,660	189,315	197,442	214,578	231,714	247,842	261,954	2,688,526
134,[illegible]98	149,040	162,972	176,823	191,970	210,843	228,420	243,405	253,854	275,886	297,918	318,654	336,798	3,456,675
452,634	502,320	549,276	595,959	647,010	710,619	769,860	820,365	855,582	929,838	1,004,094	1,073,982	1,135,134	11,650,275
558,068	3,948,640	4,317,752	4,684,718	5,086,020	5,586,038	6,051,720	6,448,730	6,725,564	7,309,276	7,892,988	8,442,364	8,923,068	91,578,404
142	182	172	171	187	233	217	185	129	272	272	256	224	4,158
1658	1840	2012	2183	2370	2603	2820	3005	3134	3406	3678	3934	4158	42,674

KEALAKEHE MASTER PLAN
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File Name: REVFINAL.WK1
Date: 09/10/90
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	Schedule	YEAR 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
Schedule A: State General Excise Tax (GET) Revenue												
Development		0	0	900,000	2,600,000	553,280	250,000	250,000	250,000	300,000	0	9
Operations		0	0	0	43,200	45,120	509,040	695,760	882,480	1,069,200	1,255,920	1,44
Personal Consumption		348,516	348,516	348,516	361,728	385,056	395,312	401,970	409,114	417,230	424,374	43
Total GET		348,516		1,248,516	3,004,928	983,456	1,154,352	1,347,730	1,541,594	1,786,430	1,680,294	1,96
Schedule A-1: Development General Excise Tax Revenue												
Golf Course Development GET		0	0	900,000	0	0	0	0	0	0	0	
Commercial Construction GET		0	0	0	0	458,000	250,000	250,000	250,000	300,000	0	
School Development GET		0	0	0	2,600,000	0	0	0	0	0	0	
Church/Child Care Development GET		0	0	0	0	95,280	0	0	0	0	0	9
Total Development GET		0	0	900,000	2,600,000	553,280	250,000	250,000	250,000	300,000	0	9
Golf Course Development GET												
Construction Cost				22,500,000								
GET Rate				4%								
Golf Course Development GET				900,000								
Commercial Development GET												
Site Improvement/Acre						200,000						
Acres						26						
Commercial Development						5,200,000						
GET Rate						4%						
Commercial Site Devevelopment GET						208,000						
Construction Cost/Sq.Ft.						125	125	125	125	125		
Sq.Ft.						50,000	50,000	50,000	50,000	60,000		
Construction Development						6,250,000	6,250,000	6,250,000	6,250,000	7,500,000		
GET Rate						4%	4%	4%	4%	4%		
Construction GET						250,000	250,000	250,000	250,000	300,000		
Commercial Development GET						458,000	250,000	250,000	250,000	300,000		
School Development GET												
Construction Development					65,000,000							
GET Rate					4%							
School Development GET					2,600,000							

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
250,000	300,000	0	95,280	0	0	0	0	0	0	0	0	0	5,198,560
882,480	1,069,200	1,255,920	1,442,640	1,629,360	1,816,080	2,002,800	2,189,520	2,376,240	2,470,560	2,472,480	2,474,400	2,402,400	25,777,200
409,114	417,230	424,374	430,060	435,260	440,460	454,537	457,047	459,557	465,057	466,647	469,032	469,032	8,387,021
541,594	1,786,430	1,680,294	1,967,980	2,064,620	2,256,540	2,457,337	2,646,567	2,835,797	2,935,617	2,939,127	2,943,432	2,871,432	39,362,781
0	0	0	0	0	0	0	0	0	0	0	0	0	900,000
250,000	300,000	0	0	0	0	0	0	0	0	0	0	0	1,508,000
0	0	0	0	0	0	0	0	0	0	0	0	0	2,600,000
0	0	0	95,280	0	0	0	0	0	0	0	0	0	190,560
250,000	300,000	0	95,280	0	0	0	0	0	0	0	0	0	5,198,560
													22,500,000
													900,000
													200,000
													26
													5,200,000
													208,000
125	125												625
50,000	60,000												260,000
50,000	7,500,000												32,500,000
4%	4%												
50,000	300,000												1,300,000
50,000	300,000												1,508,000
													2,600,000